Globalization of the Automotive Industry: Is Indonesia Missing Out?*

Moekti P. Soejachmoen
Mandiri Institute
Plaza Bapindo, Mandiri Tower 18th floor
Jl Jend. Sudirman Kav 54-55
Jakarta 12190, Indonesia
moekti.soejachmoen@bankmandiri.co.id

Abstract

International trade in automotive and auto parts has grown rapidly during the last two decades but Southeast Asia's largest economy, Indonesia, is lagging behind in its export performance. This paper uses a comparative perspective in examining Indonesia's role in automotive production networks in the context of the contemporary debate on opportunities for reaping gains from economic globalization through engagement in global production sharing.

This research aims to answer two questions; the first addresses the determinants of a country's participation in the global production network, the second asks why Indonesia is being left behind in global production networks. Our analysis is based on the Jones and Kierzkowski fragmentation theory. The unbalanced panel trade data for 98 countries for the period 1988–2007 are estimated using the least square dummy variable method. The results show that in Asian countries, foreign direct investment openness is the most important determinant followed by trade cost, trade openness, competitiveness, and labor quality. Indonesia is being left behind for a number of reasons, such as restrictive foreign investment policies, higher trade costs and remaining high protection in the automotive sector in terms of tariff and non-tariff measure, and a low education level that hampers the absorption capacity in technology.

1. Introduction

International trade in automotive and auto parts has been growing rapidly in the last two decades. Globally, auto parts trade increased from US$ 109 billion in 1988 to almost US $680 billion in 2007, with an annual growth of 8.7 percent, which reflects the higher intensity of global production networks in the automotive industry. There is a shift in a

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global production pattern from the North America and European countries' dominance in the1960s to Japanese dominance in the 1970s and 1980s. And for the last 20 years, some Asian countries such as Japan, China, South Korea, and Thailand have increased their production shares in the global market.

The participation of developing countries in the automotive industry was made possible by technology developments and innovations in telecommunication and transportation, which enabled the automotive industry to fragment its production process into smaller segments in which components of productions or assemblies can be relocated to different places based on cost advantages. The relocation of segmented production process creates global production networks. Indonesia, as the largest economy in Southeast Asia, seems to be missing out on the opportunity to reap gains from globalization in the automotive industry, however.

Using a comparative perspective, this paper examines Indonesia's role in automotive production networks in the context of the contemporary debate on accessing the gains from economic globalization through engagement in global production networks. The automotive industry is one of the biggest in the world and employs more than 8 million people making vehicles directly, and more than 40 million people indirectly through related manufacture and services sectors. In principle, the automotive industry is an assembly industry, where more than one thousand parts and components (P&C) are produced by independent industries.

This paper provides a new contribution to the empirical studies on global production networks. While the existing studies focus on selected countries and group of countries, this research covers 98 countries with a share of manufactured exports of more than 0.01 percent and over longer period (1988–2007). This benchmark is used to make sure there is no selection bias and that all counties in this data set export auto parts.

Section 2 reviews the literature on the product fragmentation. Section 3 discusses the development of automotive global production networks in general, followed by a discussion on Indonesia's participation in the global production networks. Section 4 develops an analytical framework for examining the factors affecting a country's participation in the global production networks. Section 5 discusses the definition of the variables and the data sources. Estimation results are reported in Section 6, and Section 7 concludes.

2. Product fragmentation

A production network is a nexus of inter-connected functions and operations through which goods and services are produced, distributed, and consumed (Henderson et al. 2002). A global production network takes place when an industry can fragment its production process into smaller segments, thus enabling components of production or assemblies to be relocated in several countries with a vertically integrated production process. Global production networks are also known as "international production sharing" (Ng and Yeats 2001), "distributed manufacturing", or "dispersed manufacturing" (Cheng and Kierzkowski 2001).

Initially, all production processes were conducted in one place as a single integrated production block. Technology developments, however, together with innovations in telecommunications and transportation, promoted the development of a fragmented production process that consists of more than one production block. These production blocks are not independent, but are connected through service links such as transportation, design, quality control, insurance, research and development (R&D), telecommunications, and other services. Several patterns of interdependence between production blocks and service links can be envisaged. One possibility is that the output of one production block can become an input for another production block, while a more complex relationship among production blocks exists where there is a simultaneous operation of several production blocks and the output of each of these is assembled in the last production block. The degree of fragmentation can be measured by the number of stages or production blocks. As the degree of fragmentation increases, so does the importance of service links for connecting the different production blocks.

The fragmentation theory developed by Jones and Kierzkowski (1990) stated that product fragmentation is made possible by three key contributory factors. First is the development in production technology that enabled slicing the production process into different production blocks. Trade liberalization is second, and the advancement in communications and transportation that have contributed to the decline in the cost of service links is the third contributory factor.

Growth of a firm's output level, increasing returns to scale, and the advantages of specialization encourage a firm to switch a production process from a vertically integrated process to fragmented production blocks connected by service links. The service links include transportation, telecommunications, and various other coordination tasks, which are often subject to economies of scale.

Service links are essential for production networks to connect production blocks into one integrated production process. Following Kimura and Takahashi (2004) elements of service link costs can be categorized into four groups: trade costs, investment costs, communications costs, and coordination costs as shown in Table 1.

Trade costs are those costs related to the trade of parts and components (P&C) among production blocks, be it in the same firm or with other firms (arm's length firm), at the

Table 1. Elements of service link costs

Category	Subcategory	Details
Trade costs	transportation costs	shipment charge, freight charge
	policy barriers	tariff barriers: ad valorem tariff, specific tariff, non-tariff barriers (quotas, others)
	information costs	search costs for sellers or buyers, research costs for preference of foreigners
	costs associated with the use of different currencies	cost of exchange rate volatility, risk edge and uncertainty
	legal and regulatory costs	direct and indirect costs to deal with legal regulatory issues and procedures
	local distribution costs	cost to utilize local infrastructure, and to efficiently deliver goods to local consumers
	policy barriers	indirect cost due to prohibition to entry, absence of national treatment, and other FDI discriminated measures
Investment costs	information costs	search cost for suppliers
	contract enforcement costs	direct and indirect costs to ensure contract implementation
	legal and regulatory cost	direct and indirect costs for dealing with legal regulatory issues and procedures
Communications costs		telecommunications costs, Internet fees
Coordination costs	timeliness	indirect costs due to inadequateness of timely delivery
	uncertainty	indirect cost due to uncertainty regarding coordination of a series of activities from production to shipment of end products

Source: *Kimura and Takahashi (2004).*

domestic and international level. Most production blocks located in foreign countries are conducted through foreign direct investment (FDI); investment cost is therefore one category in total service link costs. Openness of FDI policies, especially in developing countries, is an important factor determining participation in global production networks. The other two categories are communications costs and coordination costs. Innovations in telecommunications have significantly reduced the communications costs and encouraged the development of production networks. Timeliness as one aspect in coordination costs becomes important as holding inventories is costly. "Just-in-time" technology, developed by Japanese production networks, has proven effective in holding down production costs. Therefore, infrastructure development is a crucial prerequisite for global production network participation as this is essential for "just-in-time" technology.

3. Globalization in the automotive industry

The automotive industry has experienced a transformation since its inception in the late 19th century, when France and Germany were the largest automotive producers but with small domestic markets (Simarmata 1997). Global automotive production experienced a change in the pattern of production as part of this transformation. Global production of automobiles was initially dominated by North America and European countries in 1960s. During the 1970s and 1980s, Japan showed dramatic development in automotive production, with an almost 55-fold increase in production and 15 percent annual growth—from only 1.3 percent in 1960 to 28 percent in 1989. In 2000, China started to enter global

Table 2. Rank of car production (unit), 2000–14

Rank	2000	2005	2010	2014
1	United States	United States	**China**	**China**
2	Japan	Japan	Japan	United States
3	Germany	Germany	United States	Japan
4	France	**China**	Germany	Germany
5	South Korea	South Korea	South Korea	South Korea
6	Spain	France	Brazil	India
7	Canada	Spain	India	Mexico
8	**China**	Canada	Spain	Brazil
9	Mexico	Brazil	Mexico	Spain
10	UK	UK	France	Canada
11	Italy	Mexico	Canada	Russia
12	Brazil	India	**Thailand**	**Thailand**
13	Russia	Russia	Iran	France
14	Belgium	**Thailand**	Russia	UK
15	India	Italy	UK	**Indonesia**
16	Poland	Belgium	Turkey	Czech Rep.
17	Czech Rep.	Turkey	Czech Rep.	Turkey
18	Turkey	Iran	Poland	Iran
19	**Thailand**	Poland	Italy	Slovakia
20	Taiwan	Czech Rep.	Argentina	Italy
21	South Africa	**Malaysia**	**Indonesia**	Argentine
22	Australia	South Africa	**Malaysia**	**Malaysia**
23	Argentina	Others	Slovakia	Poland
24	Sweden	**Indonesia**	South Africa	South Africa
25	**Indonesia**	Taiwan	Romania	Belgium
26	**Malaysia**	Australia	Belgium	Hungary
27	Iran	Sweden	Taiwan	Romania

Source: *OICA (http://www.oica.net).*

Notes*: Production includes cars and commercial cars.* ***Boldface*** *highlights the South Asian countries.*

automotive production with a relatively high level of production at more than 2 million units. This decreased the dominance of Germany, the United States, and Japan. Automobile production in the world reached its highest annual growth during the period 1989–2000, with almost 5 percent growth per annum. In 2000, Canada, South Korea, and Malaysia experienced higher growth in automobile production compared with other countries. This reflects the spread of technology from the United States and Japan to other countries. In 2014, China was still the biggest producer of cars in the world, with the annual growth rate decreasing from 23 percent in period 2000–07 to 15 percent in period 2007–14. Germany and Japan showed a negative growth rate of production in those periods, whereas Indonesia continued to increase its production—from around 400,000 cars in 2007 to more than 1.2 million cars in 2014 (as shown in Table 2).

The automotive industry has an extremely concentrated firm structure, with a small number of giant companies dominating global production. An important characteristic of auto parts is that there are few fully generic P&C that can be used in a wide variety of final products without extensive customization such as in the electronics industry. This characteristic limits auto parts firms from achieving economies of scale in production and economies of scope in design. The relationship between auto parts suppliers and car assemblers are typically captive and relational. Many components are larger and heavier than electronics P&C and therefore relocation to close proximity of producer is preferable to a more distant location.

East Asian countries contributed around 21–23 percent of autopart trade for the period 1988–2007. Among East Asian countries, Japan, China, South Korea, and Thailand are the major players in the auto parts trade. Japan's role in export share has declined over time, from 18 percent in 1989 to 9 percent in 2007, although it is still the largest exporter of auto parts in Asia. Meanwhile, China's export share increased from a low 0.6 percent in 1992 to more than 7 percent in 2007. Other countries in Asia that experienced an increase in export share are South Korea, Thailand, and Indonesia. South Korea's share increased from 1.5 percent in 1989 to 3 percent in 2007, and Thailand increased from only 0.2 percent in 1999 to 1.5 percent in 2007. Meanwhile, Indonesia's export shares are relatively modest, from 0.2 percent in 1992 to 0.5 percent in 2007.

For the last 20 years, the value of the auto parts trade has increased four-fold, from around US$ 165 billion in 1990 to US$ 680 billion 2010. Japan was the largest exporter of auto parts in Asia during this period, with an increase in export value from around US$ 27 billion in 1990 to more than US$ 61 billion in 2008. Indonesia's position in the export of auto parts was ninth throughout the period, with a substantial increase in export value from only US$ 112 million in 1990 to almost US$ 3.5 billion in 2008. Thailand also experienced a substantial increase in its export value, from US$ 312 million in 1990 to almost US$ 10 billion in 2008. This impressive performance makes Thailand one of the major hubs in the regional automotive production network.

As expected, the major export destination countries for Indonesia and Thailand are Japan and the United States, followed by other ASEAN countries. The destination for Indonesia's exports has changed from 1990 to 2010. In the 1990s, the major destination was Singapore, not because Singapore has car assembler firms but because Indonesia used Singapore as an entrepôt for export to other countries. Since 2001, however, the main destination of Indonesian export has been Japan and the United States, followed by other ASEAN countries such as Thailand, Malaysia, Singapore, and the Philippines.

In comparison, Thailand's major export destinations are Japan and the United States. In the 1990s, the first destination was the United States, but from 2001 onward, Japan replaced the United States as Thailand's first export destination, followed by other ASEAN countries such as Malaysia and Indonesia. In addition, Thailand also exports auto parts to more distant countries such as India and Brazil. Considering the size and weight of auto parts compared with electronics parts and components, export of parts to relatively distant countries reflects the importance of Thailand as a hub in regional and global automotive production networks. The increased intensity of intra-Asian trade reflects the higher degree of global production networks in Asian countries.

4. Model

The empirical model used in this paper is based on Jones and Kierzkowski's (1990) fragmentation theory. The hypothesis is that this participation depends on relative costs as well as service link costs. Relative costs are measured by the labor cost and real exchange rate (RER). The service link costs are measured by the trade cost, infrastructure condition, trade openness, and FDI openness. The full specification of the model can be written as follows:

$$\ln Frag_{i,t} = \alpha + \beta_1 \ln Lab\_Cost_{i,t} + \beta_2 \ln RER_{i,t} + \beta_3 Trade\_Cost_i + \beta_4 Trade\_Open_{i,t} \\ + + \beta_5 Infrastructure_i + \beta_6 FDI\_Open_{i,t} + \varphi_1 C + \tau_t T + \varepsilon_{i,t}, \quad (1)$$

where subscript i represents the ith country, $i = 1, 2, \ldots, 98$, and t represent the year, $t = 1988, 1989, \ldots, 2007$. $Frag_{i,t}$ is fragmentation trade, which is measured by the real value of exports of P&C. Labor cost (*Lab_Cost)* has a positive expected sign based on the new trade and fragmentation theory whereby a higher-quality product requires higher capital-intensity in production and in an open-economy the capital-rich country will export high-quality products whereas the labor-rich country will export low-quality product. The higher capital intensity products require higher skill labor, which implies higher cost of labor.

Product competitiveness is measured by the *RER*. Traditionally, the appreciation of domestic currency raises the cost of imports and lowers that of exports. In production networks, however, the relationship can be reversed. The response of a country's exports to a change in the exchange rates should decline as the share of the imported components of its exports rises. Therefore, the relationship between changes in *RER* and trade will be smaller in the presence of production networks.

Fragmentation trade depends significantly on service links that connect the production blocks and ensure that the production blocks interact effectively. Trade cost (*Trade_Cost)* is crucial in determining the flow of goods between countries, especially in the fragmentation trade because of the double trade-cost incidence of exporting components and re-importing them (or vice versa). Labor abundant countries that have low trade costs import components and export assembled products, whereas countries with higher trade costs import and assemble components for the local market only. A lower trade cost will increase the trade flows in a country, and therefore the expected sign is negative.

Trade openness (*Trade_Open)* has a positive expected sign because a country with a more open trade flow is expected to have greater participation in the global production networks as it will be easier for the firms to move the auto parts across plants in different countries. An efficient infrastructure (*Infrastructure*) affects both communication and coordination costs. This includes reliable and affordable telecommunications and electricity, roads in good conditions, as well as reliable and efficient port management. FDI openness (*FDI_Open)* is crucial because foreign producers are willing to bring the latest technology when it is possible to have full foreign ownership in the country. Two dummy variables are included in the model. First, the country dummy variable (*C*) captures the unobserved country differences such as geographical location and historical involvement in the global production networks. Second, the year dummy variable (*T*) controls for time-varying factors relating to auto parts such as technology and price changes.

5. Data

The model covers 98 countries that had more than 0.01 percent share of world manufactured goods export in 2007. The cutoff using the share of manufactured export was chosen to avoid a selection bias problem. The data set was assembled from six different databases: UN COMTRADE, ILO Laborsta, Index of Doing Business, UNCTAD database, World Development Indicators (WDI), and the Logistic Performance Index by the World Bank. The initial year is 1988, because it is the first year the UN COMTRADE database started reporting under SITC Revision 3, on which the commodity listing of P&C in this study is based. The end point is 2007, because this was the latest year for which data for most of the variables are available, while the data for 2008–09 are liable to have been affected by the 2008–09 global financial crisis.

The dependent variable (*Frag)* is the real value of export of P&C sourced from the UN COMTRADE database. The real value is derived using the U.S. import price index for automotives. For the automotive sector, the list of P&C has been modified from Athukorala's list (2011) by including other P&C, which are considered to be auto parts by the Japan Auto Parts Industries Association (JAPIA) and the Indonesian Automotive P&C Industries Association (GIAMM). Additional P&C goods include tires, safety glass, automotive electronics parts, brakes, and safety airbags. The complete list of P&C in the automotive sectors is provided in Appendix A.

Labor cost (*Lab_Cost)* is represented by real wage, which is calculated from the nominal manufacturing wages in US$ deflated by the U.S. Wholesale Price Index. Trade cost (*Trade_Cost)* uses administration cost for export at the port collected by the World Bank's Doing Business Survey. This cost does not include customs tariffs and duties or costs related to ocean transport, and only official costs are recorded.

Trade openness (*Trade_Open)* is measured as the ratio of total export and import to GDP. This measurement has a shortcoming, as discussed in Athukorala and Hill (2010). The caveat of using this measurement is that it is a comparison between a net and a gross concept. Trade is measured in gross terms (intermediate materials + value-added) whereas GDP is measured on a value-added basis. Therefore the measured change in trade orientation is sensitive to changes in import intensity of export production. Krugman (1995) argued that countries involved in production networks tend to have (artificially) high trade-to-GDP ratios. Therefore the inclusion of this variable will raise an endogeneity problem and an instrumental variable is needed to overcome the problem. The data are sourced from the WDI Logistic Performance Index constructed by the World Bank is used as a proxy infrastructure condition. The variable used to represent FDI openness is a ratio of FDI inflow stock to GDP sourced from the UNCTAD database. The use of FDI stock instead of FDI flow is to avoid high fluctuation in the data.

There is a possible two-way causation between trade costs and trade flows. Besides the effect of trade costs on trade flows, it is possible that higher trade flows will stimulate lower trade costs because exporters and importers become more efficient and thus they can influence the government to reduce the trade costs. The Hausman-Wu specification test is conducted to judge whether this causation is a problem in the data compiled in this study. The result rejects the null hypothesis that there is causality from trade flows to trade cost. Therefore there is no evidence that trade flows will lower the trade costs.

There is still a possibility of endogeneity of trade openness, however. Quality of democracy and political institution from the Polity IV database is used as an instrument. The democracy variable is the difference between the democracy and the autocracy scores in this database, averaged over the period. It measures the competitiveness and regulation of political participation, the openness and competitiveness of executive recruitment, and the constraints on the executive. These instrument variables are directly correlated to trade openness but not directly related to the trade flows.

There are two estimation techniques available for panel data regression: fixed and random effects. Because the difference among countries is important, the fixed-effect estimation is used for this model. The fixed-effect estimator can be implemented in three ways: time demeaning (or within transformation), the first-difference, or the least square dummy variable (LSDV). The first two cannot be implemented in this model because they will eliminate the time-invariant variables such as trade cost and infrastructure condition, all of which are important for the model. On the other hand, the LSDV technique with country and time dummies can handle the time-invariant variables. Finally, to guard against the heteroscedasticity problem, I use the heteroscedasticity-consistent standard errors (i.e., the White correction) clustered by country.

Table 3 summarizes the information on data sources for variables as explained here.

Table 3. Summary of variables

Variable	Variable names	Data	Data source	Period	Expected sign	Mean	SD	Coefficient of variation	No. obs.
Dependent variable									
Fragmentation trade	*Frag*	Real values of parts and components export	UN Comtrade	Varies among countries		12.81	4.55	0.35	2,372
Explanatory variables									
Labor cost	*Lab_Cost*	Real wages	LABORSTA	Varies among countries	(+)	1.55	2.31	1.49	1,577
Competitiveness	*RER*	RER	WDI	1980 - current	(+)	5.15	2.92	0.57	2,006
Trade cost	*Trade_Cost*	Export cost	Doing Business Report	2007	(−)	6.89	0.46	0.07	2,072
Trade openness	*Trade_Open*	Ratio of total export and import to GDP	WDI	All period	(+)	4.29	0.55	0.13	2,211
Infrastructure	*Infrastructure*	Logistic Performance Index	Connecting to Complete - LPI 2007 Report	2007	(+)	2.82	0.73	0.26	1,868
FDI openness	*FDI_Open*	Ratio of FDI inflow stock to GDP	UNCTAC Database	All period	(+)	4.12	0.91	0.22	1,740

Source: *Author's summary.*

Table 4. Estimation results for auto parts, 1988–2007

Dependent variable: *real export value*	**All countries**	**Developed countries**	**Developing countries**	**Asian countries**
lnLab_Cost	0.257**	0.575***	0.315**	0.339**
	(0.119)	(0.205)	(0.139)	(0.150)
lnRER	0.053*	0.027	0.007	0.347**
	(0.028)	(0.037)	(0.037)	(0.164)
lnXCost	0.524	2.911***	0.493	−1.532**
	(0.691)	(0.211)	(0.979)	(0.681)
Infrastructure	4.197***	1.972***	3.114***	1.412
	(0.294)	(0.337)	(0.444)	(1.047)
lnTrade_Open	0.777**	1.517***	0.282	−0.994**
	(0.333)	(0.409)	(0.368)	(0.442)
lnFDI_Open	0.533***	−0.049	0.347**	2.212***
	(0.157)	(0.106)	(0.175)	(0.588)
d_Ind				−0.063
				(0.935)
d_Thai				1.616***
				(0.273)
_cons	−7.299	−19.864***	−3.004	12.486**
	(5.422)	(2.689)	(7.808)	(4.959)
Instrumental var.	No	No	No	Yes
Country dummy	Yes	Yes	Yes	No
Year dummy	Yes	Yes	Yes	Yes
No. of observations	995	497	517	266
Adjusted R^2	0.973	0.982	0.962	0.845

Notes: *Time and country dummies are included, but the results are suppressed here. Standard errors based on White's heteroscedasticity correction cluster by country are given in parentheses, with statistical significance (two-tailed test) denoted as follows: ***Statistically significant at the 1 percent level; **statistically significant at the 5 percent level; *statistically significant at the 10 percent level.*

6. Results and discussion

6.1 Determinants of participation in automotive global production networks

Table 4 depicts the estimation results for all models of auto parts. Infrastructure condition, measured by the Logistic Performance Index, is the most important variable that determines the participation in the global production network. The coefficient for developing countries is larger than for developed countries. This larger coefficient implies that participation in global production networks by developing countries is more sensitive to the improvement of infrastructure quality than it is for developed countries.

An efficient infrastructure affects both the communications and coordination costs, as shown in the elements of service link costs by Kimura Takahashi, and Hayakawa (2007). Efficient infrastructure includes reliable and affordable telecommunication and electricity, roads in good conditions, as well as reliable and efficient port management. This is especially the case for the automotive sector where just-in-time delivery is crucial. Reliable infrastructure is necessary to guarantee that delivery from one production network to another in the same country as well as delivery from warehouse to port for export. This characteristic differentiates the fragmentation trade from the traditional trade flows, where real wages and competitiveness are the most important factors.

There are several studies that focus on the role of infrastructure in global production networks and all found the same results. Golub, Jones, and Kierzkowski (2007) find evidence that successful exporters of manufactures in East Asia have relatively favorable service links such as transport and telecommunications infrastructure. Limão and Venables (2001) emphasize the relation between infrastructure and trade cost especially for landlocked countries. A deterioration of infrastructure will raise transportation costs and reduce trade flows. Their closer investigation on Southern African countries found that low trade flows in these countries are caused by poor infrastructure.

The estimated coefficients for trade openness are positive and significant for the automotive sector. Trade openness is a result of trade liberalization and the automotive sector is usually highly protected in developing countries. There is considerable government involvement in this sector because the automotive sector is considered as a vital sector in national economic development strategies. These government interventions support the development of domestic production and protection for domestic production; they are usually in the form of high import tariffs and non-tariff barriers, both on the auto parts and the final goods. Trade liberalization in the automotive sector in the form of a reduction of tariff barriers and/or the elimination of non-tariff barriers increases trade openness and affects the trade of auto parts. Several studies in developing countries confirmed that trade liberalization, especially for intermediate inputs, increases the variety of imported intermediate input and firms' productivity, which in turn increases their exports.

The estimated coefficients for FDI openness are positive and significant except for developed countries. With full ownership, a foreign carmaker is willing to bring the latest technology into the host economy and improve managerial practices and practice close supervision of assembly/production by bringing in foreign technicians and managers.

As discussed by Kimura (2008), because of resource limitations, the late-comers in the developing countries do not have to improve their overall investment environment for the whole economy to attract more FDI. They can focus on a minimal set of FDI facilitation, infrastructure services, and convenient service link arrangements at some specific locations to attract the initial wave of production blocks. One of the major bottlenecks to overcome is the high service link cost such as customs clearance and logistics, which are included in the trade cost measure.

Previous studies using the augmented gravity model found different results on the relationship between labor cost and export of P&C depending on the countries used in the models. Athukorala and Yamashita (2006) found a negative and significant relationship for East Asian countries, whereas Zeddies (2011) found a positive and significant relationship for the EU. East Asian countries can be regarded as developing countries that are labor intensive, whereas the EU members are developed countries that are more technology intensive. Another study by Athukorala (2009) on 40 countries found a negative but insignificant relationship between labor cost and export of P&C.

The positive and significant coefficient for developed countries agrees with previous studies. The positive and significant coefficient for developing countries is a new finding, which is due to the different level of analysis. The existing studies were conducted for P&C for all sectors, whereas this research focuses on P&C for automotives. The positive effect of labor cost to participation in global production networks in developing countries therefore suggests that a higher labor cost implies higher labor productivity, which in turn will produce a higher export value since it relates to higher quality of products.

Quality of labor is closely related to the level of technology in each country. Technology capacity becomes a more important determinant, as the increase in labor wage leads to a decline in the comparative advantage in simple labor intensive activities (Hill 2001). Technology capacity has a positive impact on participation in global production networks through export, as argued by Lall (2000) and Fagerberg (1996). Products with simple technologies tend to have slower market growth, limited potentials, smaller scope to upgrade technology, and fewer spillovers to other activities.

This positive and significant coefficient for *Lab_Cost* suggests that skilled labor is important in increasing a country's participation in the global production network and it is highly related to education level. Higher labor cost relates to higher quality of labor, and therefore it is crucial for a country to improve its education system and provide an environment that facilitates the supply of highly skilled labor that can support technology development.

A country's competitiveness, as measured by the real exchange rate, has a positive effect on the fragmentation index, as predicted by the traditional trade theory. An increase in RER reflects the depreciation of the domestic currency, which in turn makes the exported P&C more competitive in the world market. The coefficients for both developed and developing countries are not significant, however, and this concurs with the findings of Arndt and Huemer (2005) and Athukorala and Yamashita (2009) that the link between exchange rate and trade is weakened in the global production network trade.

From this analysis, it can be concluded that the determinants of participation are different in developed and developing countries in the automotive global production network. In the developed countries, participation through export of auto parts is highly dependent on trade cost, infrastructure, trade openness, and labor quality. On the other hand, participation of the developing countries depends on infrastructure condition, FDI openness, and labor quality.

6.2 Why is Indonesia missing out?

The second research question is why Indonesia has been left behind in the globalization of the automotive sector. To answer this question, equation (1) is modified by replacing the country dummy variables with dummy variables for ASEAN-4 countries, which includes Indonesia, Malaysia, the Philippines, and Thailand. Singapore is not included because Singapore is considered as new industrialized economy whereas the other four countries are considered as developing countries. The estimation equation for the second question is as follows:

$$\begin{aligned}\ln Frag_{i,t} = \alpha + \beta_1 \ln Lab\_Cost_{i,t} + \beta_2 \ln RER_{i,t} + \beta_3 Trade\_Cost_i + \beta_4 Trade\_Open_{i,t} \\ + \beta_5 Infrastructure_i + \beta_6 FDI\_Open_{i,t} + \varphi_1 d\_Ind + \varphi_2 d\_Thai \\ + \varphi_3 d\_Phil + \varphi_4 d\_Mal + \tau_t T + \varepsilon_{i,t}. \end{aligned} \quad (2)$$

To make a reasonable comparison between Indonesia and other countries, equation (2) is estimated for Asian countries data rather than the full data set or the developing countries data set.

The estimation result for the export side is depicted in the last column of Table 3. The coefficient of *d_Ind* is negative, as expected. Meanwhile, the estimated coefficients for *d_Thai* are positive and significant, which means that Thailand is ahead of other Asian countries, and this is consistent with the fact that Thailand is one of the major hubs of automotive production for regional and global markets.

From the estimation results, the major determinants for the Asian countries to participate in the automotive production networks are FDI openness, trade cost, labor quality, and competitiveness. The author provides the following analytical narrative based on the empirical findings.

Indonesia is relatively more restrictive toward FDI compared to Thailand and Malaysia. There are rather ambivalent attitudes toward FDI. The FDI policy (in 1974) requires the establishment of a joint venture for foreign investment in Indonesia. Although this policy was changed in 1994 allowing 100 percent of foreign ownership in Indonesia, the frequent policy changes affected the automotive industry as it created uncertainty for both domestic and foreign investments. Because majority of foreign ownership was not permitted before 1994, Japanese car makers were reluctant to transfer the related technology to their partners in Indonesia, which resulted in less participation from Indonesia in the regional production networks as compared with Thailand.

Trade cost and infrastructure affect Indonesian participation in the automotive production network because they increase uncertainty in delivering auto parts from one production block to another. In interviews with auto parts firms in Jakarta, I found that many prefer to locate their plants near the port to avoid the traffic congestion to and from the port. If they must locate near the port, they prefer to avoid peak hours and choose to transport the parts at nights or on weekends. Although the additional cost of paying overtime for the drivers is still cheaper than the cost of congestion, this additional cost still affects the competitiveness of their products.

An unexpected result from this model is the negative and significant coefficient for trade openness. As explained earlier, trade openness should have a positive impact on the trade of auto parts because the automotive sector is a protected sector and therefore any trade liberalization will improve the trade of auto parts. The negative coefficient in this model means that more open trade in the Asian countries leads to less trade in auto parts, especially in technology intensive auto parts. Because most Asian countries are developing countries, protection for the automotive sector is usually in the form of an import ban on cars, with the intention of developing the domestic car industry. Because the domestic car industry (especially the auto parts producers) is not yet fully developed, however, the car industry has to import vital auto parts and these are usually technology intensive parts. When the automotive sector is liberalized, the import ban on cars can be lifted and the domestic car industry can import cars rather than technology intensive parts. Trade openness therefore has a negative impact on the trade of the technology intensive auto parts.

For Asian countries, labor cost and technology capacity are the other determinants that affect participation in the automotive global production network. Labor cost depends not only on the wage level but also on labor productivity. Labor productivity and technology capacity are closely related to a country's education and the skill level of its labor. Indonesia's human capital quality still lags its neighbors. First, the quality of labor in Indonesia is relatively low compared with the neighboring countries. The completion rate of tertiary education is low (only 1.4 percent in 2010), and the completion rates for primary and secondary education were 37.4 percent and 22.8 percent, respectively, in 2010. Comparing Indonesia with other South East Asian countries reveals that for the quality of labor force, in 2001 Indonesia is the second lowest of ten countries and Cambodia is the lowest. Improving education conditions in Indonesia is critical for attracting FDI as well as for improving Indonesia's absorptive capacity.

The relatively low education level in Indonesia hampers the absorption capacity for new technology, as argued by Jacob and Szirmai (2007). Indonesia's technology capacity is still limited compared with other Asian countries. Many high-tech projects such as aircraft, shipbuilding, railroads, telecommunications, and steel and machinery were developed before the 1997–98 Asian financial crisis, but these projects have been abandoned since the crisis and no technology policies have been created to replace them. As a result, Indonesia remains near the bottom of the technology ladder in the region (Lipsey and Sjöholm 2010). One indicator of this is the low investment in research and development. This holds true not only for the public sector, but also for foreign companies operating in Indonesia. A survey by the U.S. Bureau of Economic Analysis shows that R&D investment as a percent of employee compensation in U.S. majority affiliates in Indonesia is only 0.6 percent, the lowest compared with other Asian countries (such as Korea, Singapore, China, and Malaysia). The highest percentage is Singapore and Taiwan at about 19 percent, followed by China (14.9 percent) and Malaysia (11.2 percent), and the next lowest is Thailand at about 2.1 percent. The reluctance of U.S. affiliates to invest in R&D is closely related to the ownership restrictions discussed earlier.

There are several reasons why Indonesia is not as advanced as Thailand in the automotive global production network. First, its investment policies toward foreign investment are more restrictive, especially the restriction on 100 percent foreign ownership that discourages foreign carmakers from making any substantial investments in Indonesia. Second, Indonesia's infrastructure is in poor condition, which not only reduces the competitiveness of P&C goods, but also limits the domestic demand for cars. Finally, protection for the domestic car industry, which is reflected in the relatively higher import tariffs for cars and auto parts, restricts Indonesia's growth in this area.

7. Conclusion

This paper provides analysis on the deteminants of a country's participation in the automotive global production networks. From the estimation results, it can be concluded that service link is important in determining a country's participation in the global prodution networks, especially infrastructure, and the second important issue in developing countries, followed by FDI openness.

Meanwhile, the reason that Indonesia is being left behind in the automotive global production networks is because of the relatively more restrictive investment policies toward foreign investment, trade cost, labor quality, and competitiveness.

With a huge domestic market in Indonesia, which creates economies of scale, it is expected that the Indonesian automotive industry can participate more in the global production network than it can in its current condition. Its participation is hampered, however, because of its investment policies, trade costs, and the remaining high protection in the automotive sector. All of these influence the openness of trade. Both central and local governments have to provide efficient investment procedures with clearer, more consistent, and simplified procedures at the lowest possible cost to attract more foreign investment in Indonesia. A resurgence of nationalist sentiment, manifested through non-tariff barriers, discourage participation in global production networks. Technical ministries should base their non-tariff barrier decisions on analytical studies that clearly outline the costs and benefits of such policies instead of ad hoc decisions triggered by nationalist sentiment. This transparent and systematic process will increase business confidence on Indonesia.

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Appendix A. List of parts and components in the automotive sector

SITC3	ISIC2	ISIC3	Description
1. Auto Parts			
6251	3551	2511	Tyres, pneumatic, new, of a kind used on motor cars (including station wagons and racing cars)
6252	3551	2511	Tyres, pneumatic, new, of a kind used on buses or lorries
62541	3551	2511	Tyres, pneumatic, new, of a kind used on motorcycles and bicycles of a kind used on motorcycles
62591	3551	2511	Inner tubes
66471	3620	2610	Safety glass, consisting of toughened (tempered) or laminated glass of toughened (tempered) glass
66472	3620	2610	Safety glass, consisting of toughened (tempered) or laminated glass of laminated glass
66481	3620	2610	Rear-view mirrors for vehicles
69915	3811	2899	Other mountings, fittings and similar articles suitable for motor vehicles
69941	3819	2899	Springs and leaves for springs, of iron or steel
74315	3829	2912	Compressors of a kind used in refrigerating equipment
7438	3829	2912	Parts for the pumps, compressors, fans and hoods of subgroups 743.1 and 743.4
7481	3829	2913	Transmission shafts (including camshafts and crankshafts) and cranks
74821	3829	2913	Bearing housings, incorporating ball- or roller bearings
74822	3829	2913	Bearing housings, not incorporating ball- or roller bearings; plain shaft bearings
7485	3829	2913	Flywheels and pulleys (including pulley blocks)
7486	3829	2913	Clutches and shaft couplings (including universal joints)
7489	3829	2913	Parts, n.e.s., for the articles of group 748
74443	3829	2915	Other jacks and hoists, hydraulic
74363	3829	2919	Oil or petrol filters for internal combustion engines
74364	3829	2919	Intake air filters for internal combustion engines
74999	3829	2919	Other machinery parts, not containing electrical connectors, insulators, coils, contacts or other electrical features

Appendix A. Continued.

SITC3	ISIC2	ISIC3	Description
71651	3831	3110	Electric generating sets with compression-ignition internal combustion piston engines (diesel or semi-diesel engines)
7169	3831	3110	Parts, n.e.s., suitable for use solely or principally with the machines falling within group 716
77812	3839	3140	Electric accumulators (storage batteries)
77821	3839	3150	Filament lamps (other than flash bulbs, infrared and ultraviolet lamps and sealed-beam lamp units)
77823	3839	3150	Sealed-beam lamp units
77833	3831	3190	Parts of the equipment of heading 778.31
77834	3839	3190	Electrical lighting or signalling equipment (excluding articles of subgroup 778.2), windscreen wipers, defrosters and demisters, of a kind used for cycles or motor vehicles
77835	3839	3190	Parts of the equipment of heading 778.34
77313	3839	3190	Ignition wiring sets and other wiring sets of a kind used in vehicles, aircraft or ships
76211	3832	3230	Radio-broadcast receivers not capable of operating without an external source of power, of a kind used in motor vehicles (including apparatus capable of receiving radio-telephony or radio-telegraphy) incorporating sound-recording or reproducing apparatus
76212	3832	3230	Radio-broadcast receivers not capable of operating without an external source of power, of a kind used in motor vehicles (including apparatus capable of receiving radio-telephony or radio-telegraphy) not incorporating sound-recording or reproducing apparatus
76422	3832	3230	Loudspeakers, mounted in their enclosures
76423	3832	3230	Loudspeakers, not mounted in their enclosures
76425	3832	3230	Audio-frequency electric amplifiers
88571	3853	3330	Instrument panel clocks and clocks of a similar type, for vehicles, aircraft, spacecraft or vessels
71391	3829	3430	Parts, n.e.s, for the internal combustion piston engines of subgroups 713.2, 713.3 and 713.8, suitable for use solely or principally with spark-ignition internal combustion piston engines
71392	3829	3430	Parts, n.e.s, for the internal combustion piston engines of subgroups 713.2, 713.3 and 713.8, suitable for use solely or principally with compression-ignition internal combustion piston engines
78431	3843	3430	Bumpers, and parts thereof
78432	3843	3430	Other parts and accessories of bodies (including cabs)
78433	3843	3430	Brakes and servo-brakes and parts thereof
78434	3843	3430	Gearboxes
78435	3843	3430	Drive-axles with differential, whether or not provided with other transmission components
78436	3843	3430	Non-driving axles, and parts thereof
78439	3843	3430	Other parts and accessories
78535	3844	3591	Parts and accessories of motorcycles (including mopeds)
78531	3844	3592	Invalid carriages, whether or not motorized or otherwise mechanically propelled
78536	3844	3592	Parts and accessories of invalid carriages
78537	3844	3592	Parts and accessories of other vehicles of group 785
82112	3320	3610	Seats of a kind used for motor vehicles
62593	3551	9999	Used pneumatic tyre
1. Assembly			
7841	3843	3410	Chassis fitted with engines, for the motor vehicles of groups 722, 781, 782 and 783
71321	3843	3410	Reciprocating piston engines of a cylinder capacity not exceeding 1,000 cc
71322	3843	3410	Reciprocating piston engines of a cylinder capacity exceeding 1,000 cc
71323	3843	3410	Compression-ignition engines (diesel or semi-diesel engines)
1. Car Body Maker			
78421	3843	3420	Bodies (including cabs), for the motor vehicles of groups 781,
78425	3843	3420	Bodies (including cabs), for the motor vehicles of groups 722, 782 and 783

Source: *Author's list.*