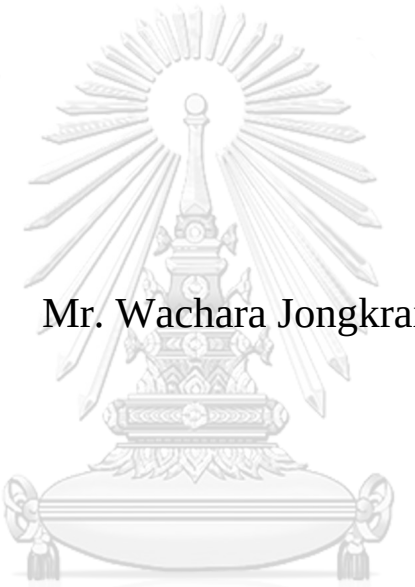
Role of Global Production Networks on Development of Automotive Industry in selected ASEAN countries

Mr. Wachara Jongkraijak



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บทบาทของเครือข่ายการผลิตของโลกต่อการพัฒนาอุตสาหกรรมยานยนต์ในประเทศอาเซียน

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วัชระ จงไกรจักร : บทบาทของเครือข่ายการผลิตของโลกต่อการพัฒนาอุตสาหกรรมยานยนต์ในประเทศอาเซียน. (Role of Global Production Networks on Development of Automotive Industry in selected ASEAN countries) อ.ที่ปรึกษาหลัก : ศ. ดร.ไพฑูรย์ วิบูลชุติกุล

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาบทบาทของเครือข่ายการผลิตของโลกต่อการพัฒนาอุตสาหกรรมยานยนต์ในประเทศอาเซียนผ่าน 3 มุมมองคือมูลค่าเพิ่ม ผลผลิตทางแรงงาน และการส่งออกของอุตสาหกรรมยานยนต์ โดยใช้ข้อมูลจาก Trade in Value Added ในระดับอุตสาหกรรมของแต่ละประเภทจาก OECD การศึกษาใช้การวิเคราะห์แบบ Pooled times series ตามเงื่อนไข cross section และ period fixed effect ครอบคลุมข้อมูลจากอุตสาหกรรมยานยนต์ใน 4 ประเทศในอาเซียนได้แก่ ไทย อินโดนีเซีย มาเลเซีย และฟิลิปปินส์ ระหว่างปี 2538 ถึง 2559 ผลการศึกษาพบว่าประเทศไทยได้รับประโยชน์จากการเข้าไปมีส่วนร่วมในเครือข่ายการผลิตของโลกผ่านการเน้นความชำนาญในกระบวนการผลิต (task specialization) และ economies of scale และในขณะเดียวกันสามารถขยายศักยภาพการผลิตในประเทศ ประเทศไทยสามารถเพิ่มมูลค่าเพิ่มและผลผลิตทางแรงงานจากการเข้าไปมีส่วนร่วมในเครือข่ายการผลิตของโลก และการเน้นเข้าไปมีส่วนร่วมแบบ Downstream Specialization สามารถเพิ่มความสามารถในการส่งออกในอุตสาหกรรม ประเทศอินโดนีเซียสามารถเพิ่มมูลค่าเพิ่มและผลผลิตทางแรงงานจากการเข้าไปมีส่วนร่วมผ่านทาง Backward linkages และในขณะเดียวกันการเข้าไปมีส่วนร่วมผ่านทาง Forward linkages สามารถเพิ่มความสามารถในการส่งออกในอุตสาหกรรมยานยนต์ของประเทศ การเข้าไปมีส่วนร่วมในเครือข่ายการผลิตของโลกของประเทศมาเลเซียทำให้มูลค่าเพิ่มและผลผลิตทางแรงงานลดลง ซึ่งแสดงถึงข้อจำกัดของความสามารถในประเทศจากการเข้าไปมีส่วนร่วมในเครือข่ายเพิ่มมากขึ้น และถึงแม้ว่าการเน้นเข้าไปมีส่วนร่วมแบบ Downstream Specialization สามารถเพิ่มความสามารถในการส่งออกในอุตสาหกรรมให้กับประเทศมาเลเซีย แต่การเข้าไปมีส่วนร่วมผ่านทาง Backward linkages กลับทำให้มูลค่าที่เกิดขึ้นจริงในประเทศจากการผลิตสินค้าเพื่อการส่งออกลดลง และการเข้าไปมีส่วนร่วมในเครือข่ายการผลิตของโลกของประเทศฟิลิปปินส์ไม่ได้มีนัยสำคัญต่อมูลค่าเพิ่มและผลผลิตทางแรงงาน ซึ่งการพัฒนาศักยภาพในประเทศหรือห่วงโซ่มูลค่าในประเทศอาจจะส่งผลมากกว่าต่อการพัฒนาอุตสาหกรรมยานยนต์ในประเทศ ประเทศฟิลิปปินส์สามารถเพิ่มมูลค่าที่เกิดขึ้นจริงในประเทศจากการผลิตสินค้าเพื่อการส่งออกโดยการผลิตชิ้นส่วนยานยนต์ที่ประเทศฟิลิปปินส์มีข้อได้เปรียบเชิงเปรียบเทียบ ดังนั้นการเข้าไปมีส่วนร่วมผ่านทาง Forward linkages จึงมีนัยสำคัญในการเพิ่มมูลค่าในการส่งออกในอุตสาหกรรมยานยนต์ในฟิลิปปินส์ แต่การเข้าไปมีส่วนร่วมผ่านทาง Backward linkages กลับทำให้มูลค่าที่เกิดขึ้นจริงในประเทศจากการผลิตสินค้าเพื่อการส่งออกลดลง

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Wachara Jongkraijak : Role of Global Production Networks on Development of Automotive Industry in selected ASEAN countries. Advisor: Prof. Paitoon Wiboonchutikula, Ph.D.

This paper investigates the impact of Global Production Networks (GPNs) on the industrial development in 3 aspects; domestic value added, labor productivity, and export performance, employing Trade in Value Added database at the country-sector level from Organization for Economic Cooperation and Development (OECD). The estimation is based on pooled time series, cross section and period fixed effect covering Automotive industry in 4 selected ASEAN countries; Thailand, Indonesia, Malaysia, and Philippines from 1995 to 2016. The results suggest that Thailand can exploit the benefit from GPNs through task specialization and economies of scales, at the same time expanding the domestic capacity. All GPNs involvements make Thailand gain positive value added and productivity, especially through forward linkages. And downstream specialization significantly boosts Thailand's export performance. Indonesia significantly gains positive value added and productivity through backward linkages in GPNs, while forward linkages boost its export performance. Malaysia significantly lowers value added and productivity from GPNs involvement, which implies the limited domestic capacity to increase the GPNs participation. And though downstream specialization significantly boosts Malaysia's export performance, backward linkages significantly decrease domestic content in gross exports. Lastly, Philippines' GPNs involvement does not have a significant impact on value added and productivity, and the domestic chains would contribute more to the industrial development. Philippines can increase domestic content in gross exports by producing selected auto parts which they have comparative advantages. As a result, its forward linkages significantly boost gross exports. However, its backward linkages significantly lower its domestic content in gross exports.

Field of Study:	International Economics and Finance	Student's Signature .....
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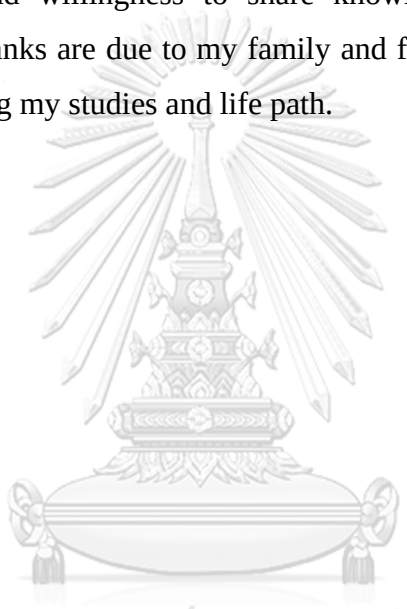
Wachara Jongkraijak



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1. INTRODUCTION

1.1 BACKGROUND

Production has become increasingly fragmented through Global Production Networks (GPNs). The world evidences the faster growth of intermediate input trade than the growth of trade in final goods, reflecting more division of production and task specialization by exploiting a country's comparative advantage and raising the benefits from economies of scale and scope. Especially, developing countries reposition themselves toward bigger and higher-value stages of production in the Global Production Networks in order to sustain strong growth.

As emerging economies, Southeast Asia has been participating this new pattern of production, especially in the Automotive Industry which each stage of production is fragmented across countries. Trade in components increases throughout the countries in the region, both intra-regional and extra-regional trade. This provides opportunity for sourcing components from different countries and assembling in suitable locations for better distribution channel, therefore strengthening automotive GPNs. Considering as one of the factors driving the industrial development, Global Production Network involvement fosters the development of a domestic value chain or supply base. Since the automotive industry in most ASEAN countries is dominated and shaped by foreign direct investment, an upgrading of country in such chains can help the country maximize the spillovers from foreign investment, which leads to higher development in the industry. As a result, ASEAN countries experience to gain economic footholds in the automotive industry due to the success of industrial development.

Automobile manufacturing and components production have skyrocketed, mostly in Thailand, Indonesia, Malaysia, and Philippines. Thailand has developed from an assembling manufacturing into a top automotive manufacturing and export hub until now it becomes the 13th largest automotive parts exporter and 6th largest commercial vehicle manufacturer in the world and the largest in the ASEAN. While Indonesia has been growing quickly due to the domestic economic development which drives the domestic sales increase by the middle class. With the continued entry of foreign suppliers of auto components into Indonesia, it gives opportunity for domestic suppliers to upgrade their domestic productive capabilities to support ongoing export potential. Malaysia is a unique case in ASEAN, which its landscape is sharply divided by locally produced vehicles and its foreign company competitors. However, only majority foreign ownership can participate in Global Production Networks. It implies that the foreign direct investment shapes how a host country involve in global production networks. And lastly, to catch up with leading countries in the industry, Philippines has become the global producer of selected automotive parts through taking advantage of GPNs.

Throughout the content of automotive industry in the ASEAN countries, global production networks play a very important role in the development of the industry. Hence, this paper tries to separately describe the development of automotive industry of 4 selected ASEAN countries; Thailand, Malaysia, Indonesia, and Philippines. Besides, it aims to examine the role of Global Production Networks on the development of the automotive industry in each country in order to further draw policy implementation on the development of automotive industry.

1.2 OBJECTIVES

1.2.1 To analyze the development of Automotive Industry in 4 selected ASEAN countries
1.2.2 To analyze the Global Production Network participation and position in the Automotive Industry in selected ASEAN countries and examine their impact on the development of the industry
1.2.3 To draw policy implementation on the development of Automotive Industry

1.3 SCOPE

This study covers the impact of global production networks on the development of automotive industry in 4 selected ASEAN countries, namely Thailand, Malaysia, Indonesia, and Philippines during the period of 1995 – 2016. Data will be annual.

2. AUTOMOTIVE INDUSTRY OF SELECTED ASEAN COUNTRIES: EXPLOITING GLOBAL PRODUCTION NETWORKS FOR INDUSTRIAL DEVELOPMENT

2.1 Development of Automotive Industry in ASEAN countries

Thailand

Thailand has developed from an assembling manufacturing into a top automotive manufacturing and export hub over 50 years. Government policies has played significant role for the industrial development. In the early stage of the development from 1975 to the early 1990s, the government implemented high protection of imported completely built-up vehicles (CBU) and imposed local content requirements on automobile assemblers aiming to support local supporting industries to reach dynamic economics and globally compete. As a result, setting up assembly facilities by foreign OEMs in the country was more feasible and the complementary investments were made by auto parts multinational firms. In the late 1990s, the government shifted toward greater liberalization due to its commitment with World Trade Organization to abolish LCR policy and import ban and replaced by tariffs. Until Thai automotive industry has shifted to export concentration since 1996 and CBU vehicles were the major export products (Jongwanich 2013). And after the economic crisis in 1998, free investment policy was implemented, which foreigners could be majority shareholder to resolve liquidity problem, hence industrial growth.

Recently, under the change in the automotive industry structure toward electric vehicles (EVs), Thailand started building the foundation of electric vehicles and upgrade local production by approving a tax incentive scheme to become Global Green Automotive Production base. To promote foreign investment, Thai government provides special tax-exemption incentives for automotive assemblers. Besides, the government also targeted at localizing higher-value-added components, such as engine parts, by imposing local production requirements in exchange for tax incentives. Three

Hybrid Electric Vehicles (HEVs) have been locally manufactured since 2009, namely Toyota Camry, Nissan X-Trail, and Honda Accord. BMW began Plug-in hybrid electric vehicles (PHEVs) in 2016. Mercedes-Benz assembled its Blue-TEC hybrid engines in 2013 and upgrading to the PHEVs platform in 2016.

Indonesia

The first automotive assembly plant was established by GM in 1928, with an initial production capacity of 6,000 units per year (Kaoru Natsuda 2015). Although industrialization had started early in Indonesia, the industry failed to develop throughout the 1960s. Indonesia began imposing the localization policy in the automotive industry in 1969 by banning the import of CBU vehicles and impose higher LC ratios in the assembly of vehicles. The industry has been liberalized since 1993 by ending the ban on importing CBU vehicles and reducing tariffs and tax on imported parts, which allowed the assemblers select which parts to localize.

Though the program called "Mobil Nasional" was introduced to support the national car producers, it contradicted WTOs rules from giving the tax and import duty privileges to national car producers. Finally the incentive program was ordered by WTO panels to abolish by July 1999. The liberalization policies were introduced again in 1999 with a new set of import duties based on type, engine size, and weight of vehicles. And recently, the government promoted the Low-Cost Green Car in 2009 to develop the small and environmentally friendly vehicles to respond the growing middle class, increasing demand shifted from motorbikes to cars and the continuous trend. Besides, the government wanted to improve the fuel consumption in order to reduce the fuel subsidy's cost, which Indonesia faced the net oil importer since 2003. Similarly to Thailand, Indonesia uses the fiscal policy to develop this particular type of vehicle, but Indonesia does not offer special incentives for the investment in the automotive sector and does not directly target localization activities to upgrade the industry, especially in the component industry which human resource development and technology transfer within the country are needed (Kaoru Natsuda 2015).

Malaysia

Malaysian automotive industry first started since the mid-1960s and had been protected by Import-substituting industrialization policies of heavy tariff protection, and LC requirements to develop local suppliers. Seven foreign assembly plants set up by the mid-1970s and further after. In the early 1980s when other countries move from import-substituting industrialization to trade liberalization for environment of increased international competition, Malaysia pursued a strategy of creating a national car industry by locally producing Japanese cars. It established Proton in May under Heavy Industry Corporation of Malaysia. The production commenced in 1985 but it suffered continuous losses since 1985 until 1989 from a collapse of local demand due to the economic recession and higher price of imported components from Japan due to the appreciation of yen. Since 1999 Proton became affordable vehicle and began to export in 1986 to Bangladesh and the United Kingdom. In 1992 Malaysia started to reveal the 2nd national car Policy expecting to utilize Proton's networks and reduce the cost of

parts procurement through economies of scale (Kaoru Natsuda 2013). However, these 2 national cars are not successful in entering the automotive GVCs.

In addition, Proton and Perodua have recently faced high foreign competition and Honda and Toyota have gained market share in Malaysia. In 2014 the government announced the new national car policy aiming to become the hub for eco-friendly vehicles. Regardless of investment size or engine capacity, Energy Efficient Vehicle (EEV) producers will automatically receive grants, tax exemptions, and manufacturing licenses, which this promotion of EEV will not be limited to national cars. However, Malaysia's supply is mainly directed at the domestic market, it does not appear that Malaysia can become the center of eco-friendly production.

Philippines

Philippines started the auto assembly industry in the early 1950s, after the government adopted an import-substituting industrial policy by banning the import of finished industrial products, including the complete built-up (CBU) vehicles. The auto development programs by different Philippine Administrations from the 1970s to 2000s failed to meet the target goal of developing Philippine capacity.

In the 1980s – 1990s, the Philippines liberalized the trade regimes in a wholesale manner under a World-Bank-assisted "Structural Adjustment Program". Import quotas were removed the high tariffs were reduced. In 1996 to 1997, the Philippines auto liberalization program was deeper of tariff liberalization adopted by the big three ASEAN producers, Thailand, Malaysia, and Indonesia. This weakened the position of the Philippines' assembly industry in its home market and squeeze the growth of the domestic parts industry (Ofrene 2016). OEMs exploit the AFTA to relocate production to Thailand or Indonesia and export from these countries. Ford and Mazda has ended production in the country by relocating to Thailand to decrease cost since the Philippines could not produce components in the required quality so that certain parts had to be imported, which increases the cost (Rosellon 2011). This trade liberalization was one of the major reasons for the stagnant assembly industry in the Philippines.

However, in the 1990s, it became a leading component supplier to Japan and among the ASEAN countries. There are 256 parts makers claimed by Philippines's BOI 2009, mostly are 2nd and 3rd tiers of the auto supply pyramid. These domestic parts producer meet the global standard from being less technologically sophisticated. There are firms that have put the Philippines on the Global Production Networks map because they have become the giant producers of parts.

2.2 Role of Global Production Networks on the Development of Automotive Industry

Value Chains have become important factor driving globalization. Companies have increasingly been moving some of their operations offshore seeking to reduce costs by sourcing components or operations with lower wage rates. Companies have increasingly been fragmented the manufacturing process, until the global production networks have been developed. Thus cross-border production sharing enable firms to reduce costs by acquiring capital- and skill-intensive components from abroad which firms can improve their competitiveness in world markets for final products through

offshore sourcing of components in which they have efficiency disadvantage (De 2011). Hence, the fragmentation of the production has dramatically changed the structure of international trades into manufacturing networks.

Multilateral free trade negotiations and the reduction of tariffs and non-tariff barriers, the opening-up of emerging market economies to global trade, financial liberalization, the internationalization of business services and technological improvements are the most prominent factors that contributed to the expansion of cross-country supply chains until recently (Vanessa Gunnella 2017). After cancelling out import-substitution policies implemented to promote the development of domestic automotive industry, the Automotive Industry in ASEAN has been increasingly participating Global Production Networks (GPNs), which mostly shaped by foreign direct investment. Trade liberalization began to change the situation in the 1990s. The global production and sales strategies of leading multinational automotive companies, therefore, were shifted and the developing countries became more integral to their plans. And upon the integration toward ASEAN Economic Community (AEC), the size and affluence of the market and the high degree and wide geographical extent of political integration have facilitated the development of an increasingly sophisticated intraregional integration of production such as the low tariffs in ASEAN region. With serious pursuing a strategy on automobiles, GPN is ready for exploiting the comparative advantages of division of labor.

Thailand

Thailand becomes the leader in automotive industry among ASEAN countries from specializing the downstream task of assembling the complete vehicles and export to other countries. The country continues to expand its manufacturing base, auto components suppliers, and setting up research and development sectors to better serve the customers. And because the domestic markets had shrunk during the Asian crisis, automotive companies revised a corporate strategy to export-oriented strategy. Firms started concentrating production in the country with the best comparative advantage instead of producing all the items in each country. According to figure no.1, Thailand started to concentrate on CBU vehicle export since 1996, as a result this makes this country a net export in the industry. And since 2013, the intermediate input imports have the decreasing trend, while the exports keep increasing. This implies the development of the domestic supply of auto components. More parts and components can be supplied through domestic supply base, rather than importing. Plus, the country can exports these inputs to with the increasing trend.

Because of local content requirement prior to 1990s and GPNs participation of the country to export more complete vehicles, the industry has been developed from increasing auto components makers in the country. And due to “industrial estates”, industrial cluster becomes successful in the country from auto component and assembly multinational firm agglomeration, which the Thai government attract FDI by providing industrial infrastructure and tax incentives. The growth in the supplying industry agglomeration started with Japanese firms and further American and European parts makers. It increased the type of components available in Thailand, reinforcing the role of the country in the international division of labor (Lecler 2002). Besides, geographical proximity facilitates closer communication and also enables car manufacturers to fully

adopt just-in-time production schedules that require the prompt delivery of parts to assembly plants (Jongwanich 2013). Targeting exports, the Laem Cha Bang Industrial Estate is one example of the proximity of new modern portal installation, a deep-sea port from where heavy containers could leave.

Throughout the development in the industry, thanks to technology transfer from foreign multinational enterprises, there are successful local auto parts producers in the country. Summit Group is one of the most competitive local first-tier supplier and competes successfully with multinational companies and tries to increase its productive capacity by creating joint venture with Japanese, German, and American competitors. And Somboon Group is one of the biggest 1st tier and 2nd tier automotive parts suppliers in Thailand, aiming to be a leader in automotive parts manufacturing in ASEAN (Lecler 2002).

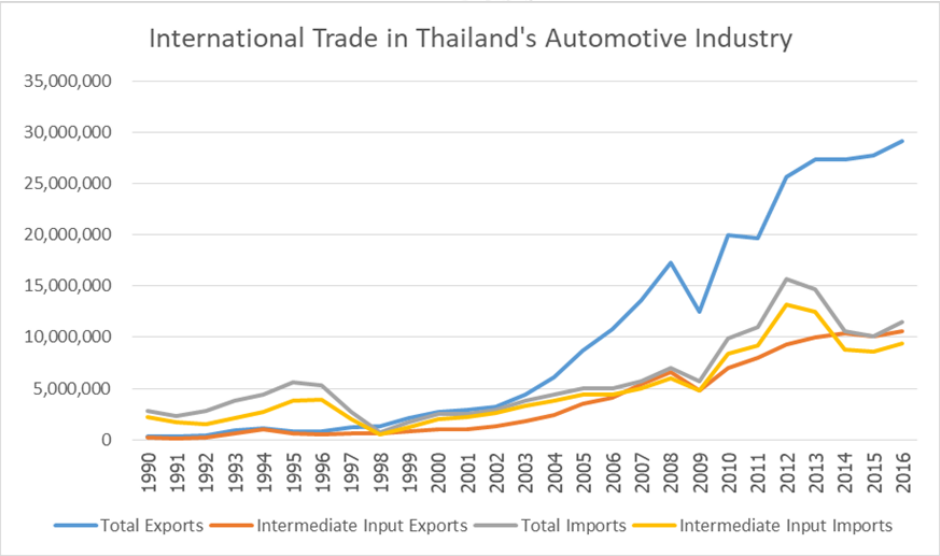


Figure no. 1: International Trade in Thailand's Automotive Industry
Source: OECD Database
Unit: Thousands, U.S. Dollars

Indonesia

Indonesia can participate in the GPNs by becoming assembly and export base for foreign OEMs, similar as Thailand. However, Indonesia is being left behind in the GPNs since the human resource development, technology transfer, and the availability of domestic supply chains are not sufficient. According to the figure no. 2, Indonesia experienced net import, which total imports, particularly the imports of intermediate input, always exceeded the total exports, reflecting the industry much relies on imported parts and components. And in 2015, total export started to exceed total import from increasing exports of intermediate inputs and completed vehicles, while the total imports and intermediate input imports experienced the decreasing trends.

And though there is a higher imported input in the production, human resource development and technology transfer are still not sufficient. Low education level that hampers the absorption capacity in technology, restrictive foreign investment policies, higher trade costs and remaining high protection in automotive sector in term of tariff

measure makes Indonesia lagged behind in the networks (Soejachmoen 2016). Nevertheless, Indonesia's rapid domestic growth has attracted foreign direct investment without having to offer excessively generous incentives. While the continued entry of foreign auto part suppliers offers opportunities for local producers to upgrade their productive capabilities, it still limits their chances to upgrade and become 1st tier suppliers.

Figure no.2: International Trade in Indonesian Automotive Industry
Source: OECD Database
Unit: Thousands, U.S. Dollars

Malaysia

Though Malaysia has its own domestically produced vehicles, namely Proton and Perodua, they have been unable successfully to enter the automotive GPNs. Without the foreign ownership, Malaysian national car company has no full access to its technology, production and sales networks within the automotive global production networks. Proton, has been unable successfully to enter the GPNs due to the choice of accepting foreign majority ownership issue. However, Perodua, as a joint venture with Mitsubishi, has more chance to participate in global value chains (Kaoru Natsuda 2013). Moreover, in the benefit of foreign ownership point of view, Noor Aini Khalifah (Khalifah 2013) provides the empirical evidence on the relationship between foreign ownership and technical efficiency of establishments in Malaysia' automotive industry. Technical Efficiency in the overall automotive industry is positively related to the degree of vertical integration, the size of establishments in the respective sub-sectors, a higher quality of the workforce, and a higher foreign ownership share in the establishments combined with higher net-import intensity (Khalifah 2013).

Another explanation why Malaysian national car companies cannot participate in the automotive GPNs is that the national cars are mostly sold to the domestic market, while the main auto components are supplied by Mitsubishi and Daihatsu and the domestic auto-component suppliers mainly supplies at the domestic market. The total of the Malaysian national car producers accounted for about 60% of the domestic

market in 2010, for example. And the auto-component system is mainly directed at the domestic market, as only 26.8 percent of production is exported (Kobayashi 2014).

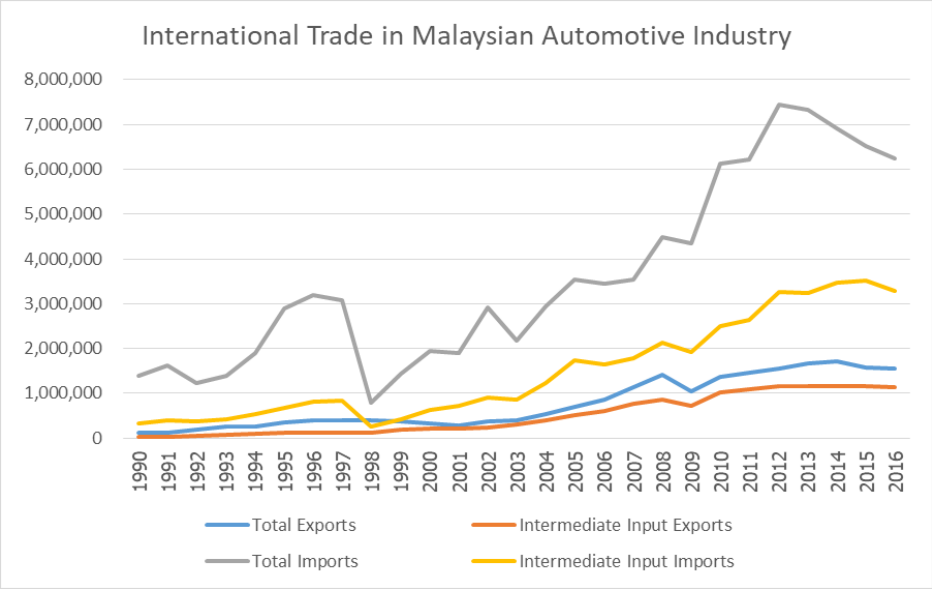


Figure no.3: International in Malaysian Automotive Industry
Source: OECD Database
Unit: Thousands, U.S. Dollars

According to the figure no.3, intermediate input imports exceeded total exports and input exports. It implies that Malaysia relies mostly on inputs. At the same time, the difference figure between total imports and intermediate imports illustrates the imported complete vehicles. The country faces much lower in total exports and intermediate input exports, which makes Malaysian automotive industry net import.

Table no. 1: Total Automobile Production and Production share in Malaysia by Brands
Source: Vehicle Production Data by Marklines Automotive Industry Portal

	2011		2013		2015		2016		2017		2018	
	Units	(%)	Units	(%)	Units	(%)	Units	(%)	Units	(%)	Units	(%)
Proton	166,229	31.16	140,082	23.29	97,662	15.89	73,400	13.46	67,170	13.44	54,103	9.58
Perodua	192,115	36.01	207,133	34.44	228,482	37.17	212,724	39.01	183,670	36.76	237,037	41.96
Toyota	71,309	13.37	79,598	13.24	84,054	13.67	61,227	11.23	62,428	12.49	55,818	9.88
Honda	23,482	4.40	47,954	7.97	93,769	15.26	96,414	17.68	105,951	21.21	108,531	19.21
Mazda	1,580	0.30	5,114	0.85	10,827	1.76	10,748	1.97	11,530	2.31	22,688	4.02
Volvo	3,330	0.62	3,734	0.62	2,395	0.39	2,051	0.38	2,433	0.49	3,298	0.58
Volkswagen	688	0.13	4,984	0.83	4,696	0.76	4,039	0.74	5,316	1.06	5,792	1.03
Pegeuot	3,551	0.67	6,056	1.01	1,243	0.20	491	0.09	650	0.13	1,483	0.26
Citroen	-	0.00	101	0.02	87	0.01	118	0.02	4	0.00	25	0.00
Subaru	-	0.00	4,850	0.81	3,101	0.50	10,420	1.91	3,257	0.65	6,343	1.12
Others	71,231	13.35	101,801	16.93	88,348	14.37	73,621	13.50	57,230	11.45	69,853	12.36
Total	533,515	100	601,407	100	614,664	100	545,253	100	499,639	100	564,971	100

However, foreign OEMs are the ones who contribute more to the development of automotive industry in Malaysia through global production network participation. At the downstream tasks, Malaysia would like to become the assembly base center in ASEAN for some brands. Since 2011, Volkswagen (VW) models are assembled by

CKD and semi-knocked-down (SKD) by its Malaysian partner DRB-HICOM while Peugeot use Naza to assemble CKDs since 2006 (Kobayashi 2014). And though there are foreign assembly plants in the country for foreign cars, the production mostly supplies to domestic market and export less finished vehicles. According to table no. 1, national cars, named Proton and Perodua, capture higher portion of number of production in Malaysia, when compared with other foreign cars assembled in Malaysia.

Philippines

Being unsuccessful in automobile assembly manufacturing, Philippines try to catch up with the leading countries in the industry by participating the automotive global production networks through, upstream specialization, producing selected auto parts which Philippines has comparative advantages. There are giant auto parts producing firms that have put the Philippines on the Global Production Networks map, i.e. Yazaki-Torres Manufacturing, Inc. (YTMI), EDS Manufacturing, Inc. and International Wiring Systems for Harness, Continental Temic for the brake system, and the ATC for Transmission. The exported-oriented auto parts producers actively participate in the networks because their sales to the local assemblers is small due to the small units of completed vehicles producing in the country. As a result, auto parts producers supply their capacity by exporting to global car assembled overseas. Yazaki-Torres Manufacturing, Inc. (YTMI), for example, is able to export annually wire harness to mainly the USA, Japan and ASEAN for over a million assembled cars, while supplied to the domestic assemblers only for 50,000-80,000 cars.

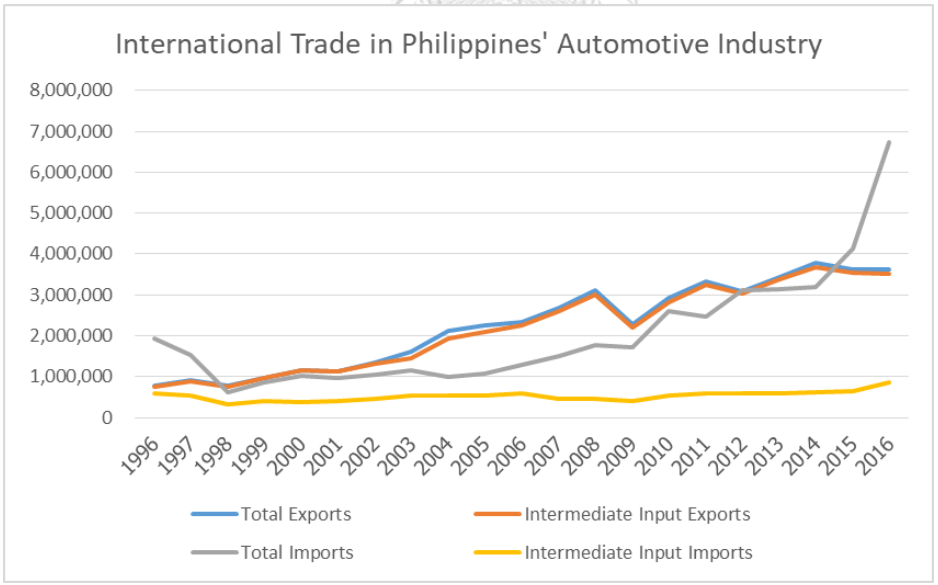


Figure no.4: International in the Philippines' Automotive Industry
Source: OECD Database
Unit: Thousands, U.S. Dollars

The Philippines has a distinct Revealed Comparative Advantage (RCA) in auto parts such as wiring harness, brake systems, transmissions and some motor vehicle parts, hence their potential for export has been growing through years. Wiring harness is exported to Japan, ASEAN, the USA and Canada, and for the brake systems, to

German, Japan, and the USA. And the transmissions are exported to Asia, particularly to Thailand by Japanese assemblers. One explanation for this successful of part producers and its revealed comparative advantage is that the technical skills and proficiency of the Filipino workers in doing manual electronic assembly works, which is both labor- and skills-intensive. Now the Philippines have established global proficiency in wire harness manufacturing, which made other Japanese wire harness manufacturers expand their facility in the Philippines (Ofrene 2016).

According to the figure no. 4, the Philippines experiences the similar figure of total exports and intermediate input exports since 1990s, reflecting the country mainly exports auto-components. And the increase in the difference between total imports and intermediate input imports showing the increasing trend of importing vehicles into the country. The country experience a trade surplus in the automotive industry, as mentioned this is because the components exports was higher than the vehicle imports. However, it has been shown that vehicle imports are increasing, leading to a decrease in trade surplus in the industry. Until year 2015, the country continues to increase imports under AEC 2015 till it became net import.

2.3 Comparative Role of Global Production Network in selected ASEAN countries

Thailand		**Indonesia**	
Manufacturers	Export Destinations	Manufacturers	Export Destinations
Toyota	Intelligent International Multi-Purpose Vehicles, mainly exported to ASEAN and the Middle East. -Hilux is exported to Europe and Australia. Yaris is exported to Europr, North America, and Japan. Vios sedan exported to the Middle East. Camry and Corolla exported to ASEAN.	Toyota	Toyota's Intelligent International Multi-Purpose Vehicles, mainly exported to ASEAN and the Middle East
Honda	The Accord is exported to ASEAN and Australia.	Honda	Freed is exported to Thailand and Malaysia.
Nissan	March and Almera are exported to ASEAN, Europe, Japan, and Australia.	Suzuki	Swift, the Grand Vitara SUV, and the MPV Ertiga are exported to ASEAN.
Mitsubishi	Triton is exported to the world except North America, while the Mirage is exported globally.	Daihatsu	MPV Xenia and Avanza are exported to ASEAN, South Africa, and the Middle East. Agya (LCGC Policy) is exported to Philippines.
Mazda	Mazda2, Mazda3, and BT-50 pickup truck are exported to ASEAN and Australia.		
Isuzu	D-Max pickup trucks are exported to ASEAN, Australia, Europe, and Africa.		
GM	GM produces Isuzu's D-Max sister model Chevrolet Colorado for ASEAN and Australia.		

Table no. 2: Strategic Assembly Bases in Thailand and Indonesia
Source: Arthur's summary from Current State and Issues of the Automobile and Auto Parts Industries in ASEAN, Kobayashi 2014

These ASEAN countries have been entering the Automotive GPNs through 2 main different roles, which are downstream and upstream tasks in GVCs. Thailand and

Indonesia enter the networks by specializing the downstream position in GVCs. They become the strategic assembly bases and export hub of the foreign complete vehicles. According to table no.1, Toyota uses Thailand and Indonesia to produce Toyota's Intelligent International Multi-Purpose Vehicles and export to ASEAN and the Middle East, for example (Kobayashi 2014).

However, Indonesia is left behind in the GPNs, while Thailand become the most successful country among ASEAN countries. The reason is that Thailand has also been developing its domestic supply chains. All 3 tier suppliers have been established by multinational and local auto components producers. But Indonesia's locally owned supporting industry is undeveloped due to the current dominance of Japanese assemblers and foreign auto component producers (Kaoru Natsuda 2015). There are only 550 or a third of Thailand auto part suppliers, mainly consists of foreign makers. And high-tech components must be imported from Thailand (Kobayashi 2014).

Table no. 3: Automobile Assembly plants and Export Market in Malaysia

Automobile Manufacturing & Assembling Plants	**Models**	**Operational Scope**	**Main Auto Components (Engine and Transmission)**	**Export Market**
Proton Holding Berhad (since 1985)	Proton: Saga	Manufacturing and Export Hub	Locally Manufactured, and Imported	Brunei
	Proton: Exora			Australia, Singapore, Thailand, Indonesia, Brunei, Mauritius, and
	Proton: Iriz, Persona, Prevé, Suprima S			Australia, Chile, Thailand, Indonesia, Brunei, Mauritius, and
Perodua Manufacturing (since 1994) Perodua Global Manufacturing (since 2014)	Perodua: Alza, Myvi, Axia, Breeza			Indonesia, Singapore, Brunei, Sri Lanka, Mauritius, and Fiji
Volvo Cars Manufacturing (since 1967)	Volvo: S90, XC90	Assembly	Imported	ASEAN
UMW Toyota Motors Sdn.BHn. (since 1968)	Toyota: HiAce (commercial van)		Imported	ASEAN
Tan Chong Motor Assemblies (since 1976)	Subaru: XV, Forester		Imported	ASEAN
Naza Automotive Manufacturing (since 2004)	Peugeot and Citroen		Imported Complete-knocked-Down (CKDs)	ASEAN
HICOM Automotive Manufacturers (Malaysia) Sdn. Bhd.	Volkswagen medols (since 2011)		Imported Complete-knocked-Down (CKD) and Semi-Knocked-Down (SKD)	Indonesia

Similarly, though their national car brands cannot successfully enter the networks, Malaysia is able to enter the networks by performing downstream task of assembling complete vehicle for foreign OEMs such as Volkswagen, Peugeot, Citroen, Volvo, and Subaru. However, there are high imported inputs in the export production.

By performing downstream task, Thailand is a largest producer in ASEAN and ranks the 12th automotive producer in the world in 2017 by producing 1,988,823 vehicles, constituting 2% of global production. Indonesia is the 2nd largest producer by producing 1,216,615 units and ranks 18th producer in the world, followed by Malaysia ranking the 25th producing 460,140 units. And Philippines produces 116,868 units.

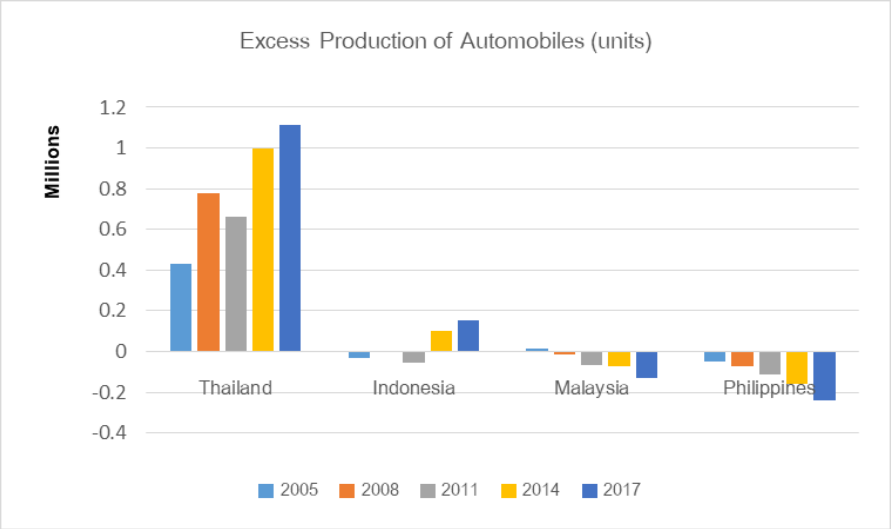


Figure no. 5: Excess Production of automobile in 2015 to 2017 in units of vehicles
Source: The International Organization of Motor Vehicle Manufacturers (OICA)

Regarding to the figure no. 5, it shows the export capacity of vehicles in each country. The greatest positive units of excess production illustrates that Thailand is the largest base of production for export, which the excess production reached almost 1.2 million units. Though Indonesia can produce the vehicles over 1 million units a year in 2015 to 2017, most domestic production was supplied to domestic market. And with the negative units of excess production, Malaysia and Philippines imported vehicles, though there is an automotive industry in the country.

	Component	Production	Export
India	Manual Transmission	148,000	137,000
Indonesia	Gasoline engine	115,000	40,000
Philippines	Manual transmission	333,000	325,000
Thailand	Diesel engine	370,000	131,000

Table no. 4: Production and Export of Components under IMV project in 2011
Source: The Indian Automotive Industry and the ASEAN Supply chain Relation, Agustin & Schroder, 2014 (Agustin 2014)

Though Philippines started the industry by assembling complete vehicles, the country recently lags far behind in this downstream tasks. It tries to catch up with leading countries in the networks by performing the upstream tasks producing and exporting their outstanding auto components to global assembly locations.

Regarding to the different roles of automotive global production networks playing by these countries, Toyota's Innovative International Multi-purpose Vehicle (IMV) project can be referred as a case. Table no.4 shows the production and export of components under the IMV project, which the key components are produced in ASEAN and India. The production and export figures reveal that Philippines is a component export base for Toyota's supply chain, whereas Thailand and Indonesia export significantly less components, indicating their functions as assembly and export hubs of vehicles. Manual transmission is produced in India and Philippines. These components are shipped and assembled into complete vehicles in Thailand, Indonesia, South Africa, and Argentina, where are the export hub. India supplies manual transmission for the Hilux pickup truck production in Thailand and Argentina, while Indonesia and South Africa are supplied through Philippines.

However, according to figure no.6, Thailand can export the highest amount of intermediate inputs in the industry among 4 countries. Thailand's gross exports of intermediate inputs reached US$ 10,611,919,960 in 2016, followed by Indonesia (US$ 3,584,894,700), Philippines (US$ 3,506,563,000), and Malaysia (US$ 1,128,314,000).

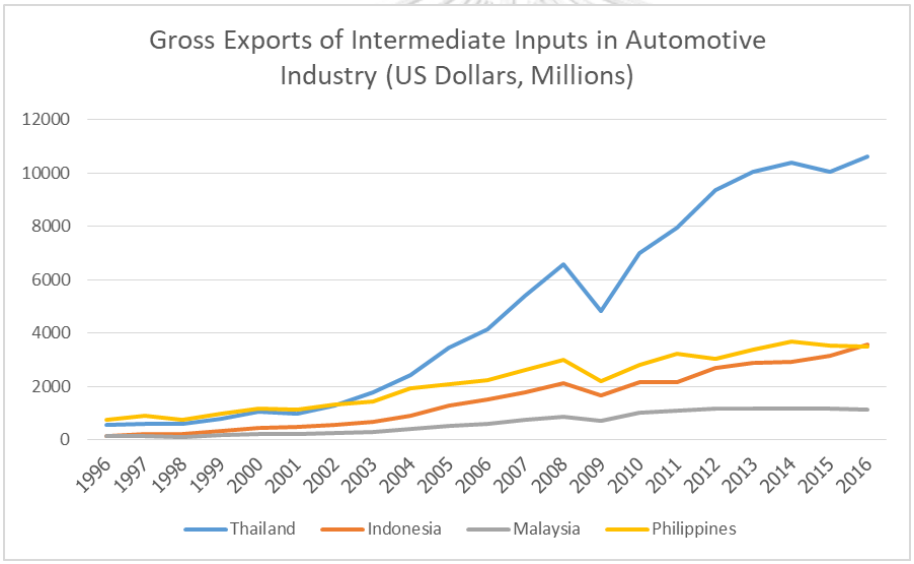


Figure no.6: Gross Exports of Intermediate Inputs Automotive Industry
Source: OECD Database
Unit: Millions, U.S. Dollars

As described, the GPN involvement of each country can be considered as a factor driving the development. Therefore, this paper would like to examine its impact on the development of the industry by employing the annual foreign value added embodied in gross exports (FVA), indirect value added embodied in gross exports (IVA), and gross exports data from Organization for Economic Co-operation and Development (OECD). The effect of GPNs on industrial development will be studied based on the following conceptual framework in section no. 3; the effect of GPN on industrial development under 3 variable (Output, Labor Productivity, and Exports), and GPN participation and position in Automotive Industry.

3. CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

3.1 Role of Global Production Networks on Industrial Development

3.1.1 Global Production Networks and Output (Domestic Value Added)

Global Production Network involvement has a positive impact on output through, firstly *"gain from task specialization"*. While the theory of international trade suggests that specializations according to comparative advantage improve the efficiency of resource allocations and hence the welfare of trading nations, specializations on tasks defined by value chains further refine specializations among nations, which enables participating nation to exploit finer comparative advantage and raise the benefits from economies of scale and scope. Hence, it enhances efficiency of resource allocations, productivity and economy growth of all economies involved.

Secondly, the positive relationship can be expected through *"technology spillover"*. Baldwin and Robert-Nicoud (Robert-Nicoud 2014) shows that an increase in productivity and value added of both countries is possible when there are *"technology spillovers*" from high-wage country to low-wage country. Offshoring, fragmentation, or trade-in tasks is akin to technological progress for the offshoring nation. For example, no goods are produced using Host or Foreign (low-wage country) technology as such goods would be uncompetitive with goods using Home (high-wage country) technology. In short, Home technology supplants Host technology globally. And Home employs Host factors to produce tasks. Capturing long-run technology spillovers brought by Foreign Direct Investment, Host might close the technology gap by learning from the presence of Home offshore production.

According to the empirical evidence study, Victor Kummritz (Kummritz 2016) investigates the role of Global Value Chains on the industrial development by estimating the model on cross-country and –industry basis covering 61 countries and 34 industries for year 1995, 2000, 2005, 2008, and 2011 as following;

$$\ln(X_{ikt}) = \alpha + \beta 1 \ln(GVC_{ikt}) + \alpha_{ik} + \alpha_{kt} + \alpha_{it} + e_{ikt},$$

where X is value added or value added per worker of industry i in the country k at time t. GVC is proxied by either foreign value added in domestic export or domestic value added in foreign export, collected from OECD' s Inter-Country Input-Output table. a_{ik} captures industry-country fixed effects, a_{kt} country-time fixed effects, and a_{it} industry-time fixed effects. The result suggests an increase in GVC participation leads to higher value added and productivity for all countries independent of their income level. 1% increase in backward GVC participation leads to 0.11% higher value added in the average industry. And 1 % increase in forward GVC participation leads to 0.60% higher value added and to 0.33% higher labor productivity.

In this paper, I simplify the estimating model including 3 additional control variables, based on the production function of the new growth theory, to minimize the potential omitted variable concern (Trade Openness, Human Capital, and Capital).

$$ln(DVA)_{it} = \alpha + \beta_1(GPN\ Indicator)_{it} + \beta_2 ln(K)_{it} + \beta_3 ln(HC)_{it} + \beta_4(TRD)_{it} + \delta_i + \delta_t + \varepsilon_{it}$$

3.1.2 Global Production Networks and Labor Productivity

As described in section 5.1.1., the relationship between Global Production Networks and Labor Productivity is expected to be positive through gain from specialization, technological transfer or spillovers. In addition, the relationship can be expected through the "learning by doing" channel.

In Li and Liu (Liu 2014), low wage countries gains through a productivity enhancing *"learning-by-doing process"* while technologically advanced high-wage nation gains are contingent on initial conditions from relocating more tasks to low-wage countries, which become more productive. The rise of GVCs allows high-wage nations and low-wage nations to specialize in tasks according to comparative advantage. The specialization enables low-wage countries to lower its unit labor requirements through a learning-by-doing process, which causes high-wage countries to relocate more tasks to low-wage countries. This process repeats itself until a steady state is reached in which wages and technology are equalized. Task dynamics are the central mechanism of this framework. The low-wage countries are given tasks for which they are technologically qualified and semi-qualified. The latter tasks provide the low-wage countries with opportunities to learn by doing and receive additional tasks, thereby adding more value to the product. Meanwhile through offshoring, the high-wage countries free its labor to focus on more sophisticated tasks. In the end, the division of tasks along the chain converges to a steady state. During the process, both countries move up the chain, as the low-wage countries cover more sophisticated tasks while the high-wage countries specialize in the most sophisticated tasks.

In order to examine the impact of GPNs on Labor Productivity, the formal econometric analysis will be used for this relationship, according to the Constantinescu (Cristina Constantinescu 2017)'s study. The econometric estimation relies on a production function that expressed value added (VA) of the industry in each country as a function of capital (K), labor (L) and a technology shifter (A).

$$VA = A(x_1, x_2, \ldots, x_n) * f(K, L) ;$$

where $(x_1, x_2, \ldots, x_n)$ captures traditional trade (Imports and exports) and trade occurring in a GVC context, reflecting the trade-related determinants of technology shifter. Dividing by L and taking logs yields the reduced form. The study covers 13 sectors in 40 countries from 1995-2009 employing data from World Input-Output Database. The result suggests that participation in GVCs is significant driver of labor productivity. Backward participation in GVCs, that is, the use of imported inputs to produce for exports, emerges as particularly important. An increase by 10 percent in the level of GVC participation increased average productivity by close to 1.7 percent. And according to OECD paper studying the impact of GVCs on jobs and productivity by providing new evidence on employment embodied in value-added trade flows. Within GVCs, jobs are shifting towards high-skill and medium-skill occupation, and also there is a shift towards service support functions such as R&D, distribution, logistics, and marketing (OECD 2016).

In addition, Import (IM), Export (EX), and 2 GPN indicators (GPN Participation and GPN Position) provides overall perspective of the trade-productivity nexus. Economic theory points to a positive relationship between trade and productivity, as

engaging in trade is considered to promote advances in productivity. Higher exposure to traded goods increases competition among heterogeneous firms, leading to a reallocation of resources towards more productive firms, while the least productive companies are forced to exit the market. Increased competition from imported products incentivizes firms to invest in the upgrading of technology while the availability of a larger range of intermediate production inputs potentially lowers firms' input costs. On the export side, the possibility to expand into larger export markets provides incentives to improve the efficiency, thereby boosting labor productivity within firms.

In this paper, I simplify the estimating model below for the analysis. Labor Productivity computed as value added divided by employment – and real capital stock per employment are denoted by LP and K/L respectively.

$$ln(Labor\ Productivity)_{it} = \alpha + \beta_1(GPN\ Indicator)_{it} + \beta_2 ln(K/L)_{it} + \beta_3 ln(HC)_{it} + \beta_4(TRD)_{it} + \delta_i + \delta_t + \varepsilon_{it}$$

3.1.3 Global Production Networks and Export

The positive effect of global production networks on export can be expected due to the spillovers effect of GPNs at micro-level, which firms participating in GPNs can benefit from brands, technology innovation and distribution networks.

The competition in the global market is much more complicated. Intangible assets such as brands turned into major hurdles to firms of developing countries, which strive to take part in the world market. In addition, new and fast growing markets have been nurtured by technology innovations and product inventions. By participating in the value chains of high-tech products and specializing in low value added segments, such as assembly and production of low-tech components, firms are able to join the value creation processes of high-tech products and grow together with lead firms. Being a part of value chains, firms can enjoy the spillover effect of lead firms' technology innovations, which they have neither the necessary intellectual properties nor comparative advantage.

Finally, selling products in world markets needs global distribution networks. The marketing and distribution is needed for supply and demand to be interconnected. In value chains, lead firms are buyers and responsible for marketing and distribution. They set up product standards and instruct suppliers upstream of chains about what to be produced. Suppliers can learn the nature of the potential market, and lead firms exercise direct quality control and often transfer valuable design, packaging and production know-how to suppliers. Hence, the required buyer–seller relations for exporting commodities to foreign markets are naturally built in GPNs. For firms without their own global distribution networks, joining GPNs can mitigate information deficiency, reduce transaction costs and facilitate market access (Xing 2016).

To examine the impact of GPNs on Export, the estimation will be based on the determinants of exports, which explain by foreign demand and domestic supply.

Real effective exchange rate (REER) is one factor determining the export performance. There is a negative relationship between the appreciation of the real effective exchange rate (REER) and export demand. An opposite expectation can be occurred for the export supply. The appreciation of the real effective exchange rate will promote to export by making exporting more beneficial. On the other hand, there is

some ambiguity about the role of exchange rate. It is argued the surging intermediate goods trade may dilute the immediate impact of real exchange rate on export performance as intermediate exports involve a high proportion of imported components (Jongwanich, 2007). World income is another factor affecting export demand. Higher world income has a positive relationship with export performance.

Based on the export supply, trade openness is expected to show a positive impact on export supply. With the increased trade liberalization, it is expected that Government will decrease the tariff and non-tariff barriers that discourage in import compression. Import compression can adversely affect export performance of a country as the export supply depends on the availability of imported inputs. Thus, decreased import compression will result in increasing export supply.

Combining all mentioned export determinants from export demand and supply and including the Global Production Networks index, the estimating model using to examine the effect of GPNs on export will be as following;

$$ln(Gross\ Export)_{it} = \alpha + \beta_1(GPN\ Indicator)_{it} + \beta_2 ln(REER)_{it} + \beta_3 ln(WY)_{it} + \beta_4(TRD)_{it} + \delta_i + \delta_t + \varepsilon_{it}$$

3.2 Global Production Network Participation and Positions in Automotive Industry

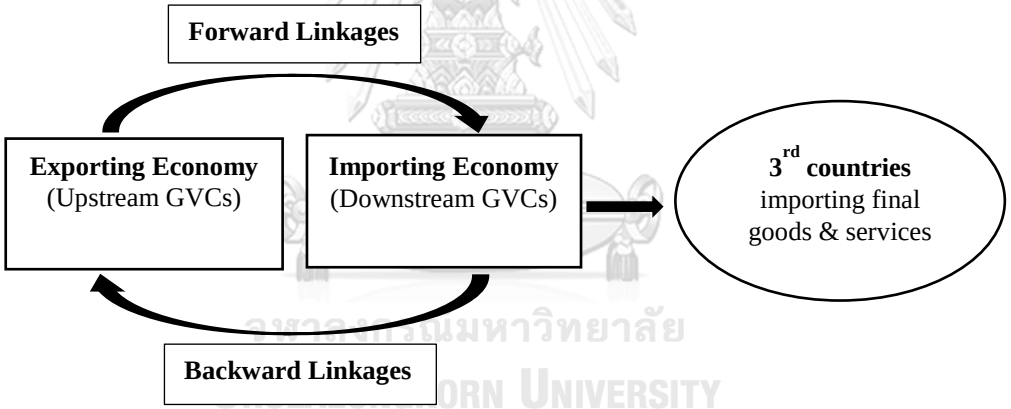


Figure No.7: Global Value Chains Participation

Countries can participate in global automotive production networks according to GVCs perspective; Forward linkages and Backward linkages (Camacho 2015).

Forward Linkage: is the linkage which the industries of the exporting country (supplying country) provide inputs into exports of the industries in the importing country. This exporting economy will be considered as "Indirect Exporter" where creates "Indirect Value Added" in content of exports.

Backward Linkage: is the linkage which the industries in the importing country (purchasing country) import intermediate products to be used in its exports. In other words, the importing economy uses other countries' Indirect Value Added in content of exports or foreign value added as the input for export of final demand.

Relatively comparing between forward and backward linkage, GPN position can be identified into Upstream and Downstream Position. The country specializing in "Upstream Position" will produce intermediates for other country's exports, thus there

will be high value added created through forward linkages. While the country that specializes in "Downstream Position" will import high level of inputs to produce and export final goods and services, thus there will be high level of value added created by other countries in the exports (Foreign Value Added or other countries' Indirect Value Added) through backward linkages. However, a country can participate in GPNs through both forward and backward linkages, which is total GPNs participation. According to Figure no.8, it describes Thailand's total GPNs participation.

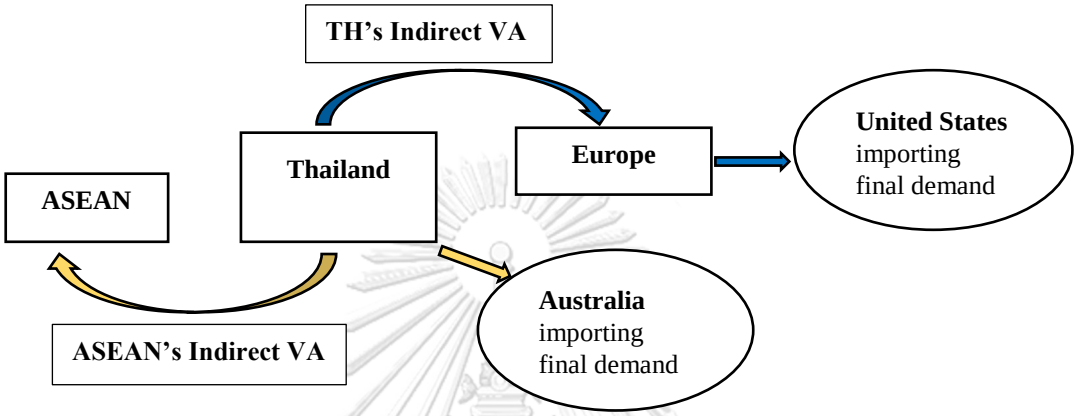


Figure no. 8: GPN Participation from Trade Flow in Value Added Term

(1.) Thailand's Backward linkage (from Thai perspective): Thailand uses ASEAN's Indirect Value Added in its export production to Australia.
(2.) Thailand's Forward linkage (from Thai perspective): Thailand supplies input for European production for exporting to United States.
(3.) Gross Exports from Europe to United States: In value added term, Gross Exports = Thailand's Indirect VA + Europe's VA in content of gross exports
(4.) Gross Exports from Thailand to Australia: In value added term, Gross Exports = ASEAN's Indirect VA + Thailand's VA in content of gross exports
(1.)+(2.): Thailand's Participation in GPNs
(2.)/(1.): Thailand's Position in GPNs

The below describes the value chains in Automotive industry into 2 chains; Upstream and Downstream supply chains, which upstream supply chains delivers raw materials, processed inputs, and services required by downstream sales chains.

Upstream Value Chains in Automotive Industry

To assemble motor vehicles, a factory needs component suppliers. Upstream tasks start from the 1st Tier suppliers required by car manufacturer. These suppliers will supply the largest components or sub-systems for cars. Moving upstream, the 2nd Tier suppliers provide components to the 1st Tier suppliers. Then, the 3rd Tier suppliers will provide the 2nd Tier suppliers. In addition to the tiered suppliers, there are raw materials and other input providers from supporting industries, such as the steel manufacturers who provide sheet to car manufacturers.

Downstream Value Chains in Automotive Industry

In the automotive industry, downstream tasks will start from the automobile plants producing finished vehicles or OEMs where all the upstream components are assembled into complete vehicles, to the 3rd party logistics providers distributing finished vehicles to storage and vehicle distribution hubs, then the dealer networks. Thereby, there are several other service sectors related to the operation of manufactured goods such as rental and leasing services, insurance, professional services, and maintenance. These associated downstream services are part of the manufactured goods sales chain.

4. RESEARCH METHODOLOGY

To empirically test the relationship between global production networks and industrial development (domestic value added, labor productivity, and export performance), I exploit the variation across 4 countries and overtime during 1995-2016, conditional on country and period fixed effects to account for unobservable factors. The choice of the analysis period is limited by the availability of data on trade in value added from OECD-WTO Tiva database used to examine the main analysis of the paper. The regression specification is as follow;

$$ln(X)_{it} = \alpha + \beta_{(i)}\,(GPNs\ Indicator)_{it} + \gamma\ Control_{it} + \delta_i + \delta_t + e_{it} \qquad (1)$$

where $ln(X)_{it}$ is dependent variable of country i at time t, while δ_i is country fixed effects and δ_t is period fixed effect. The β captures the effect of GPNs on dependent variables as a common coefficient and β will also be conditioned on cross section specific coefficient analysis in order to capture the effect of each country (i). A number of controls, $Control_{it}$, are also included.

4.1 Estimation Model

4.1.1 Global Production Networks and Output (Value Added)

$ln(DVA)_{it} = \alpha + \beta_{1(i)}(GPNPART)_{it} + \beta_{2(i)}(GPNPOS)_{it} + \beta_3 ln(K)_{it} + \beta_4 ln(HC)_{it} + \beta_5(TRD)_{it} + \delta_i + \delta_t + \varepsilon_{it}$

$ln(DVA)_{it} = \alpha + \beta_{1(i)}(FORWARD)_{it} + \beta_{2(i)}(BACKWARD)_{it} + \beta_3 ln(K)_{it} + \beta_4 ln(HC)_{it} + \beta_5(TRD)_{it} + \delta_i + \delta_t + \varepsilon_{it}$

4.1.2 Global Production Networks and Labor Productivity

$ln(LP)_{it} = \alpha + \beta_{1(i)}(GPNPART)_{it} + \beta_{2(i)}(GPNPOS)_{it} + \beta_3 ln(K/L)_{it} + \beta_4 ln(HC)_{it} + \beta_5(TRD)_{it} + \delta_i + \delta_t + \varepsilon_{it}$

$ln(LP)_{it} = \alpha + \beta_{1(i)}(FORWARD)_{it} + \beta_{2(i)}(BACKWARD)_{it} + \beta_3 ln(K/L)_{it} + \beta_4 ln(HC)_{it} + \beta_5(TRD)_{it} + \delta_i + \delta_t + \varepsilon_{it}$

4.1.3 Global Production Networks and Exports

$ln(Gross\ Exports)_{it} = \alpha + \beta_{1(i)}(GPNPART)_{it} + \beta_{2(i)}(GPNPOS)_{it} + \beta_3 ln(REER)_{it} + \beta_4 ln(WY)_{it} + \beta_5(TRD)_{it} + \delta_i + \delta_t + \varepsilon_{it}$

$$ln(Gross\ Exports)_{it} = \alpha + \beta_{1(i)}(FORWARD)_{it} + \beta_{2(i)}(BACKWARD)_{it} + \beta_3 ln(REER)_{it} + \beta_4 ln(WY)_{it} + \beta_5(TRD)_{it} + \delta_i + \delta_t + \varepsilon_{it}$$

where; Dependent Variable:
DVA – Domestic Value Added of country i's automotive industry at time t
LP – Labor Productivity of country i's automotive industry at time t
Gross Exports – Gross Export of country i's automotive industry at time t
Independent variables:
GPNPART- Global Production Network Participation of country i's automotive industry at time t
GPNPOS – Global Production Network Position of country i's automotive industry at time t
FORWARD – Forward Linkages of country i's automotive industry at time t
BACKWARD – Backward Linkages of country i's automotive industry at time t
TRD – Trade Liberalization of country i at time t
HC – Human Capital of country i at time t
K – Gross Capital of country i's automotive industry at time t
K/L – Capital-labor ratio of country i's automotive industry at time t
REER – Real Effective Exchange rate of country i at time t
WY – World Income at time t

4.2 The Global Production Network Indicators

According to Koopman (Robert Koopman 2011), the GPN indicators are constructed by employing OECD-WTO Trade in Value Added (TiVA) database, based on the concept of gross export decomposition in value added terms**.**

Constructing Global Production Networks Indicators

By using the decomposition results at the country-sector level, an index can be constructed to gauge if a country is likely to be in any position of the GPNs in particular sector and the extent to which a country-sector is involved in the GPNs.
Firstly Upstream GPNs and Downstream GPNs are defined as following;

$$Forward\ Linkages = \frac{Indirect\ Value\ Added\ embodied\ in\ Gross\ Export\ (IVA)}{Gross\ Exports}$$

$$Backward\ Linkages = \frac{Foreign\ Value\ Added\ embodied\ in\ Gross\ Exports\ (FVA)}{Gross\ Exports}$$

Second, GPN Participation index gives a sense of how integrated a country is in GPNs, either via backward or forward linkage, defined as followed;

$$GPN\ Participation = (FVA + IVA) / Gross\ Exports$$

Finally, GPN Position measures the relative position of the sector in a country, calculated as the log difference between upstream and downstream components;

$$GPN\ Position = ln\ (1 + \frac{IVA}{Exports}) - ln\ (1 + \frac{FVA}{Exports})$$

The positive value implies *"Upstream Specialization"* in the GPNs or phases of the production of intermediate products either raw materials or manufactured inputs used by other countries in their exports. Its IVA share in gross exports will be higher than its FVA share. The negative value implies *"Downstream Specialization"* in phases close to final demand or use of imported inputs to produce final goods for exports. If a country lie downstream, it will use a large portion of other countries inputs to produce final goods for exports, and its FVA share will be higher than its IV share.

Table no. 5: Variables, Measurement of Variables, and Data Sources

Variables	Measurement	Data Sources
Domestic Value Added	Domestic Value Added in Automotive Industry	Organization for Economic Co-operation and Development (OECD), TiVA database
Global Production Network Participation, Position, Forward linkages, and Backward linkages	Foreign Value Added in gross export, Indirect Domestic Value Added in gross export and Gross export of Automotive Industry	Organization for Economic Co-operation and Development (OECD), TiVA database
Gross Exports	Gross Exports in Automotive Industry	Organization for Economic Co-operation and Development (OECD), Bilateral Trade in Goods by Industry and End-use dataset
Domestic Value Added embodied in gross exports	Domestic Value Added embodied in gross export in Automotive industry	Organization for Economic Co-operation and Development (OECD), TiVA database
Trade Liberalization	Trade Ratio = (Exports + Imports) / GDP	World Development Indicator from World Bank
Human Capital	Skilled labor measured from the following categories of occupation: 1. Managers, professionals and technicians, 2. Clerical, service and sales workers, skilled agricultural and trade workers, and plant and machine operators and assemblers.	International Labor Organization
Capital	Gross Capital in Automotive Industry	Industrial Statistics Database, United Nations Industrial Development Organization, Manufacturing Industrial Statistics Indonesia, and Annual Survey of Philippines Business and Industry.
Capital to Labor Ratio	$\frac{Gross\ Capital\ in\ Automotive\ Industry}{Labor\ in\ Autootive\ Industry}$	
Labor Productivity	$\frac{Domestice\ Value\ Added\ in\ Automotive\ Industry}{Labor\ in\ Automotive\ Industry}$	Organization for Economic Co-operation and Development (OECD) and Industrial Statistics Database, UNIDO
REER	Real Effective Exchange Rate	World Development Indicator from World Bank
WY	World Income (World GDP)	World Development Indicator from World Bank

5. VALUE ADDED CONTENT OF GROSS EXPORTS AND GLOBAL PRODUCTION NETWORKS INVOLVEMENT OF AUTOMOTIVE INDUSTRY IN SELECTED ASEAN COUNTRIES

According to the concept of gross export decomposition, this section employs the Trade in Value Added (TiVA) database from OECD to analyze the global automotive value chains involvement of Thailand, Indonesia, Malaysia and Philippines, including the origin of gross exports by industry and country of origin.

Table no.6 shows 3 main elements of gross exports consisting of direct domestic value added (DDVA), indirect domestic value added (IVA), and foreign value added embodied in gross exports (FVA) in million US$. Share of IVA in gross exports is interpreted as "Forward Linkages", while share of FVA in gross exports is interpreted as "Backward Linkages" in GPNs. Forward and backward linkages in Thailand, Indonesia, and Philippines experienced the decreasing trend, reflecting the slow-down trend in GPNs involvement. Trade in tasks decreases, which the export production in each country relies more on domestic content. But Malaysia's automotive industry experienced increasing trend of backward and forward linkages, which backward linkages dramatically grew from 33.69% in 1995 to 53.11% in 2015.

Table no. 6: Domestic and Foreign Content of Gross Exports, Forward and Backward Linkages in Automotive Industry

	Domestic Value Added content of Gross Exports (DVA)						**Foreign Value Added content of Gross Exports (FVA)**			**Gross Exports**		
	Direct DVA content of gross exports (DDVA)			Indirect DVA content of gross exports (IVA)								
	1995	2005	2015	1995	2005	2015	1995	2005	2015	1995	2005	2015
Thailand	361.3	2,129.40	6,881.90	377.2	1,987	5,285.20	688.03	4,073.20	10,783.51	1,427.70	8,201.40	22,992.50
Indonesia	226.1	715.7	2,229.50	172.1	594.8	1,574.20	146.4	637.81	1,242.93	545.2	1,952.80	5,056.50
Malaysia	473.4	507	600	238.5	406	703.5	362.32	1,220.49	1,483.92	1,075.50	2,138.80	2,793.80
Philippines	82.4	881.3	1,843.30	80.1	586.1	1,119.30	127.87	796.07	1,502.81	290.5	2,264.60	4,468.60
	Share of DDVA in gross exports			Forward Linkages (IVA/Gross Exports)			Backward Linkages (FVA/Gross Exports)					
	1995	2005	2015	1995	2005	2015	1995	2005	2015			
Thailand	0.2531	0.2596	0.2993	0.2642	0.2423	0.2299	0.4819	0.4966	0.469			
Indonesia	0.4147	0.3665	0.4409	0.3157	0.3046	0.3113	0.2685	0.3266	0.2458			
Malaysia	0.4402	0.2370	0.2148	0.2218	0.1898	0.2518	0.3369	0.5706	0.5311			
Philippines	0.2836	0.3892	0.4125	0.2757	0.2588	0.2505	0.4402	0.3515	0.3363			

The element of DDVA content of gross exports reflects the domestic value added content directly created in the export production of final goods and intermediates absorbed by direct importers. It implies that to reap greater benefits from GPN participation, it needs to move towards more upstream associated with increasing share of GPN value added (Kevin Cheng 2015). Thailand, Indonesia, and Philippines are facing the increasing trend of DDVA share in gross exports. Only Malaysia experienced the opposite trend. It relies more imported inputs in the exports.

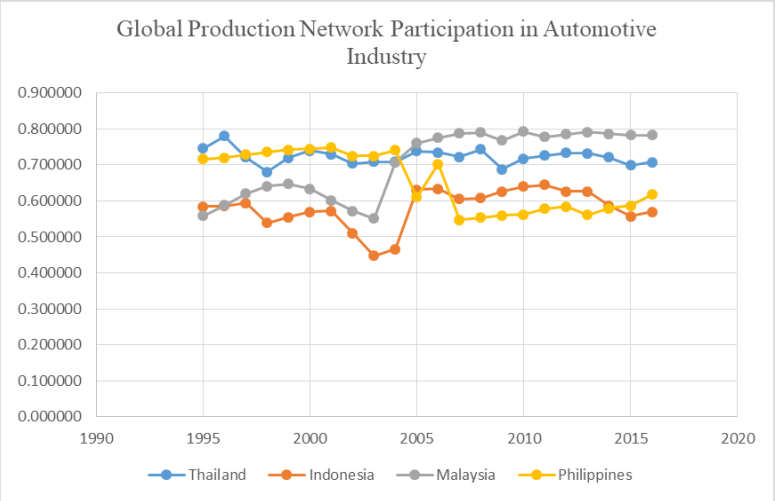
With 2 components of Forward and Backward Linkages, Global Production Network Participation and Position indicator can be calculated, as per table no. 7.

Table no. 7: Global Production Network Participation and Position Indicator in Automotive Industry

	GPN Participation			GPN Position		
	1995	2005	2015	1995	2005	2015
Thailand	0.7461	0.7389	0.6989	-0.1589	-0.1863	-0.1777
Indonesia	0.5842	0.6312	0.5571	0.0365	-0.0167	0.0513
Malaysia	0.5586	0.7605	0.783	-0.0901	-0.2777	-0.2014
Philippines	0.7159	0.6103	0.5868	-0.1212	-0.0711	-0.0664

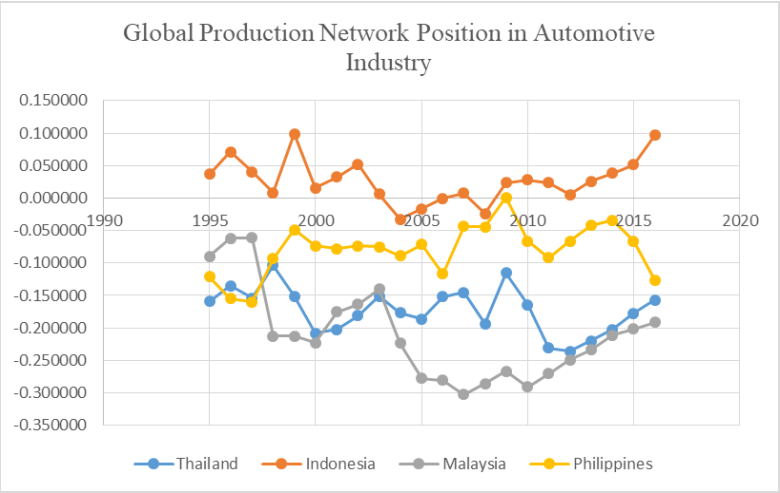
Throughout the period of 1995 to 2016, the average of GPN participation in Thailand is about 0.72, followed by Malaysia (0.70), Philippines (0.65), and Indonesia (0.58). However, Malaysia recently increased participation in GPNs, through both backward and forward linkages, and reached the highest degree at 0.783 in 2015 and 0.7829 in 2016, followed by Thailand, Philippines, and Indonesia. Thailand's GPN participation slightly decreased from 0.7461 in 1995 to 0.7083 in 2016. Indonesia's GPN participation is at 0.5842 in 1995, reached its lowest point at 0.4474 in 2003 and its peak at 0.6445 in 2011, and drops to 0.5693 in 2016. And Philippines participated in GPNs at 0.7159 in 1995, reached its highest point at 0.7483 in 2001, dropped at the lowest point at 0.5532 in 2007, and continuously increased to 0.6176 in 2016.

Figure no.11: Global Production Network Participation of Automotive Industry



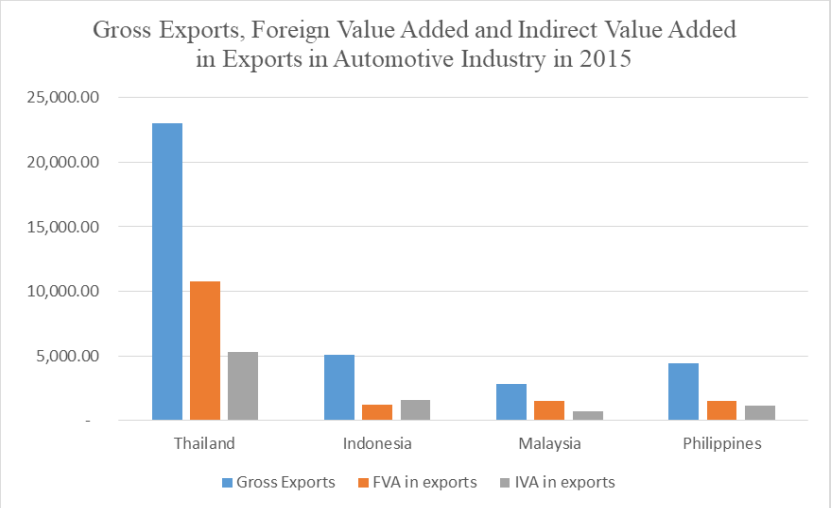
Being specific to the GPN position, the value chains have been separated into 2 positions. Positive value denoted "Upstream Specialization", while negative value denotes "Downstream Specialization". During 1995 to 2016, Thailand and Malaysia specialized in downstream position, i.e. assembling the finished vehicles by importing foreign inputs, hence having higher FVA share compared to indirect DVA share in gross exports. In 2016, Malaysia was at the highest degree of downstream position, followed by Thailand and Philippines. And though Philippines' position was at negative value, the degree of position seemed to move forward to upstream specialization. Philippines' GPN Position index reached the positive value at 0.0009 in 2009, but it again moved toward higher degree of downstream position at -0.1264 in 2016. Indonesia's position is always at the upstream position. However the index reached the highest degree of downstream position at -0.0330 in 2004. The position index moved toward to upstream position again, reaching at 0.0969 in 2016.

Figure no. 12: Global Production Network Position of Automotive Industry



However, from year 2015 data, figure no. 13 evidences Thailand reached the highest value of gross exports among ASEAN countries. However, it also reached the highest foreign value added and indirect value added content of gross exports among 4 countries. FVA accounted for 46.90% of the gross exports. This implies that about half of the gross exports in the industry relies on the imported inputs, while the another half is real activity occurs domestically. And about 20% of gross exports accounts for forward linkage in GPNs. Malaysia experienced the lowest gross exports, including and IVA content of gross exports, among 4 countries since Malaysia's automotive industry dominates by its own domestically produced vehicles for domestic market. And Indonesia accounted the lowest FVA content of gross exports. This might reflect the substitution of incoming FDI, especially from Japan.

Figure no. 13: Gross Exports, Foreign Value Added and Indirect Value Added in Gross Exports in Automotive Industry (Unit: US$, million)
Source: OECD TiVA database



Thailand

Thailand has developed its automotive industry. Through backward linkages, Thailand's FVA share in gross exports decreased from 48.19% in 1995 to 46.90% in 2015, which means DVA share in exports increased at the same percentage, according to table no.8. Also the share of Direct DVA increased from 25.31% in 1995 to 29.93% in 2015, which reflects the development of domestic supply base that can support the final goods and intermediate production absorbed by direct importers. Beginning the industry from importing the inputs and assembling into the finished vehicles can contribute the development in the domestic supply chains in Thailand. The growth of vehicle production would encourage the development of domestic suppliers and would make the cost of local production become more competitive.

Table no. 8: Value Added content in gross exports in Thailand's Automotive Industry by industry of origin

Source Industry	Domestic Value Added content of Gross Exports					Foreign Value Added content of Gross Exports				
	DVA in million US$	share in Exports (%)	DVA in million US$	share in Exports (%)	Change in DVA share in exports (%)	FVA in million US$	share in exports (%)	FVA in million US$	share in Exports (%)	Change in FVA share in exports (%)
	1995		2015			1995		2015		
Total Manufactures	**463.38**	**32.46**	**8,641.92**	**37.59**	**5.13**	**328.34**	**23.00**	**5,164.28**	**22.46**	**-0.54**
Transport Equipment	361.62	25.33	6,892.43	29.98	4.65	95.71	6.70	1,100.63	4.79	-1.92
Basic Metals & fabricated metal products	18.30	1.28	415.31	1.81	0.52	86.67	6.07	1,478.64	6.43	0.36
Chemicals & non-metallic mineral products	35.38	2.48	555.34	2.42	-0.06	53.98	3.78	938.55	4.08	0.30
Machinery & Equipment	14.65	1.03	182.22	0.79	-0.23	32.63	2.29	498.83	2.17	-0.12
Computers, electronic & electrical equipment	4.22	0.30	228.63	0.99	0.70	34.71	2.43	796.64	3.46	1.03
Total Business Sector Services	**220.38**	**15.44**	**2,893.51**	**12.58**	**-2.85**	**288.36**	**20.20**	**3,621.97**	**15.75**	**-4.45**
Distributive Trade, Transport, accomm. & food services, plus Information & Communication	122.33	8.57	2,371.32	10.31	1.74	187.17	13.11	2,407.93	10.47	-2.64
Financial and Insurance Activities	79.39	5.56	399.29	1.74	-3.82	37.92	2.66	472.13	2.05	-0.60
Real Estate, rent and business activities	18.66	1.31	101.00	0.44	-0.87	63.27	4.43	147.00	0.64	-3.79
Community, Social & personal services	**14.12**	**0.99**	**92.54**	**0.40**	**-0.59**	**11.51**	**0.81**	**231.13**	**1.01**	**0.20**
Total Services (Total Business Sector Services + Community, social & personal services)	**234.51**	**16.43**	**2,986.05**	**12.99**	**-3.44**	**299.87**	**21.00**	**3,853.10**	**16.76**	**-4.25**
Mining & quarrying	**9.07**	**0.64**	**221.74**	**0.96**	**0.33**	**33.91**	**2.38**	**1,250.40**	**5.44**	**3.06**
Electricity, Gas & Water Supply	**21.45**	**1.50**	**284.83**	**1.24**	**-0.26**	**14.97**	**1.05**	**337.44**	**1.47**	**0.42**
Agriculture, hunting, forestry & fishing	**10.30**	**0.72**	**73.23**	**0.32**	**-0.40**	**5.96**	**0.42**	**124.07**	**0.54**	**0.12**
Construction	**0.92**	**0.06**	**1.24**	**0.01**	**-0.06**	**4.98**	**0.35**	**54.23**	**0.24**	**-0.11**
Domestic Value Added content of Gross Exports	**739.62**	**51.81**	**12,209.00**	**53.10**	**1.29**					
Foreign Value Added content of gross exports	**688.03**	**48.19**	**10,783.51**	**46.90**	**-1.29**					
Gross Exports	**1,427.65**	**100**	**22,992.51**	**100**	**0.00**					

However, forward linkages decreased from 26.42% in 1995 to 22.99% in 2015 because Thailand specializes on assembling finished vehicles, hence domestic inputs

would supply to production of finished vehicles in the country rather than supply to foreign assembly facilities. And due to lower forward and backward linkages through years, GPN participation drops from 74.61% in 1995 to 69.89% in 2015.

By country of origin, regarding to the table no.9, Japan was the major source of FVA in automotive exports in Thailand in 1995. However, the share of FVA from Japan in gross exports dramatically decreased from 17.23% in 1995 to 9.86% in 2015, though the Thailand increased the export production over time. China becomes the major source of FVA in gross exports, capturing 11.21% in 2015, this reflects the importance of China in global value chains. Besides, regional value chains also play an important role in Thailand's automotive exports. ASEAN constituted about 3.90% of FVA share in exports (FVA from Indonesia, Malaysia, Singapore, and Philippines).

Specifically sourcing by the industry of origin, the share of FVA from its own source sector of transport equipment also decreased from 6.70% in 1995 to 4.79% in 2015, according to table no. 8. And the DVA share from transport equipment sector captured the highest percentage among all sectors, increasing from 25.33% in 1995 to 29.98 % in 2015. This reflects the development of automotive domestic supply chains in Thailand, which caused by foreign direct investment and also the development of domestic suppliers. But Thailand increases higher dependency on basic metal and fabricated metal product sector used in export production of automotive industry. The domestic content in gross exports was low (1.28% in 1995 and 1.81% in 2015). However, the foreign content was high increasing from 6.07% in 1995 to 6.43% in 2015. This reflects weak capacity of Thai metal sector to support automotive GVCs. Hence, country can further develop capacities in area of industrial and services activities that provide a better linkages with the automotive chains (Lejarraga 2016).

Table no. 9: Value Added content of gross exports in Thailand's Automotive Industry by country of origin

1995			**2015**		
Source Country	Value Added content of gross exports (Mill. US$)	Share of VA in gross exports (%)	Source Country	Value Added content of gross exports (Mill. US$)	Share of VA in gross exports (%)
Thailand (DVA)	739.618	51.81	Thailand (DVA)	12209.003	53.10
Foreign Value Added	688.03	48.19	Foreign Value Added	10783.510	46.90
Japan	245.98	17.23	China	2,577.712	11.21
France	67.659	4.74	Japan	2,266.884	9.86
USA	59.934	4.20	USA	809.189	3.52
Germany	41.739	2.92	Korea	430.251	1.87
Korea	28.525	2.00	Germany	426.897	1.86
Australia	18.457	1.29	Australia	384.475	1.67
Taiwan	17.947	1.26	Indonesia	339.651	1.48
UK	16.833	1.18	Malaysia	255.562	1.11
Russia	15.429	1.08	Taiwan	250.301	1.09
Singapore	13.963	0.98	India	189.857	0.83
China	12.362	0.87	Singapore	176.245	0.77
Malaysia	11.98	0.84	France	147.064	0.64
Italy	11.89	0.83	Russia	132.696	0.58
Netherland	9.435	0.66	Saudi Arabia	130.104	0.57
Switzerland	7.67	0.54	Philippines	124.384	0.54
Rest of the world	108.229	7.58	Rest of the world	2,142.234	9.32
Total	1,427.65	100	Total	22,992.509	100.00

Service sector plays an important role in global automotive value chains. Value added content of gross exports sourcing from total services sector captures at 29.75% in 2015, almost a third of total value added in gross exports. As an input for manufactured exports, service is traded indirectly through trade such as distributive trade, transport, storage, information and communication, and financial or insurance activities. Thailand tends to outsource service activities in automotive exports, from higher share of FVA when compared to DVA share.

Indonesia

Table no. 10: Value Added content of gross exports in Indonesia's Automotive Industry by Industry of Origin

Source Industry	Domestic Value Added content of Gross Exports					Foreign Value Added content of Gross Exports				
	DVA (Million US$)	Share in exports (%)	DVA in million US$	Share in exports (%)	Change in DVA share in exports (%)	FVA (Million US$)	Share in exports (%)	FVA in million US%	Share in exports (%)	Change in DVA share in exports (%)
	1995		2015			1995		2015		
Total Manufactures	**299.73**	**54.98**	**2,720.13**	**53.80**	**-1.18**	**65.747**	**12.06**	**582.57**	**11.52**	**-0.54**
Transport Equipment	226.23	41.49	2,268.01	44.85	3.36	13.889	2.55	200.47	3.96	1.42
Basic Metals & fabricated metal products	29.92	5.49	130.92	2.59	-2.90	28.112	5.16	128.08	2.53	-2.62
Chemicals & non-metallic mineral products	28.79	5.28	206.71	4.09	-1.19	12.145	2.23	119.56	2.36	0.14
Machinery & Equipment	0.35	0.06	9.11	0.18	0.12	3.308	0.61	42.45	0.84	0.23
Computers, electronic & electrical equipment	0.81	0.15	52.95	1.05	0.90	4.163	0.76	50.68	1.00	0.24
Total Business Sector Services	**70.03**	**12.84**	**831.28**	**16.44**	**3.60**	**60.082**	**11.02**	**440.95**	**8.72**	**-2.30**
Distributive Trade, Transport, accomm. & food services, plus Information & Communication	47.34	8.68	647.15	12.80	4.12	41.988	7.70	285.86	5.65	-2.05
Financial and Insurance Activities	11.70	2.15	131.77	2.61	0.46	6.669	1.22	59.87	1.18	-0.04
Real Estate, renting, and other business activities	10.99	2.02	29.47	0.58	-1.43	11.426	2.10	18.07	0.36	-1.74
Community, Social & personal services	**16.08**	**2.95**	**13.73**	**0.27**	**-2.68**	**11.939**	**2.19**	**24.91**	**0.49**	**-1.70**
Total Services (Total Business Sector Services + Community, social & personal services)	**86.11**	**15.79**	**845.02**	**16.71**	**0.92**	**72.02**	**13.21**	**465.87**	**9.21**	**-4.00**
Mining & quarrying	**1.86**	**0.34**	**169.62**	**3.35**	**3.01**	**3.849**	**0.71**	**138.73**	**2.74**	**2.04**
Electricity, Gas & Water Supply	**1.57**	**0.29**	**40.40**	**0.80**	**0.51**	**2.347**	**0.43**	**35.05**	**0.69**	**0.26**
Agriculture, hunting, forestry & fishing	**8.77**	**1.61**	**36.38**	**0.72**	**-0.89**	**1.362**	**0.25**	**15.10**	**0.30**	**0.05**
Construction	**0.77**	**0.14**	**1.98**	**0.04**	**-0.10**	**1.071**	**0.20**	**5.61**	**0.11**	**-0.09**
Domestic Value Added Content of Gross Exports	398.81	73.15	3,813.52	75.42	2.27					
Foreign Value Added content of gross exports	146.40	26.85	1,242.94	24.58	-2.27					
Gross Exports	545.21	100.00	5,056.46	100.00	0.00					

According to Table no.10, through backward linkages, share of FVA in gross exports decreased from 26.85% in 1995 to 24.58% in 2015, while the domestic content increased from 73.15% in 1995 to 75.42% in 2015. These imply that the development of domestic supply base has been caused by FDI to support the assembling task and export of finished vehicles. The share of Direct DVA clearly evidences the development

the domestic supply chains in the industry (41.47% in 1995 to 44.09% in 2015, according to table no.7). As country of origin, Japan OEMs, as an example, chose Indonesia as the production and export hub for some models, that's why Japan increased FDI to support the export production.

According to the table no.11, share of FVA in gross exports from Japan decreased from 8.91% in 1995 to 4.40% in 2015, as an evidence of FDI substituted for imported inputs in the export. However, China becomes the major source of FVA, share of FVA from China increased from 0.73% in 1995 to 4.92% in 2015. Besides, Thailand becomes the 3rd biggest source of FVA in Indonesia export production, capturing 1.97%. And as a regional value chain involvement, ASEAN countries (Thailand, Singapore, Malaysia, and Vietnam) accounted for 4.07% of gross exports.

Specifically sourcing by its own sector, the domestic content in gross exports from transport equipment sector accounted the highest percentage among all sectors, increasing from 41.49% in 1995 to 44.85% in 2015. However, the foreign content in gross exports also increased from 2.55% in 1995 to 3.96% in 2015, which reflects that Indonesia increase its dependency on imported inputs in transport equipment sector. Though the domestic supply base has been expanded by FDI, the development of domestic supply base in Indonesia is not sufficient to support the increasing export production. Among manufacturing sectors, basic metal sector captured the 2nd biggest source of FVA in Indonesia's automotive exports. However, Indonesia decrease its dependency on both domestic and imported inputs from metal sector. Indonesia turned to rely on more imported inputs from chemical sector. The share of FVA from chemical sector increased from 2.23% in 1995 to 2.36% in 2015. Indonesia tends to source the service activities to support the export production from domestic source. DVA share from service sector increased from 15.79% in 1995 to 16.71% in 2015, while the FVA share from service sector decreased from 13.21% in 1995 to 9.21% in 2015.

Table no.11: Value Added content of gross exports in Indonesia's Automotive Industry by country of origin

1995			2015		
Source Country	Value Added content of Gross Exports (Mill. US$)	Share of VA in gross exports (%)	Source Country	Value Added content of Gross Exports (Mill. US$)	Share of VA in gross exports (%)
Indonesia (DVA)	398.81	73.15	Indonesia (DVA)	3813.523	75.42
Foreign Value Added	146.4	26.85	Foreign Value Added	1242.94	24.58
Japan	48.586	8.91	China	248.93	4.92
USA	10.24	1.88	Japan	222.40	4.40
Germany	9.841	1.81	Thailand	99.44	1.97
Australia	9.603	1.76	USA	83.04	1.64
Korea	5.95	1.09	Korea	55.61	1.10
Russia	4.133	0.76	Singapore	51.83	1.03
China	3.956	0.73	Germany	43.30	0.86
Taiwan	3.706	0.68	Malaysia	35.94	0.71
UK	3.531	0.65	India	33.49	0.66
Singapore	3.495	0.64	Australia	31.81	0.63
Saudi Arabia	3.42	0.63	Saudi Arabia	26.08	0.52
Netherland	3.165	0.58	Russia	23.05	0.46
Chile	2.895	0.53	France	21.19	0.42
France	2.85	0.52	Taiwan	20.17	0.40
Malaysia	2.776	0.51	Vietnam	18.05	0.36
Rest of the world	28.25	5.18	Rest of the world	228.61	4.52
Total	545.207	126.85	Total	5,056.46	100

Malaysia

According to Table no.12, through backward linkages, Malaysia increases its dependency on imported inputs in the export production. FVA share in gross exports dramatically increased from 33.69% in 1995 to 53.11% in 2015, while DVA share decreased from the 66.31% in 1995 to 46.89% in 2015. The industry moves toward assembling the finished goods by relying imported inputs.

Table no.12: Value Added content of gross exports in Malaysia's Automotive Industry by Industry of Origin

Source Industry	Domestic Value Added content of Gross Exports					Foreign Value Added content of Gross Exports				
	DVA (Mill. US$)	share in exports (%)	DVA (Mill. US$)	share of exports (%)	Change in DVA share in exports (%)	FVA (Mill. US$)	Share in exports (%)	FVA (Mill. US$)	Share in exports (%)	Change in DVA share in exports (%)
	1995		2015			1995		2015		
Total Manufactures	**562.02**	**52.26**	**860.06**	**30.78**	**-21.47**	**167.479**	**15.57**	**696.44**	**24.93**	**9.36**
Transport Equipment	476.87	44.34	601.24	21.52	-22.82	45.212	4.20	155.54	5.57	1.36
Basic Metals & fabricated metal products	2.92	0.27	64.02	2.29	2.02	27.760	2.58	159.38	5.70	3.12
Chemicals & non-metallic mineral products	71.42	6.64	88.39	3.16	-3.48	52.532	4.88	139.27	4.98	0.10
Machinery & Equipment	1.97	0.18	37.92	1.36	1.17	16.717	1.55	84.23	3.02	1.46
Computers, electronic & electrical equipment	0.58	0.05	30.49	1.09	1.04	10.050	0.93	104.61	3.74	2.81
Total Business Sector Services	**104.41**	**9.71**	**296.67**	**10.62**	**0.91**	**160.226**	**14.90**	**542.42**	**19.41**	**4.52**
Distributive Trade, Transport, accomm. & food services, plus Information & Communication	41.88	3.89	205.87	7.36	3.47	113.914	10.59	344.29	12.32	1.73
Financial and Insurance Activities	50.88	4.73	74.84	2.68	-2.05	14.167	1.32	71.51	2.56	1.24
Real Estate, renting, R&D and other business activities	11.66	1.08	4.29	0.15	-0.93	32.145	2.99	22.87	0.82	-2.17
Community, Social & personal services	**10.87**	**1.01**	**7.543**	**0.27**	**-0.74**	**11.616**	**1.08**	**31.45**	**1.13**	**0.05**
Total Services (Total Business Sector Services + Community, social & personal services)	**115.28**	**10.72**	**304.22**	**10.89**	**0.17**	**171.84**	**15.98**	**573.87**	**20.54**	**4.56**
Mining & quarrying	**10.84**	**1.01**	**86.989**	**3.11**	**2.11**	**7.84**	**0.73**	**143.901**	**5.15**	**4.42**
Electricity, Gas & Water Supply	**6.00**	**0.56**	**32.161**	**1.15**	**0.59**	**6.306**	**0.59**	**43.202**	**1.55**	**0.96**
Agriculture, hunting, forestry & fishing	**16.26**	**1.51**	**25.836**	**0.92**	**-0.59**	**6.328**	**0.59**	**19.186**	**0.69**	**0.10**
Construction	**2.79**	**0.26**	**0.643**	**0.02**	**-0.24**	**2.528**	**0.24**	**7.32**	**0.26**	**0.03**
Domestic Value Added content of Gross Exports	**713.18**	**66.31**	**1309.90**	**46.89**	**-19.43**					
Foreign Value Added content of gross exports	**362.32**	**33.69**	**1483.92**	**53.11**	**19.43**					
Gross Exports	**1,075.50**	**100.00**	**2793.82**	**100.00**	**0.00**					

Sourcing by the country of origin according to table no. 13, China becomes the major source of FVA in gross exports, constituting for 12.76% in 2015. However, Japan becomes the 2nd biggest source of FVA in 2015, decreasing from being the major source accounting about 11.87% in 1995 to only 5.74% in 2015. Besides, FVA from USA and

Germany increased from 3.72% and 2.19% in 1995 to 5.34% and 2.47% in 2015, respectively. The FVA from USA and Germany would reflect the assembling task of American and German OEMs vehicles in Malaysia. Malaysia also outsourced from regional value chains in ASEAN. The FVA from Singapore, Thailand, and Indonesia increased from total 2.71% in 1995 to 6.03% in 2015.

Sourcing by the industry of origin, FVA share in gross exports sourcing from transport equipment sector increased from 4.20% in 1995 to 5.57% in 2015, while the DVA share decreased from 44.34% in 1995 to 21.52% in 2015. This even reflects the increasing dependency on imported input, especially from its own sector. It would be more competitive in the export production to import inputs rather than employ domestic content. In other words, the domestic supply base still cannot develop and compete with other countries. Malaysia also depends on imported inputs from metal and chemicals sector. Malaysia increased its dependency on imported inputs from chemicals sector, which the FVA share in gross exports increased from 4.88% in 1995 to 4.98% in 2015, while the DVA share decreased from 6.64% in 1995 to 3.16% in 2015. And though Malaysia can source more domestic content from metal sector by increasing DVA share from 0.27% in 1995 to 2.29% in 2015, Malaysia increased importing inputs from metal sector overseas by increasing FVA share from 2.58% in 1995 to 5.70% in 2015. This would imply that the domestic metal sector could not grow to sufficiently support the export production in automotive industry.

Table no.13: Value Added content of gross exports in Malaysia's Automotive Industry by country of origin

1995			2015		
Source Country	Value Added content of Gross Exports (Mill. US$)	Share of VA in gross exports (%)	Source Country	Value Added content of Gross Exports (Mill. US$)	Share of VA in gross exports (%)
Malaysia (DVA)	713.18	66.31	Malaysia (DVA)	1309.903	46.89
Foreign Value Added	362.32	33.69	Foreign Value Added	1483.92	53.11
Japan	127.646	11.87	China	356.421	12.76
USA	40.012	3.72	Japan	160.387	5.74
Germany	23.603	2.19	USA	149.319	5.34
France	16.989	1.58	Germany	68.981	2.47
Korea	14.932	1.39	Singapore	63.344	2.27
Taiwan	14.932	1.39	Thailand	61.321	2.19
Singapore	13.503	1.26	Korea	61.196	2.19
UK	13.343	1.24	Australia	50.15	1.80
Australia	11.761	1.09	France	45.591	1.63
Thailand	8.352	0.78	Indonesia	43.922	1.57
Indonesia	7.205	0.67	India	38.854	1.39
Italy	6.127	0.57	Taiwan	36.493	1.31
Hong Kong	4.895	0.46	UK	31.493	1.13
Netherland	4.716	0.44	Italy	19.47	0.70
Switzerland	4.569	0.42	Saudi Arabia	18.824	0.67
Rest of the world	49.738	4.62	Rest of the world	278.155	9.96
Total	1075.503	100.00	Total	2793.824	100.00

Service sector play an increasing role in Malaysian automotive value chains. Both DVA share and FVA share in gross exports from service sector increased. However, the higher share of FVA compared with DVA share reflected that Malaysia outsourced service activities to support the export production in automotive industry.

Philippines

According to Table no. 14, through backward linkages, share of FVA in gross exports decreased from 44.02% in 1995 to 33.63% in 2015, while DVA share increased from 55.98% in 1995 to 66.37% in 2015. This reflects the development of domestic supply base. According to the table no. 6, direct domestic content in gross exports increased dramatically from 28.36% in 1995 to 41.25% in 2015. And the indirect domestic content in gross exports slightly decreased from 27.57% in 1995 to 25.05% in 2015. More domestic content in exports have been employed in the export production, which Philippines relies less on imported inputs. This might be because the Philippines export less automobiles and increase export production of intermediates to other countries instead.

Table no.14: Value Added content of gross exports in Philippines' Automotive Industry by Industry of Origin

Source Industry	Domestic Value Added content of Gross Exports					Foreign Value Added content of Gross Exports				
	DVA (Mill. US$)	share in exports (%)	DVA (Mill. US$)	share in exports (%)	Change in DVA share in exports (%)	FVA (Mill. US$)	Share in exports (%)	FVA (Mill. US$)	Share in exports (%)	Change in DVA share in exports (%)
	1995		2015			1995		2015		
Total Manufactures	**109.59**	**37.73**	**2213.857**	**49.54**	**11.81**	**63.318**	**21.80**	**769.76**	**17.23**	**-4.57**
Transport Equipment	82.43	28.38	1851.452	41.43	13.05	24.710	8.51	269.64	6.03	-2.47
Basic Metals & fabricated metal products	9.07	3.12	166.261	3.72	0.60	15.154	5.22	152.91	3.42	-1.80
Chemicals & non-metallic mineral products	14.09	4.85	74.095	1.66	-3.19	10.193	3.51	124.98	2.80	-0.71
Machinery & Equipment	0.36	0.12	14.216	0.32	0.19	3.641	1.25	59.45	1.33	0.08
Computers, electronic & electrical equipment	1.61	0.55	57.776	1.29	0.74	5.158	1.78	114.70	2.57	0.79
Total Business Sector Services	**37.07**	**12.76**	**535.429**	**11.98**	**-0.78**	**51.288**	**17.66**	**498.38**	**11.15**	**-6.50**
Distributive Trade, Transport, accomm. & food services, plus Information & Communication	16.34	5.63	402.069	9.00	3.37	36.552	12.58	329.14	7.37	-5.21
Financial and Insurance Activities	2.66	0.92	120.376	2.69	1.78	4.810	1.66	68.19	1.53	-0.13
Real Estate, renting, and other business activities	18.07	6.22	10.614	0.24	-5.98	9.924	3.42	19.95	0.45	-2.97
Community, Social & personal services	**2.53**	**0.87**	**17.56**	**0.39**	**-0.48**	**6.376**	**2.20**	**27.96**	**0.63**	**-1.57**
Total Services (Total Business Sector Services + Community, social & personal services)	**39.60**	**13.63**	**552.99**	**12.37**	**-1.26**	**57.66**	**19.85**	**526.35**	**11.78**	**-8.07**
Mining & quarrying	**3.95**	**1.36**	**103.880**	**2.32**	**0.96**	**2.81**	**0.97**	**143.17**	**3.20**	**2.24**
Electricity, Gas & Water Supply	**6.09**	**2.10**	**77.134**	**1.73**	**-0.37**	**2.11**	**0.73**	**40.83**	**0.91**	**0.19**
Agriculture, hunting, forestry & fishing	**2.78**	**0.96**	**17.87**	**0.40**	**-0.56**	**1.201**	**0.41**	**17.27**	**0.39**	**-0.03**
Construction	**0.58**	**0.20**	**0.09**	**0.00**	**-0.20**	**0.773**	**0.27**	**5.45**	**0.12**	**-0.14**
Domestic Value Added content of Gross Exports	**162.59**	**55.98**	**2,965.82**	**66.37**	**10.39**					
Foreign Value Added content of gross exports	**127.87**	**44.02**	**1,502.81**	**33.63**	**-10.39**					
Gross Exports	290.46	100.00	4,468.63	100.00	0.00					

By country of origin, the share of FVA in gross exports from Japan dramatically decreased from 17.23% in 1995 to 5.36% in 2015. However, China becomes the major

source of FVA by increasing FVA share in gross exports from 0.58% in 1995 to 7.55% in 2015, highlighting the importance of China in ASEAN automotive value chains. And Thailand becomes the 3rd biggest source of FVA in Philippines from increasing FVA share of 1.21% in 1995 to 2.75% in 2015. And as regional value chains, FVA share from ASEAN; Thailand, Indonesia, Singapore, and Malaysia accounted about 3.32% in total in 1995, and increased to 4.33% from Thailand, Singapore, and Malaysia in 2015. However, the FVA from countries owning the OEMs vehicles turned to decrease. The FVA share from Japan decreased from 17.23% in 1995 to only 5.36% in 2015. The FVA share from USA and Germany decreased from 5.58% and 1.69% in 1995 to 2.43% and 1.21% in 2015.

By industry of origin, the FVA share in gross exports sourcing from transport equipment sector decreased from 8.51% in 1995 to 6.03% in 2015, while its DVA share increased dramatically from 28.38% in 1995 to 41.43% in 2015. It illustrates the development of the supply chains in the automotive industry, especially the development of the intermediate or auto component production in automotive industry in the country. Besides, domestic metal sector can contribute more to Philippines automotive industry. Its DVA share increased from 3.12% in 1995 to 3.71% in 2015, while Philippines automotive sector decreased its dependency on imported inputs from metal sector in overseas (decreased from 5.22% in 1995 to 3.42% in 2015).

Table no.15: Value Added content in gross export in Philippines' Automotive Industry by country of origin

1995			2015		
Source Country	Value Added content of Gross Exports (Mill. US$)	Share of VA in gross exports	Source Country	Value Added content of Gross Exports (Mill. US$)	Share of VA in gross exports
Philippines (DVA)	162.586	55.98	Philippines (DVA)	2965.816	66.37
Foreign Value Added	127.87	44.02	Foreign Value Added	1502.81	33.63
Japan	50.049	17.23	China	337.27	7.55
USA	16.213	5.58	Japan	239.56	5.36
Korea	9.082	3.13	Thailand	122.97	2.75
Taiwan	5.004	1.72	USA	108.65	2.43
Germany	4.895	1.69	Korea	93.23	2.09
Russia	4.257	1.47	Germany	54.16	1.21
Thailand	3.507	1.21	Taiwan	46.98	1.05
Australia	3.095	1.07	Singapore	43.41	0.97
France	2.391	0.82	India	41.75	0.93
Saudi Arabia	2.29	0.79	France	29.61	0.66
Indonesia	2.251	0.77	Malaysia	27.22	0.61
Singapore	2.038	0.70	Australia	23.91	0.53
UK	1.869	0.64	Saudia Arabia	20.53	0.46
Malaysia	1.868	0.64	UK	19.86	0.44
China	1.688	0.58	Italy	14.10	0.32
Rest of the world	17.375	5.98	Rest of the world	279.62	6.26
Total	290.458	100.00	Total	4,468.63	100.00

In service sector, Philippines automotive sector decreased its dependency on total service sector since both FVA and DVA share decreased from 19.85% and 13.63% in 1995 to 11.78% and 12.37% in 2015. However, the DVA share from distributive trade, transport, accommodation & food service, including Information & communication and Financial & Insurance activities sector increased from 5.63% and 0.92% in 1995 to 9.00% and 2.69% in 2015, while its FVA share decreased over time from 12.58% and 1.66% in 1995 to 7.37% and 1.53% in 2015.

6. ESTIMATION ANALYSIS

6.1 Impact of Global Production Networks on Value Added in Automotive Industry

Table no. 16: Estimating Results for Impact of GPNPART and GPNPOS on Domestic Value Added and Labor Productivity in Automotive Industry

Independent Variables		Dependent Variables			
		Domestic Value Added in Automotive Industry		Labor Productivity in Automotive Industry	
		1	2	3	4
GPNPART	Thailand	**- 1.6589 * (0.8410)**	**10.0371 ** (3.8758)**	- 0.0361 (0.9055)	**12.9371 *** (4.7000)**
	Indonesia		**2.8697 ** (1.3961)**		2.7166 (1.6819)
	Malaysia		**- 8.7776 *** (1.8694)**		**- 6.3437 *** (2.2325)**
	Philippines		- 1.3539 (1.2533)		0.9184 (1.5082)
GPNPOS	Thailand	1.8966 (1.2894)	**4.5142 * (2.4610)**	1.8525 (1.4015)	**5.9034 * (2.9715)**
	Indonesia		- 3.2584 (2.2240)		- 4.0290 (2.6756)
	Malaysia		**- 3.3432 * (1.7538)**		- 1.1145 (2.1051)
	Philippines		- 1.3699 (2.2110)		- 3.6992 (2.6731)
log(K)		0.1252 ** (0.0573)	0.0373 (0.0409)		
log(K/L)				0.2033 *** (0.0580)	0.0373 (0.0409)
log(HC)		- 0.6985 (1.8704)	- 0.8686 (1.5828)	- 1.2940 (2.0371)	- 0.8686 (1.5828)
TRD		0.0085 * (0.0049)	0.0037 (0.0039)	0.0040 (0.0053)	0.0037 (0.0039)
Constant		26.8118 (19.5491)	29.0941 * (16.1347)	21.8536 (21.2102)	29.0941 * (16.1347)
Fixed Effect (Cross)		Yes	Yes	Yes	Yes
Fixed Effect (Period)		Yes	Yes	Yes	Yes
Cross-Section specific Coeffcients		No	Yes	No	Yes
Observations		84	84	84	84
Sample Period		1995-2015	1995-2015	1995-2015	1995-2015
R-square		0.89	0.95	0.75	0.95
Durbin-Watson stat		0.54	1.45	0.58	1.45

Based on the result on table no.16 column no. 1, GPN Participation (GPNPART) significantly has a negative impact on value added at 10% level. It infers that increasing the degree of GPN participation significantly leads to lower value added in the industry. It would reflect that how these countries participate in the networks has a negative impact on domestic value added since most of them rely on imported foreign content in their exports production. And according to the table no. 16 column no. 1, the

estimation is for deeper analysis by studying impact of 2 different GPN channels on the output of the industry. BACKWARD significantly has a negative impact on value added in the industry at 1% level of -3.1409 coefficient. It implies that increasing in foreign content share in the gross exports might not gain higher value added from low-value added activities. By increasing foreign content from imported inputs and focusing on assembling tasks would not create additional value added through global production networks. And the GPNPOS and FORWARD's result is not significant.

Table no. 17: Estimating Results for Impact of FORWARD and BACKWARD on Domestic Value Added and Labor Productivity in Automotive Industry

Independent Variables		Dependent Variables			
		Domestic Value Added in Automotive Industry		Labor Productivity in Automotive Industry	
		1	2	3	4
FORWARD (Upstream GPNS)	Thailand	0.2349 (1.5859)	**13.8360 *** (5.1316)**	1.7978 (1.7301)	**17.8142 *** (6.1894)**
	Indonesia		0.3653 (2.1776)		- 0.4111 (2.6062)
	Malaysia		**- 11.1501 *** (3.1363)**		**- 6.9187 * (3.7313)**
	Philippines		- 2.5619 (2.6074)		- 2.0672 (3.1242)
BACKWARD (Downstream GPNs)	Thailand	**- 3.1409 *** (0.8380)**	**7.0076 ** (3.4164)**	- 1.4732 (0.8922)	**8.9312 ** (4.1139)**
	Indonesia		**5.4755 ** (2.3045)**		**5.9202 ** (2.7610)**
	Malaysia		**- 6.4795 *** (1.2452)**		**- 5.5686 *** (1.4850)**
	Philippines		- 0.3578 (1.4294)		**3.6109 ** (1.7283)**
log(K)		0.1230 ** (0.0568)	0.0378 (0.0411)		
log(K/L)				0.2014 *** (0.0576)	0.1218 ** (0.0459)
log(HC)		- 0.5759 (1.8561)	- 0.8384 (1.5915)	- 1.1796 (2.0258)	- 0.7131 (1.9076)
TRD		0.0089 * (0.0049)	0.0040 (0.0039)	0.0043 (0.0053)	0.0006 (0.0046)
Constant		25.4685 (19.4024)	28.7068 * (16.2196)	20.5716 (21.0981)	15.1218 (19.3389)
Fixed Effect (Cross)		Yes	Yes	Yes	Yes
Fixed Effect (Period)		Yes	Yes	Yes	Yes
Cross-Section specific Coeffcients		No	Yes	No	Yes
Observations		84	84	84	84
Sample Period		1995-2015	1995-2015	1995-2015	1995-2015
R-square		0.89	0.95	0.75	0.87
Durbin-Watson stat		0.54	1.44	0.59	1.63

To analyze its effect on each cross section, the estimation model is conditioned by cross section specific coefficient analysis at the studied independent variables (GPNPART, GPNPOS, FORWARD, and BACKWARD), according to column no.2 in table no. 16 and 17. And with the cross section fixed effect specification, the constant

term is significant at 10% level, this implies that the specific characteristic of each country does have an impact on value added of each country. For example, the policy in automotive industry between Thailand and Malaysia are totally different. While Malaysia pursued their national cars mostly for their domestic demand, Thailand automotive industry focused on assembling vehicles for foreign car manufacturers. The individual characteristic of each country can be referred as per section no. 2 in the paper.

Thailand can increase value added by increasing the degree of GPN participation. The result of Thailand shows the significant level at 5% with the coefficient of 10.0371. Also its result of GPN Position shows a positive impact with the significant level at 10%. It implies Thailand can significantly increase value added from increasing the degree of specialization and economies of scale. Besides, participating through forward and backward linkages can significantly gain higher value added. The results show significant level at 1% for forward linkages and 5% for backward linkages. Besides, the size of coefficient shows that forward linkages can significantly create higher value added than backward linkages (FORWARD: 13.8360, and BACKWARD: 7.0076).

Indonesia GPN participation's result shows the significant level at 5% with the positive sign of coefficient at 2.8697, lower than Thailand. Besides, And Indonesia's backward linkages can significantly gain higher value added at 5%, according to table no.15 column no.2. But GPNPOS and FORWARD's result is not significant.

Malaysia's GPNPART significantly lowers value added at 1% level with the size of coefficient at -8.7776. Since the Malaysia's automotive industry mostly dominated by the domestic demand. Within the limited capacities of the industry, if the industry decides to participate more in GPNs either backward or forward linkages, the now available domestic factors might be reallocated to the export sector, thereby decreasing total domestic value added which mostly generated through domestic market. Also GPNPOS has a significantly negative effect on value added at 10% level. Due to specializing toward more downstream position in GVCs, Malaysia keeps increasing foreign content share in exports, which cannot gain higher value added to the industry. Considering between forward and backward linkages, both of them significantly decrease the value added. Besides, Forward linkages' size of coefficient (-11.1501 at 1%) is bigger than backward linkages (-6.4795 at 1%). This would reflect that increasing the intermediate export portion involving in the GPNs can significantly lower value added in the industry. Within the limited domestic capacity, intermediates should be supplied to the domestic production than exporting to other countries. And through backward linkages, Malaysia cannot gain higher value added. Relying on imported inputs and specializing only assembling task might not gain further value added. Without technology transfer promotion and domestic supply base development, the country could be trapped in the low-value added activities in GVCs.

While Philippines' GPNPART, GPNPOS, FORWARD, and BACKWARD have a negative impact on value added, but not significant. Philippines' GPN involvement does not significantly gain higher value added. This estimating result would evidence the unsuccessful assembling industry in Philippines. And according to the value added content of exports in table no.6, the data evidences the development of domestic supply base from dramatically increasing in direct domestic value added share of gross exports from 28.36% in 1995 to 41.25% in 2015. It reflects that the

development of domestic supply base in supporting export production would contribute more to the industrial growth in the country, rather than GPN involvement.

6.2 Impact of Global Production Networks on Labor Productivity in Automotive Industry

Based on the result on table no. 15 and 16 column no. 3, the overall shows no significant impact on labor productivity from GPNs involvement (GPNPART, GPNPOS, FORWARD, and BACKWARD).

However, based on cross section specific analysis in column no. 4, Thailand's GPNPART and GPNPOS significantly cause higher labor productivity with 1% and 10% level, respectively. Both FORWARD and BACKWARD significantly have a positive impact on productivity. But FORWARD can significantly gain higher labor productivity, compared with BACKWARD linkages (17.8142 at 1% level and 8.9312 at 5% level). This result again evidences the success of Thailand automotive industry involvement in GVCs.

Indonesia's BACKWARD significantly has a positive impact on productivity at 5% level of 5.9202 coefficient. It shows that Indonesia can significantly gain productivity from increasing share of foreign content in gross exports though backward linkages in GVCs. However, GPNPART, GPNPOS, and FORWARD's impact on productivity are not significant.

Similar to the domestic value added model, Malaysia's GPNPART significantly leads to lower productivity at 1% level. FORWARD and BACKWARD significantly have a negative impact on productivity, and coefficient of FORWARD (-6.9187 at 10% level) is greater than BACKWARD (-5.5686 at 1% level). And GPNPOS's impact is not significant.

Philippines' BACKWARD significantly shows a positive impact on productivity at 5% level of 3.6109 coefficient. However, GPNPART, GPNPOS, and FORWARD's impact on productivity are not significant.

6.3 Impact of Global Production Networks on Export Performance in Automotive Industry

Based on the result from the table no. 18 and 19 in column no. 1, GPNPART and GPNPOS significantly have a positive impact on gross exports at 1% level. These reflect that increasing the participation degree and the specialization can significantly boost gross exports. Specifically, FORWARD can significantly gain gross exports from positive sign of 4.1345 at 1% level. Increasing the participation degree through intermediate production for another stage of production in other countries significantly gains gross exports. But BACKWARD can lower the gross export performance, which the result shows the negative sign of -1.3798 at 1% level. It shows the opposite relationship between foreign content share in gross export and export performance. In other words, increasing domestic content in exports created through comparative advantages of participating countries would boost better export performance.

Hence, to examine export performance in term of domestic content really created in the export production, the domestic value added embodied in the exports (DVA in gross exports) is also used as another dependent variable. As per table no. 18 and 19 in column no. 3, GPNPART's impact on DVA embodied in exports significantly

shows a negative sign at 1% level. Besides, BACKWARD significantly has a negative impact on DVA in gross exports. And the coefficient of BACKWARD in DVA in gross exports (-4.1092) is bigger than the size of BCAKWARD coefficient in gross exports model (-1.3798). This clearly evidences that increasing foreign content share in gross exports could lower the domestic content in export production, hence gross exports. And it would further describe the negative impact of total GPN participation on DVA in gross exports. However, GPNPOS and FORWARD significantly have a positive impact on DVA in gross exports, similar to gross exports model.

And with the cross section fixed effect specification, the constant term is significant at 1% level at all export models, this implies that the specific characteristic of each country does have an impact on export performance of each country. For example, Thailand and Indonesia focus on exporting finished vehicles and becoming the export hub in ASEAN, while Philippines keep exporting more auto parts. But Malaysia's production mostly supplies to domestic market.

Table no. 18: Estimating Results for Impact of GPNPART and GPNPOS on Gross Exports and Domestic Value Added embodied in Gross Exports in Automotive Industry

Independent Variables		Dependent Variables			
		Gross Exports in Automotive Industry		Domesitc Value Added embodied in Gross Exports	
		1	2	3	4
GPNPART	Thailand	**1.2309 *** (0.4498)**	0.8301 (1.5753)	**- 1.2321 *** (0.4256)**	0.0890 (2.3484)
	Indonesia		0.7567 (0.4771)		0.2241 (0.9097)
	Malaysia		0.7909 (2.0010)		-0.8695 (1.1803)
	Philippines		**2.3304 *** (0.5123)**		**- 1.8119 ** (0.8001)**
GPNPOS	Thailand	**3.6938 *** (0.6794)**	**2.2329 * (1.3121)**	**4.0445 *** (0.6428)**	**3.2152 * (1.6280)**
	Indonesia		1.0187 (1.2601)		1.7267 (1.3493)
	Malaysia		**5.3708 *** (1.6103)**		**5.2041 *** (1.2243)**
	Philippines		**1.9350 *** (0.5139)**		**3.4546 ** (1.4144)**
log(REER)		0.6460 *** (0.2126)	0.4460 ** (0.1851)	0.2745 (0.2012)	0.1083 (0.2348)
log(WY)		2.5192 *** (0.0789)	2.6244 *** (0.0983)	2.6204 *** (0.0747)	2.5828 *** (0.0939)
TRD		0.0167 *** (0.0015)	0.0147 *** (0.0020)	0.0147 *** (0.0014)	0.0144 *** (0.0020)
Constant		- 69.6172 *** (2.6628)	- 71.7519 *** (2.6734)	- 63.1079 *** (2.5195)	- 61.5295 *** (3.0736)
Fixed Effect (Cross)		Yes	Yes	Yes	Yes
Fixed Effect (Period)		No	No	No	No
Cross-Section specific Coeffcients		No	Yes	No	Yes
Observations		88	88	88	88
Sample Period		1995-2016	1995-2016	1995-2016	1995-2016
R-square		0.96	0.97	0.96	0.96
Durbin-Watson stat		0.68	0.92	0.83	0.91

By cross section specific analysis as per column no. 2 and 4 on table no. 18 and 19, Thailand's GPNPOS significantly has a positive impact on gross exports and DVA in exports. The results show a significant impact at 10% level of 2.2329 and 3.2152 coefficient, inferring increasing GPN specializing position significantly leads to higher gross exports and domestic contents in gross exports. This result confirms the success of Thailand becoming the export hub of finished vehicles in ASEAN, or downstream specialization in automotive GVCs. However, GPNPART, FORWARD and BACKWARD's impact on gross exports and DVA in gross exports are not significant.

Indonesia's FORWARD significantly gains performance export in gross export and DVA in gross exports at 10% significant level of 1.5230 and 1.5554 coefficient. Again, increasing exports of inputs to other production process in GVCs significantly boosts export performance in Indonesia. GPNPART, GPNPOS, and BACKWARD's impact on both gross exports and DVA in gross exports are not significant.

Table no. 19: Estimating Results for Impact of FORWARD and BACKWARD on Gross Exports and Domestic Value Added embodied in Gross Exports in Automotive Industry

Independent Variables		Dependent Variables			
		Gross Exports in Automotive Industry		Domesitc Value Added embodied in Gross Exports	
		1	2	3	4
FORWARD (Upstream GPNS)	Thailand	**4.1347 *** (0.8627)**	2.5732 (1.9278)	**1.9634 ** (0.8128)**	2.6393 (2.2943)
	Indonesia		**1.5230 * (0.8347)**		**1.5554 * (0.8085)**
	Malaysia		5.1663 (3.1847)		3.4944 (2.8270)
	Philippines		**3.8643 *** (0.6327)**		0.9761 (1.3770)
BACKWARD (Downstream GPNs)	Thailand	**- 1.3798 *** (0.4251)**	- 0.7208 (1.7961)	**- 4.1092 *** (0.4005)**	- 2.1428 (2.0513)
	Indonesia		- 0.0334 (1.3052)		- 1.1343 (1.2065)
	Malaysia		**- 2.8541 ** (1.2924)**		**- 4.3691 *** (0.9849)**
	Philippines		0.9182 (0.6649)		**- 4.3768 *** (1.0689)**
log(REER)		0.6274 *** (0.2122)	0.4549 ** (0.1852)	0.2533 (0.19986)	0.1216 (0.1827)
log(WY)		2.5225 *** (0.0787)	2.6232 *** (0.0980)	2.6250 *** (0.0741)	2.5811 *** (0.0824)
TRD		0.0165 *** (0.0015)	0.0147 *** (0.0020)	0.0145 *** (0.0014)	0.0144 *** (0.0020)
Constant		- 69.7027 *** (2.6542)	- 71.8371 *** (2.6703)	- 63.2346 *** (2.5005)	- 61.6511 *** (2.6602)
Fixed Effect (Cross)		Yes	Yes	Yes	Yes
Fixed Effect (Period)		No	No	No	No
Cross-Section specific Coeffcients		No	Yes	No	Yes
Observations		88	88	88	88
Sample Period		1995-2016	1995-2016	1995-2016	1995-2016
R-square		0.96	0.97	0.96	0.97
Durbin-Watson stat		0.68	0.91	0.84	0.91

Malaysia's GPNPOS significantly boosts export performance at 1% level, both gross exports and DVA in exports. This implies increasing downstream specialization in GVCs by foreign OEM assembly plants significantly boosts Malaysia's export performance, though the value of gross exports is the lowest among these 4 ASEAN countries. However, BACKWARD significantly leads to lower export performance in both gross exports and DVA in gross exports. BACKWARD's impact on gross export is -2.8541 at 5% level, while BACKWARD's impact on DVA in gross exports is even greater and clearer at -4.3691, 1% level. It reflects the opposite relationship between foreign content share in gross exports and export performance, which the development of domestic content in gross export should boost higher export performance. According to the gross export composition of Malaysia, it increases the GPN participation degree over time due to the rising share of foreign content in gross export or backward linkages, as a result domestic content in exports keeps decreasing. It means that higher GPN participation may not necessarily imply higher gain. This export with little value-addition and high foreign-content may not be able to generate substantial growth. GPNPART and FORWARD's result are not significant.

Philippines' GPNPART significantly shows a positive impact on gross exports at 1% level of 2.3304 coefficient, while its impact on DVA in gross exports significantly shows a negative impact at 5% level of -1.8119 coefficient. This result has been evidenced by the 2 different channels of GVCs participation analysis. FORWARD significantly has a positive impact on gross exports at 1% level of 3.8643 coefficient. But BACKWARD's impact on DVA in gross exports is significant and negative at 1% level of -4.3768 coefficient. This shows that increasing participation through forward linkages can boost growing gross exports in the country, yet increasing degree of backward linkages can somehow lower the domestic content in gross exports. The impact of forward linkages again confirms that Philippines can gain their gross export from increasing export production of auto parts and other inputs to other countries. And through backward linkages, it reflects the unsuccessful assembly industry from relying on imported foreign content in gross exports in Philippines. Besides, GPNPOS significantly shows the positive effect at both models, (its impact on gross exports: 1.93497 at 1% level, its impact on DVA in gross exports: 3.4546 at 5% level).

7. CONCLUSION

This paper attempts to empirically assess the impact of global production networks on the development of automotive industry in 4 selected ASEAN countries namely; Thailand, Indonesia, Malaysia, and Philippines in 3 aspects, production, productivity, and export performance. Employing Trade in Value Added (TiVA) from OECD-WTO to construct GPNs indicator as the variable of interest.

These ASEAN countries started the industry from assembly manufacturing then started to participate the GPNs. However, reliance on imported inputs to assemble into finished vehicles is not sufficient to further develop the industry. It needs to expand the domestic supply base to produce the auto components, raw materials, research and development, and any activities in upstream global production networks. To participate in GPNs, countries need to develop strong domestic backward linkages in order to support the task of assembling finished vehicles. And once the domestic backward linkages have been developed, the countries will be able to further

participate strong international forward linkages in the GPNs which truly capture the domestic content. This is to move towards Upstream in value chains.

Therefore, countries should increase GPN participation through ***the development of domestic content in exports*** by creating ***"domestic productive capacity"*** to substitute imported content of exports, therefore gain higher value added. In order to build and improve domestic productive capacity along the chains or upgrading in the GPNs, it is based on skills, capabilities, and comparative advantages of the industry. Countries should improve workers' skill, absorptive capacity and technology, increasing productivity, and comparative advantages along the value chains in order to successfully in the global market.

Upgrading in GPNs will be able to resolve the Artificial Intelligence issue, which in case it can substitute the workforce in the downstream GPN activities, especially the assembling tasks that can be easily performed by robots. Furthermore, in case of labor cost competiveness, moving up the value chains can be considered as an alternative strategy if the GPN participating countries are losing the labor cost competiveness. Vietnam is now taking part in the automotive GPNs by performing the downstream position. Foreign car manufacturers exploit Vietnam's lower cost of labor by importing most auto parts and assembling into vehicles. Therefore, it could be the risk for other participating countries where focus on only footloose activities, which the foreign OEMs can reallocate their assembly plants to other countries based on comparative advantages.

It is evidenced that upgrading through GPNs, share of Domestic value added content and Direct Domestic value added content in gross export increase over time in Thailand, Indonesia, and Philippines.

Thailand can exploit the benefit from GPNs participation, through task specialization and economies of scale, and at the same time expanding the domestic base supporting in GPN involvement. Beginning the industry by assembling manufacturing, it upgrades towards higher value added activities. There are all 3 tier auto part suppliers supporting the assembling task in the country and also exporting auto parts to other countries. And due to the technology transfer, there are successful local auto parts producers producing and exporting 1st and 2nd tier components. According to empirical evidence, all GPNs involvements (GPNPART, GPNPOS, FORWARD and BACKWARD) make Thailand gain positive value added, productivity. Especially forward linkage, it can create additional value added and productivity from high-value added activities. Thai export performance, both value of gross exports and domestic content in gross exports, can be boosted by specializing itself in downstream position within GPNs.

Indonesia becomes the assembly and export hub for foreign car manufacturers, similar to Thailand. It can somehow upgrade towards higher value added activities. But since the productive capacities, human resources and technology transfer are insufficient, these still limit the chance of local suppliers to upgrade and become the first-tier suppliers. High technology components must be supplied by multinational auto part producers and imported by other countries such as Thailand. According to the empirical evidence, increasing participation in GPNs, especially through backward linkages, significantly boosts Indonesia's value added and productivity. However, forward linkages still cannot boost value added and productivity. But forward linkages significantly boost gross exports and domestic content in gross exports.

Due to the unsuccessful assembling manufacturing, Philippines reposition themselves towards more upstream in GPNs by producing and exporting selected auto parts which they have the comparative advantages. That's why they can capture increasing domestic content in gross exports. However, the selected auto parts are in the 2nd and 3rd tier supplier, normally labor and skill-intensive. They still cannot upgrade towards high-tech components. According to the empirical evidence, Philippines GPNs involvement does not have the significant impact on value added and productivity. Though Philippines try to reposition themselves towards upstream, Philippines still cannot produce the high-tech components which can make them gain higher value added and productivity from GPNs. However, Philippines' forward linkages significantly boost gross exports by exporting auto parts to other assembly plants in other countries. Lastly, its backward linkages significantly lower its domestic content in gross exports, which reflects the unsuccessful assembling manufacturing relying on only imported inputs.

Though Thailand, Indonesia, and Philippines can upgrade their productive capabilities along the GPNs even with the different levels, there are also some risks of limited domestic value capture in GPNs. The opportunities to upgrade in GPNs should be ensured, otherwise the participating countries would remain locked into low value added activities from relying on imported high-tech inputs.

Malaysia keeps increasing foreign content in gross exports, while the country cannot upgrade domestic capability to support export production. It is more competitive to import inputs from other countries' comparative advantages. This is evidenced by the increasing foreign car assembling plants in Malaysia, which most auto parts are imported and assembled in Malaysia. The country remain locked into low value added activities. At the same time, the industry has dominated by domestic market which has been subsidized and protected by the government. According to the empirical evidence, Malaysia's GPNs participation shows clearly a negative impact on value added and productivity from relying on increasing foreign content in gross exports, which it cannot gain any additional value added from low-value added activities. Besides, the negative impact of forward linkages on value added and productivity evidences the limited capacities of the industry, which intermediate inputs should be supplied to the domestic production instead of exported to other countries. Lastly, though positioning itself as downstream specialization significantly increases Malaysia's export performance, backward linkages significantly decrease domestic content in gross exports, as a result gross exports.

Furthermore, considering Malaysia's national car strategy as the development path in the GPNs circumstance, the national cars are unsuccessfully enter in the GPNs. As a result, they cannot access to the technology, production and sales networks within the automotive GPNs. Then it limits their chance to upgrade along the GPNs, therefore cannot successfully compete with other foreign cars manufacturers in the global market. Even in the domestic market, 2 national cars in Malaysia are facing high competition. And though they can employ domestic content in gross exports from subsidy and protection by the government, they still cannot easily compete in the global market since it's not competitive from employing domestic content without having comparative advantages.

Furthermore, the development of suppliers in supporting sectors linked to the automotive chains is also considered important and required. The countries should

increase capabilities in industrial and service activities that can provide a good base linking with automotive chains. For example, the participating countries can develop capacities of metal sector to sufficiently support the automotive chains. Besides, the efficient network infrastructure and complementary service sectors, such as logistic chains, transport and communication, are also required to enhance the competiveness of manufacturing firms along the automotive value chains.

Since the proportion of participation of each country is still high. Policy supporting the GPN integration is still important. As goods and services cross border multiple time due to the fragmented stage of production, border barriers can accumulate significant cost to the productions. Therefore, trade facilitation measures are very essential to foster GPN integration.

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APPENDIX

According to Koopman (Robert Koopman 2011), the Global Production Network indicators are constructed by employing OECD-WTO Trade in Value Added (TiVA) database, based on the concept of gross export decomposition into 5 items in value added terms.

Estimating Trade in Value Added (TiVA)

The process of estimating TiVA requires an international input-output table to feed the amounts of data into the estimation. The figure below shows the simplified international IOT with 2 countries and 2 sectors. It is divided into a supply side and a use side. The rows in the table represents the use side, containing the information about the distribution of each sector's output (the inter-sector transactions as intermediate demand and final demand, both domestic and foreign consumption). The columns represent the supply side providing information on the origin of goods from domestic production and imports. In each column, we can see the inputs required in production, plus value added generated domestically, which reflects the employees' compensation, and capital income. And total supply must be equal total use.

Simplified international input-output table with 2 countries and 2 sectors

		Intermediate Demand				**Final Demand**		**Output**
		Country A		Country B				
		Sector 1	Sector 2	Sector 1	Sector 2	Country A	Country B	
Country A	Sector 1	Z_{11}^{AA}	Z_{12}^{AA}	Z_{11}^{AB}	Z_{12}^{AB}	F_1^{AA}	F_1^{AB}	X_1^A
	Sector 2	Z_{21}^{AA}	Z_{22}^{AA}	Z_{21}^{AB}	Z_{22}^{AB}	F_2^{AA}	F_2^{AB}	X_2^A
Country B	Sector 1	Z_{11}^{BA}	Z_{12}^{BA}	Z_{11}^{BB}	Z_{12}^{BB}	F_1^{BA}	F_1^{BB}	X_1^B
	Sector 2	Z_{21}^{BA}	Z_{22}^{BA}	Z_{21}^{BB}	Z_{22}^{BB}	F_2^{BA}	F_2^{BB}	X_2^B
VA		V_1^A	V_2^A	V_1^B	V_2^B			
Output		X_1^A	X_2^A	X_1^B	X_2^B			

	Intermediate use of Domestic Output
	Intermediate use of Foreign Output
	Final Use of Domestic Output
	International Transaction of Final Use

Source: Author's Adaptation from Global Value Chains Indicators in the production of International Trade and the application towards economic assessment, FAQ Issue 131, Bank of Thailand (Teerapap P. 2018)

The estimation is to create Matrix of gross exports in terms of value added, called "Matrix VBE", which is calculated from 3 Matrix; Matrix V, B, and E.

Matrix B is Input-coefficient matrix or Leontif inverse matrix, as a total requirement matrix that gives the amount of gross output required for one unit increase in final demand. According to international input-output table, the matrix B can be calculated from linear regression from reading the international IOT in the rows

(showing the distribution of each industry's output or how each good or service is utilized).

From the first row of the table, it can be interpreted that total output of sector 1 in country A (X_1^A) is used as intermediate goods and final demand, both domestic and foreign use).

$$\begin{array}{ccccccccc} X_1^A & = & Z_{11}^{AA} & + & Z_{12}^{AA} & + & Z_{11}^{AB} & + & Z_{12}^{AB} & + & F_1^{AA} & + & F_1^{AB} \\ \vdots & & \vdots & & \vdots & & \vdots & & \vdots & & \vdots & & \vdots \\ X_2^B & = & Z_{21}^{BA} & + & Z_{22}^{BA} & + & Z_{21}^{BB} & + & Z_{22}^{BB} & + & F_2^{BA} & + & F_2^{BB} \end{array} \quad (1)$$

or $X = Z + F$ (2)

where X is a vector of gross outputs, Z is a matrix of intermediate demand and F is a vector of final demand.

Z can be rewritten as A_{ij}^{rs}, which represents the technical coefficient between inputs produced by sector i in country r and used in the production of sector j in country s.

$$A_{ij}^{rs} = \frac{Z_i^{rs}}{X_j^s} \ ,$$

where i, j = 1, 2 and r, s = A, B
i represents row sectors and j represents column sectors.
Equation (1) can be rewritten as;

$$\begin{array}{ccccccccc} X_1^A & = & A_{11}^{AA} X_1^A & + & A_{12}^{AA} X_2^A & + & A_{11}^{AB} X_1^B & + & A_{12}^{AB} X_2^B & + & F_1^{AA} & + & F_1^{AB} \\ \vdots & & \vdots & & \vdots & & \vdots & & \vdots & & \vdots & & \vdots \\ X_2^B & = & A_{21}^{BA} X_1^A & + & A_{22}^{BA} X_2^A & + & A_{21}^{BB} X_1^B & + & A_{22}^{BB} X_2^B & + & F_2^{BA} & + & F_2^{BB} \end{array} \quad (3)$$

or $X = AX + F$ (4)

where A is a technical coefficient matrix. Equation can be solved for X as

$(1-A)X = F$

$X = (1-A)^{-1}F$

or $X = BF$

where B is the Leotief inverse.
Rearrange equation (3) in a block matrix as;

$$\begin{matrix} X_i^A \\ X_i^B \end{matrix} = \begin{bmatrix} B_{ij}^{AA} & B_{ij}^{AB} \\ B_{ij}^{BA} & B_{ij}^{BB} \end{bmatrix} \begin{matrix} F_i^A \\ F_i^B \end{matrix} \quad (5)$$

Matrix V is a value-added coefficient matrix, which can be calculated from value added vector in table no.9's VA row.

$$V_1^A \quad V_2^A \quad V_1^B \quad V_2^B \quad (6)$$

The value added coefficient vector can be calculated by value added vector divided by total output vector. The calculated coefficient will reflects the proportion of value added in total output. It is equal to one minus the intermediate input share from all countries (including the domestically produced intermediates).

$$v_i = \frac{V_i}{X_i} = 1 - \sum_s A_{is} \quad (7)$$

After calculated value added coefficient vector and rearrange in a block matrix as;

$$\begin{bmatrix} v_i^A & o \\ o & v_i^B \end{bmatrix} \quad (8)$$

Multiplying the matrix V with the Leotief inverse B will get the value-added share matrix (VAS) giving the information on how much value added each country needs from its own production and how much from others to reach its current levels of output. This means, the underlying international production structure helps us to understand how the value added of all countries is being used.

$$\text{VAS} = \text{VB} = \begin{bmatrix} v_i^A & o \\ o & v_i^B \end{bmatrix} \begin{bmatrix} B_{ij}^{AA} & B_{ij}^{AB} \\ B_{ij}^{BA} & B_{ij}^{BB} \end{bmatrix} = \begin{bmatrix} v_i^A B_{ij}^{AA} & v_i^A B_{ij}^{AB} \\ v_i^B B_{ij}^{BA} & v_i^B B_{ij}^{BB} \end{bmatrix} \quad (9)$$

In VAS matrix, it contains information how to allocate the domestic share in production and the foreign component. From equation (9), the first column shows the proportion of value added in country A's production. $v_i^A B_{ij}^{AA}$ is value added created by country A (Domestic Value Added), while $v_i^B B_{ij}^{BA}$ is value added created by country B and used by country A's production (Foreign Value Added). The second column shows the same proportion of value added in country B's production.

Matrix E is a gross export matrix, which can be defined from the international IOT as;

$$E_i^r = \sum_{s \neq r} E_i^{rs} = \sum_s (A_{ij}^{rs} X_j^s + F_i^{rs}) \quad (10)$$

where r, s = country A, B and i, j = sector 1, 2

E_i^{rs} is exports value from sector i in country r to country s, which includes $A_{ij}^{rs} X_j^s$ reflecting the exports of intermediate inputs from sector i in country r to country s, and F_i^{rs} reflecting the exports of final demand from sector i in country r to country s. Equation (10) can be rewritten in a block matrix as;

$$\text{E} = \begin{bmatrix} E_i^A & o \\ o & E_i^B \end{bmatrix} \quad (11)$$

By multiplying the value added share matrix and the exports matrix, the actual domestic and foreign value added embodied in gross exports can be obtained as;

$$\text{VBE} = \begin{bmatrix} v_i^A & o \\ o & v_i^B \end{bmatrix} \begin{bmatrix} B_{ij}^{AA} & B_{ij}^{AB} \\ B_{ij}^{BA} & B_{ij}^{BB} \end{bmatrix} \begin{bmatrix} E_i^A & o \\ o & E_i^B \end{bmatrix}$$
$$= \begin{bmatrix} v_i^A B_{ij}^{AA} E_i^A & v_i^A B_{ij}^{AB} E_i^B \\ v_i^B B_{ij}^{BA} E_i^A & v_i^B B_{ij}^{BB} E_i^B \end{bmatrix} \qquad (12)$$

From the first column of VBE matrix, $v_i^A B_{ij}^{AA} E_i^A$ represents domestic value added embodied in gross exports of country A, while $v_i^B B_{ij}^{BA} E_i^A$ represents the value added created by country B and used in the exports of sector i in country A, or Foreign Value Added embodied in gross exports of country A. At the same time, $v_i^B B_{ij}^{BA} E_i^A$ is also considered as indirect domestic value added exports of country B. Hence, $v_i^A B_{ij}^{AB} E_i^B$ is considered as indirect domestic value added exports of country A. The second column reflects the same source of value added in country B's exports.

From the above, the total value of each country sources from other countries has to equal to the total level of value added in exports of other countries, that means Foreign Value Added exports (FVA) must equal to Indirect Domestic Value Added exports (IVA) on a global level. Therefore, this rough estimation can address the double counting embodied in gross trade statistics.

Decomposition of Gross Exports

From the estimation of domestic value added and foreign value added exports, the gross exports can be further decomposed from how the value is used by importers.

$$E_i^r = \sum_{s \neq r} E_i^{rs} = \sum_s (A_{ij}^{rs} X_j^s + F_i^{rs}) \qquad (10)$$

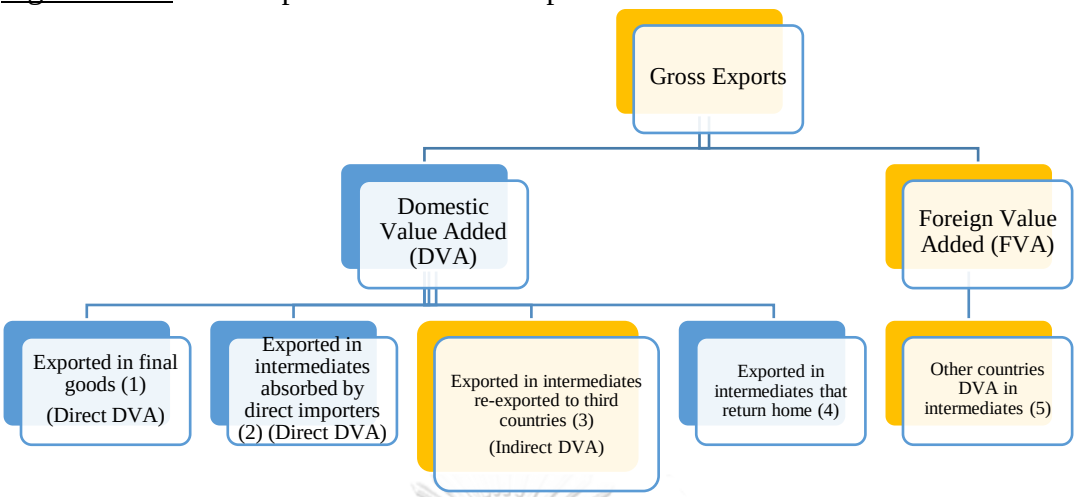
According to equation (10), intermediates can further be decomposed into intermediates processed and absorbed for final consumption in country ***s*** ($A_{ij}^{rs} X_j^s$), intermediate processed in country s and exported to any third country ***t*** ($A_{ij}^{rs} X_j^t$), and intermediates processed in country s and exported back to country ***r*** ($A_{ij}^{rs} X_j^r$), obtaining the following decomposition of gross exports;

$$E_i^{rs} = F_i^{rs} + A_{ij}^{rs} X_j^s + A_{ij}^{rs} X_j^t + A_{ij}^{rs} X_j^r \qquad (13)$$

And from the basic decomposition of gross country of country r to domestic and foreign value added exports according to equation (12), i.e. E = DVA + FVA, the gross exports can be decomposed into 5 elements as;

$$E_i^{rs} = \underset{<1>}{v_i^r B_{ij}^{rr} \sum_{s \neq r} F_i^{rs}} + \underset{<2>}{v_i^r B_{ij}^{rr} \sum_{s \neq r} A_{ij}^{rs} X_j^s} + \underset{<3>}{v_i^r B_{ij}^{rr} \sum_{t \neq r,s} A_{ij}^{rs} X_j^t} +$$
$$\underset{<4>}{v_i^r B_{ij}^{rr} \sum_{s \neq r} A_{ij}^{rs} X_j^r} + \underset{<5>}{FVA_i^r} \qquad (14)$$

Figure no. 10: Decomposition of Gross Exports



The gross export is decomposed into 5 items;

1. Domestic value-added embodied in exports of final goods and services absorbed by the direct importer
2. Domestic value-added embodied in exports of intermediate inputs used by the direct importer to produce its domestically needed products
3. Domestic value-added embodied in intermediate exports used by the direct importer to produce goods for third countries (Indirect Value Added) or (IVA)
4. Domestic Value Added embodied in intermediate exports used by the direct importer to produce goods shipped back to source (Reflected DVA)
5. Value-added from foreign countries embodied in gross exports (Foreign value added used in exports) or (FVA)

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