

ERIA Discussion Paper Series**No. 370****The Effect of the COVID-19 Pandemic on Global Production
Sharing in East Asia**

Archnaun KOHPAIBOON*

Juthathip JONGWANICH*

Faculty of Economics, Thammasat University, Thailand

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Abstract: *This paper examines the effect of the COVID-19 pandemic on global production sharing in ASEAN Member States. Product-level analysis – on hard disk drives, air conditioners, microwaves, televisions, washing machines, and automotive parts – is undertaken to examine trade patterns between January 2019 and October/November 2020. The key finding suggests that the pandemic caused parts shortages, but this effect has been short-lived. There is no strong evidence that multi-national enterprises have altered their supply chains or means of sourcing parts and components in response to the pandemic. There is some indication that multi-national enterprises are moving away from China, but whether this reflects a ‘COVID-19 effect’ or the trade war between the United States and China is not clear. COVID-19, a once-in-a-century event, may not alone be a compelling reason to restructure supply chain management relating to global production sharing, which has been a structural phenomenon driving economic globalisation.*

Keywords: COVID-19, Global production sharing, ASEAN

JEL Classification: F14; F20

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1. Introduction

By 4 February 2021, over 104 million people have been infected by COVID-19, culminating in 2.26 million deaths (WHO, 2021). COVID-19 has had wide-ranging economic effects and has induced economic contagion, which will be far worse than the 2008 global financial crisis. According to the International Monetary Fund, almost all countries will experience negative growth in their gross domestic product (GDP) per capita in 2020 (Wolf, 2020). The economic contagion taking place – as well as its economic impact – remains unclear, but a better understanding of its underlying processes is needed to gauge the impacts of an evolving shock to mitigate any adverse impacts (Menon, 2020).

It is debated to what extent the pandemic will lead to a permanent change in how multi-national enterprises (MNEs) operate their production networks globally, in which the different stages of the production processes are located across different countries – known as global production sharing (GPS).¹ In other words, the COVID-19 pandemic seems to have re-ignited a discussion of the risks associated with international production induced by international trade shocks, including the 2011 Tōhoku earthquake and tsunami in Japan and the 2011 Thailand floods. This debate has policy implications especially for East Asia, which is intensively involved in GPS (Athukorala 2005; Kimura, Takahashi, Hayakawa 2007; Obashi and Kimura, 2017). The issue has also become more complicated, as the pandemic has taken place with various social-distancing policies attempting to cease its spread – as well as amongst a trade war between the United States and China.

Many businesses have reported disruptions in their supply chains during the COVID-19 pandemic, but GPS has continued, based on company-specific experience (OECD, 2020).² Interestingly, the impact has been inferred from pre-COVID-19 performance (e.g. Baldwin and Tomiura, 2020; *The Economist* 2020a, 2020b; Bonadio, Huo, Levchenko, Pandalai-Nayar, 2020). Actual trade

¹ In the literature, an array of alternative terms have been used to describe this phenomenon, including GPS, international production fragmentation, vertical specialisation, slicing the value chain, and outsourcing.

² For example, Apple has launched a new model (the iPhone SE) during the crisis, sold mostly online. Another example is Samsung, which reported not having any meaningful production disruptions (OECD 2020:6)

transactions, with a view towards how the pandemic interrupted GPS, have not yet been systematically examined. Thus, this paper aims to examine the effect of the COVID-19 pandemic on GPS in East Asia by undertaking a product-level analysis of hard disk drives, air conditioners, microwaves, televisions, washing machines, and automotive parts. Firm-level information is used to develop input–output mapping at the product level.

Section 2 presents the analytical framework on how GPS is being affected by the pandemic as well as adjustment options. Section 3 provides an overview of GPS in Association of Southeast Asian Nations (ASEAN) Member States, followed by the analysis in Section 4. Section 5 concludes with policy recommendations.

2. Analytical Framework

The COVID-19 pandemic has created massive shocks, both on the demand and supply side, to global trade. The pandemic began in Wuhan, China, in which 300 of the world’s 500 top companies have facilities. In particular, the province of Hubei is a high-technology manufacturing hub, home to domestic and foreign firms that are highly integrated in the automotive, electronics, and pharmaceuticals industries. The province accounts for 4.5% of Chinese GDP (*Financial Times*, 2020).

The lockdowns imposed by the Government of China, to help slow and stop the spread of the coronavirus, caused disruptions to supply chains on all continents. Given the importance of Hubei Province in the global supply chain, it was difficult for firms to find the most cost-effective suppliers immediately, reflected by a survey conducted by the Shanghai Japanese Commerce and Industry Club in February 2020 (Nakafuji and Moriyasu, 2020). Less than one-quarter of firms said that they had alternative production or procurement plans in case of a prolonged disruption. Knock-on effects may be even greater, as companies often did not know where the suppliers of their suppliers are located.

Indeed, many countries discovered how dependent they are on supplies from China. In addition, political tensions increased as some world leaders

stressed where the virus originated, especially those who failed to prepare their countries for a robust response.

Generally, GPS was impacted through four channels. First, a direct impact occurred when companies operating in GPS stopped producing due to health precautions (i.e. because some employees were ill or due to social-distancing rules). This direct impact was not specific to GPS but to locations where the virus had spread. Second, GPS was affected by international transport interruptions, which had a magnification impact on GPS, as cross-border transactions frequently occur. The recent container shortages worldwide and hike in freight charges resulted in such an interruption (*Financial Times*, 2020). Arguably, domestic transport interruptions could have a similar effect but these would be less severe.

Third, a demand impact occurred, whereby production continued but fewer consumers were willing to buy products. This could also result from a surge in demand – as observed for some key medical supplies and electrical appliances – or demand contraction. Changes in demand for final products in a given country had significant impacts on demand for inputs produced in other countries derived from the final products.

The final channel stemmed from a nationalist sentiment, that drives domestic self-sufficiency. It has grown during the pandemic, especially for medical products. While countries have generally committed to keeping markets open and to maintaining a free, fair, transparent, and non-discriminatory trade and investment environment, there are some exceptions, especially for food and medical products. This could create uncertainty in the future trade and investment regime, impacting the organisation of supply chains.

To what extent the pandemic will lead to a permanent change in the way that MNEs operate their supply chains remains a question. Often, resilient supply chains are created, and supply chains are made less vulnerable. While there are various options for firms to enhance their ability to respond to shocks quickly,³

³ Such as improving the supply chain risk management system (e.g. having control towers and real-time flows of inputs to anticipate disruption), diversifying suppliers and locations of production, taking greater control (e.g. through vertical integration with ownership of main suppliers), and sharing risk (one objective of outsourcing and offshoring). These are often referred to ‘agility’ or ‘reactivity’ in the business literature (Gallagher and Worrell 2007). The response could be different across firms, depending on various factors such as the structure of

the current debate amid policymakers and academics is if the pandemic will diversify their supplier base or reshore some activities to home countries. Diversification could bring new opportunities to those that were previously less-popular investment destinations as well as downsize activities in those already participating.

In practice, it is complicated and expensive to relocate whole factories. It is even harder amid the worst global depression since World War II, together with a slow recovery. As reflected in a Standard Chartered poll, just 10% of firms are looking at moving their supply chains, while 6% are considering shortening them (*Financial Times*, 2021). Similar evidence is found in the World Bank's monitoring of foreign investors' sentiments since the crisis. Caroline Freund, global director of trade, investment and competitiveness at the World Bank, said in December that the expectations of reshoring or nearshoring 'may be driven more by rhetoric than reality' (*Financial Times*, 2021).

Amid a 42% contraction of global foreign direct investment (FDI), however, FDI inflows to China and India actually increased, by 4% and 13%, respectively (UNCTAD, 2021). Such trends are, of course, in stark contrast with the many warnings of rapid reshoring or nearshoring as a result of supply chain disruption during the pandemic. Interestingly, most FDI in China was driven by businesses planning to access growing markets and to seed strategic assets. Solutions to resilience are varied and do not necessarily imply investment reallocation.

suppliers (i.e. a high or low concentration), geographic distance, cost-effectiveness, and efficiency. Jain, Girotra, and Netessine (2016) argued that supplier diversification is associated with slower recovery from supply disruptions at the firm level, while the use of long-term relationships is associated with faster recovery.

3. Global Production Sharing in ASEAN

ASEAN Member States have engaged in GPS since 1968 when two United States-based electronics companies, National Semiconductor and Texas Instruments, set up production bases in Singapore for assembling semiconductor devices (Grunwald and Flamm, 1985; Lee, 2000). Since then, Singapore-based MNEs have relocated some low-end assembly activities to Malaysia, the Philippines, and Thailand in response to the rapid increase of wages and land prices in Singapore. Many new MNEs to the region also set up production bases in these countries, bypassing Singapore.

ASEAN Member States intensively participated in GPS between 2003 and 2019, as indicated by the relative importance of parts and components in total manufacturing trade. In 2003–2004, parts and components accounted for 55.0% and 49.9% of total manufacturing imports and exports, respectively. These figures declined to 28.6% and 26.8% by 2018–2019, respectively (Table 1).

Table 1: Share of Parts and Components in the Manufacturing Trade, 2003–2019

	Imports					Exports				
	2003–2004	2010–2011	2015–2016	2017–2018	2019	2003–2004	2010–2011	2015–2016	2017–2018	2019
Brunei Darussalam	18.1	17.6	18.5	22.5	17.9	17.8	28.7	24.2	18.9	19.0
Cambodia	8.4	8.6	12.7	12.8	13.4	0.2	0.2	4.0	4.1	3.8
Indonesia	24.4	26.8	26.1	25.7	24.8	18.3	15.7	14.8	14.5	14.4
Lao People's Democratic Republic	n.a.	21.6	27.9	29.7	26.9	n.a.	6.5	9.5	7.4	7.8
Malaysia	58.3	47.6	44.4	29.2	29.5	48.8	45.0	45.7	25.6	24.1
Myanmar	n.a.	14.5	10.4	13.1	12.5	n.a.	0.9	7.8	3.9	2.2
Philippines	68.4	47.9	44.8	32.7	28.3	66.4	56.2	60.0	38.5	25.6
Singapore	56.8	54.7	54.2	30.6	33.9	56.2	57.2	54.0	25.9	28.2
Thailand	38.6	34.0	32.6	28.8	27.8	32.8	26.5	27.2	23.8	22.7
Viet Nam	16.2	22.5	36.1	27.0	26.7	11.6	19.2	37.5	37.7	37.1
ASEAN+6	58.8	43.8	42.2	29.4	29.7	52.0	43.4	42.5	26.1	24.5
ASEAN10	55.0	41.2	40.2	28.5	28.6	49.9	41.1	41.1	27.2	26.8
China	38.6	40.0	44.6	21.8	20.8	21.5	22.9	26.2	25.5	24.8
Japan	27.1	25.6	28.7	25.3	24.2	32.7	31.3	31.5	27.5	26.5
Korea	35.1	29.8	32.4	20.5	22.6	36.0	33.1	37.5	22.6	24.3
North-East Asia	34.3	35.0	39.2	22.4	21.8	28.8	26.7	28.8	25.4	25.0
EU27	24.0	23.5	23.6	22.1	22.1	23.7	22.3	22.1	21.5	21.3
NAFTA	25.4	26.0	26.2	26.2	26.2	33.3	27.5	27.7	25.8	25.4

ASEAN = Association of Southeast Asian Nations, EU = European Union, NAFTA = North American Free Trade Agreement.
Source: Authors' compilation, using data from UNCTAD (2021b).

Note that the slightly declining trend observed is largely driven by price deflation in GPS-intensive countries in which technological advances brought down prices due to better product quality. In fact, a decline does not necessarily imply the lessening importance of GPS (Kohpaiboon and Jongwanich, 2020). This seems to be consistent with the findings of recent studies, such as Obashi and Kimura (2017) and Gaulier, Sztulman, and Unal (2020).

GPS participation varies significantly across ASEAN Member States. The share of parts and components to total manufacturing trade remains substantial for the original global value chain participants in ASEAN – Malaysia, Singapore, and Thailand – despite a slightly declining trend in recent years. Although both started as assembly bases, Malaysia and Singapore intensively participated in GPS as parts and components suppliers. Hence, their import and export shares are virtually the same. By 2019, Singapore's import and export shares were 33.9% and 28.2%, respectively, and Malaysia's were 29.5% and 24.1%, respectively (Table 1). Thailand, however, always had a greater import share (e.g. parts and components exports accounted for 22.7% of total manufacturing exports in 2017–2018 while the corresponding import share was 27.8%). This indicates Thailand's position in GPS as producing finished products while sourcing parts and components from elsewhere.

GPS trade also played an important role in manufacturing in the Philippines. For example, parts and components imports and exports accounted for 28.3% and 25.6% in 2019, respectively. The relative importance in such exports reflects the fact that the Philippines plays a role as a parts and components supplier in the GPS network.

Despite obvious advantages in terms of location, relative wages, and experience in global integration, Indonesia has remained a small player in regional production networks. Fairchild Semiconductor and National Semiconductor set up assembly plants in Indonesia in the mid-1970s, but both terminated operations in 1986, presumably because of the unfavourable business environment, in particular labour market rigidities that hindered restructuring operations in line with global changes in the semiconductor industry (Thee and Pangestu, 1998; Manning and Purnagunawan, 2011). The exception is automotive MNEs, who have been producing multi-purpose vehicles for both domestic and regional markets.

Until recently, MNEs were returning to Indonesia, including LG Electronics, Samsung Electronics, and ASUSTeK Computer. Indonesia's engagement in global value chains remains in assembly activities; thus, the import of parts and components only slightly increased from 24.0% in 2003–2004 to 24.8% in 2019. The parts and components export share to total manufacturing exports was even lower, ranging between 14.4% and 18.3%, with a mild declining trend.

Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar, and Viet Nam are also important in GPS, especially Viet Nam, which became an increasingly active player between 2003 and 2019. Its parts and components import share rapidly increased to 37.1% by 2019, from 16.2% in 2003–2004. Its parts and components export share also jumped from 11.6% in 2003–2004 to 37.1% in 2017–2018.

Following its adoption of market-oriented policy reforms starting in the late 1980s, several Korean, Taiwanese, and Japanese firms set up assembly plants in Viet Nam. Beginning with parts and components assembly within regional production networks in the late 1990s, Viet Nam deeply engaged in GPS after Intel, the world's largest semiconductor producer, set up a \$300 million testing and assembly plant (subsequently revised to \$1 billion) in Ho Chi Minh City in February 2006 (Athukorala and Tien, 2012). Many other major players in the electronics industry then arrived in Viet Nam, including Taiwanese-based Hon Hai Precision Industry and Nidec Corporation, as well as those involved in electrical and optical components. In 2009, Samsung set up a large plant in Ha Noi to assemble handheld products such as smartphones and tablets. Samsung has been gradually shifting such assembly from its plant in China to its Viet Nam plant as part of a diversification strategy in response to increasing wages and rental costs in China. There is also a new Samsung research and development centre in Ha Noi and its purchase of a 30% equity stake in CMC Corporation, the second-largest information and communications technology group in Viet Nam (Onishi, 2020).

Since the trade war between China and the United States began in 2018, many MNEs have started reallocating their production facilities away from China to South-East Asia, particularly Viet Nam. For example, Apple plans to start iPad production in Viet Nam around the middle of 2021, marking the first time that the world's biggest tablet maker will build a significant number of the devices outside of China (Li and Ting-Fang, 2021).

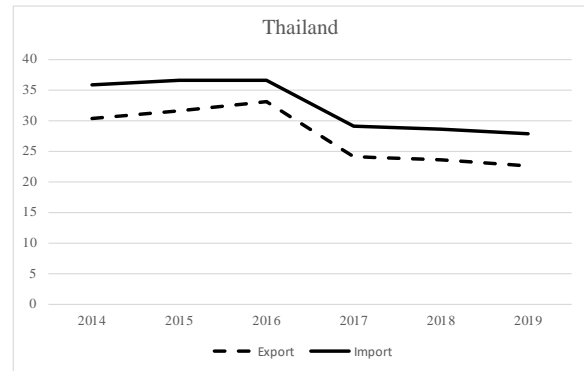
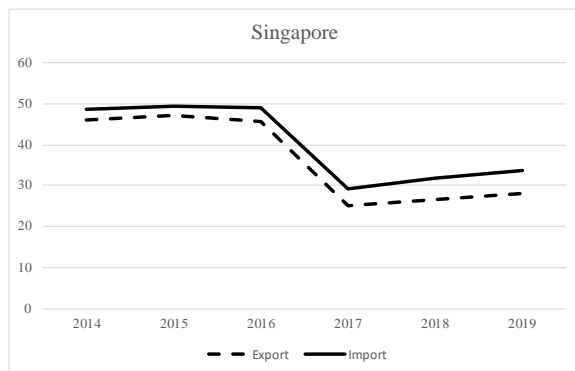
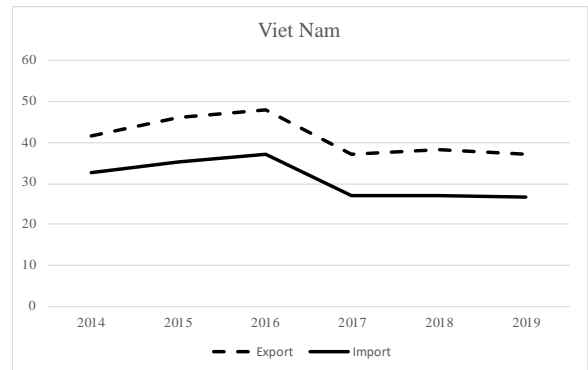
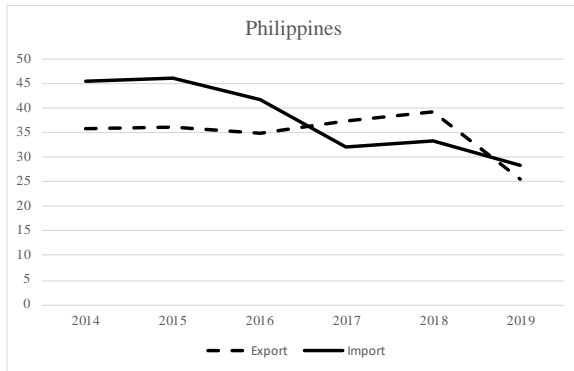
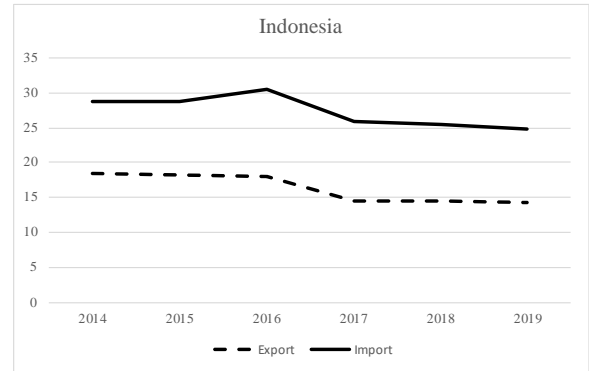
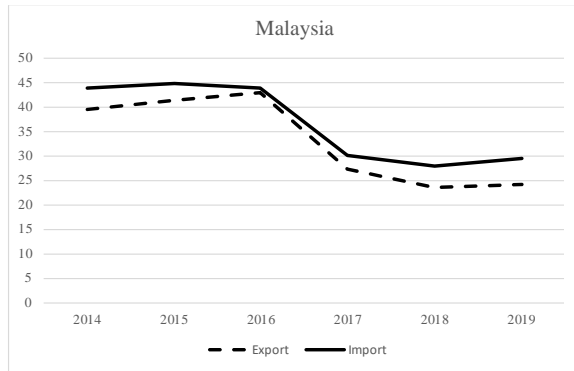
GPS engagement in Cambodia began around 2011 when MinebeaMitsumi, a large Japanese MNE that produces a wide range of parts and components for the automotive and electronics industries, set up a plant (i.e. Minebea Cambodia) in the Phnom Penh Special Economic Zone to assemble parts for cellular phones using components imported from its factories in China, Malaysia, and Thailand. Other MNEs that have set up assembly plants in Cambodia include Japan's Sumitomo Corporation, which wires harnesses for cars; Japan's DENSO, which makes motorcycle ignition components; Belgium's Pactics, which makes microfibre sleeves for sunglasses; Tiffany & Company, from the United States, which polishes diamonds; and Hyundai, which recently set up a plant to assemble cars for exporting to European Union countries under the Generalised Scheme of Preferences Plus tariff concessions.

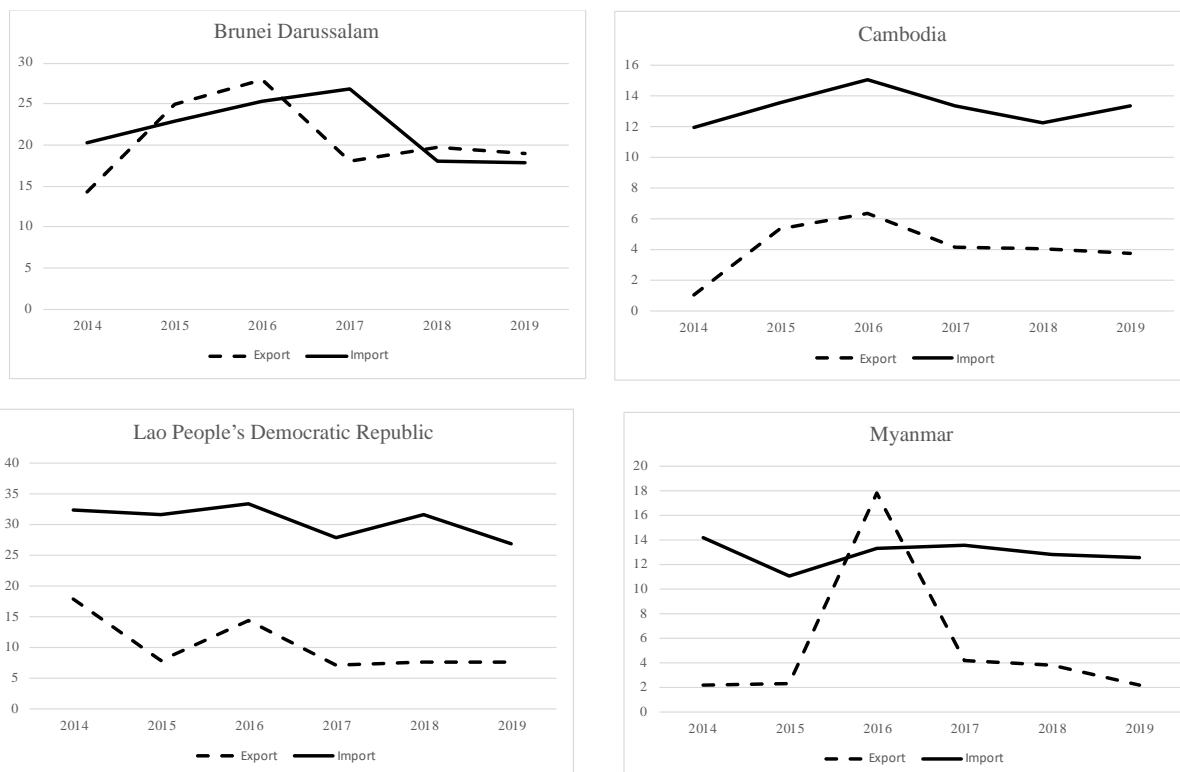
As of 2014, there are signs that a number of other Japanese companies, which have production plants based in China and Thailand, are planning to relocate some segments of their production processes to Cambodia. Rising wages and rental costs in China and Thailand, and production disruption caused by the 2011 Thailand floods, seem to have contributed to Cambodia's attractiveness as a new host country within regional production networks (Hill and Menon, 2013; Abe, 2014). Nonetheless, the trade share of parts and components in total manufacturing remains low in Cambodia.

The GPS engagement of Brunei Darussalam, the Lao PDR, and Myanmar is rather limited. The reported shares of parts and components import and export only reflect an early stage of industrialisation (Table 1). The share of the manufacturing sector to GDP accounted for less than 15% by 2018. Figure 1 shows the patterns of global value chain engagement of ASEAN over time.

**Figure 1: Share of Parts and Components to Total Manufacturing Trade,
2014–2019**

(%)





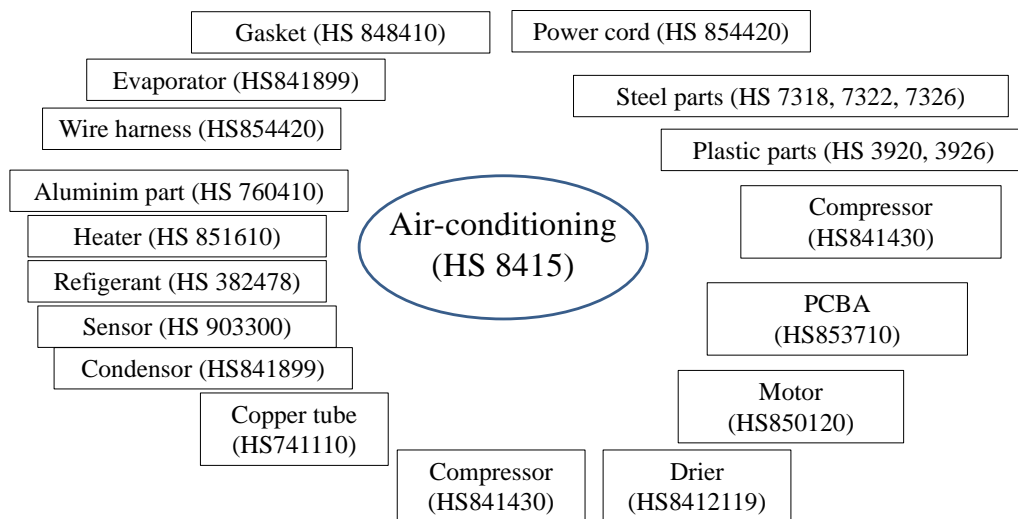
Source: Authors' compilation, using data UNCTAD (2021b).

Compared to Europe and North America, GPS has a more important role in ASEAN (Table 1). Import and export shares of parts and components in total manufacturing in Europe and North America were much lower than those of ASEAN and North-East Asia. In ASEAN, GPS also accounted for a sizable share in the intra-regional trade pattern from 2003 to 2019 for total manufacturing and parts and components only, respectively. As illustrated in Kohpaiboon and Jongwanich (2020), the intra-ASEAN trade in parts and components was slightly higher than total manufacturing, implying that the trade of final goods produced in ASEAN Member States rely more on demand from other regions. To a certain extent, the reversal trend is related to the tension between the United States and China, so that many MNEs have begun moving away from China to South-East Asia (Garcia-Herrero, 2020).

4. COVID-19 Impact

To examine the effect of the COVID-19 pandemic on GPS in East Asia, a product-level analysis is undertaken. Information at the firm level is used to develop input–output mapping at the product level for hard disk drives, air conditioners, microwaves, televisions, washing machines, and automotive parts, whose production activities are intensively engaged in GPS. Each product’s corresponding Harmonised System (HS) code is identified to track any changes during the COVID-19 pandemic. As an example, Figure 2 illustrates the input–output mapping of air conditioners and their parts. Their trade patterns are first analysed to examine the effect of the pandemic, including changes in the export value of finished products, export destinations, and input sources of key parts and components used in these finished products, using monthly trade data between 2019 to latest possible for all countries. In addition, the ratio of imported inputs to finished goods exports is used to illustrate any possible switch from foreign to domestic suppliers.

Figure 2: Input–Output Mapping of Air Conditioners and Their Parts



Source: Kohpaiboon and Jongwanich (2020).

The coverage is grouped into three subperiods: pre-COVID (2019), strict lockdown (January to May, 2020), and afterwards (from May 2020).

Table 2 reports the relevance of these six products in ASEAN economies. Some countries, like Thailand, act in a GPS as the assembling centre, so the six products' shares are relatively large as opposed to those of the other countries. In particular, these six products in Thailand account for 19.2% of total manufacturing export. When focusing on the finished manufacturing export (i.e. the total manufacturing net of parts and components exports), the share increases to 25.0%.

Table 2: Relative Importance of the Six Products in ASEAN

	Six Products		% parts and components to total manufacturing
	% of total manufacturing	% of total finished manufacturing	
Brunei Darussalam	0.0	0.0	19.3
Cambodia	0.4	0.4	3.9
China	2.8	3.7	25.2
Indonesia	6.0	7.1	14.4
Japan	17.9	24.5	26.8
Korea	9.2	12.0	23.4
Lao People's Democratic Republic	1.6	1.7	7.8
Malaysia	3.5	4.5	23.9
Myanmar	0.2	0.2	2.9
Philippines	6.6	9.8	32.4
Singapore	0.9	1.3	27.4
Thailand	19.2	25.0	23.2
Viet Nam	2.1	3.4	38.3

ASEAN = Association of Southeast Asian Nations.

Note: Data between 2018 and 2019 are used.

Source: Authors' compilation, using data from UNCTAD (2021b).

In contrast, Malaysia, the Philippines, Singapore, and Viet Nam play important roles as parts manufacturers in GPS. The six products account for less than 10% of total manufacturing exports. Nonetheless, their shares of all parts and components to total manufacturing exports exceed 25%, except for Malaysia, which has been a production hub of electrical appliances for Japanese MNEs since the late 1970s. As a consequence, Malaysia's share of parts and components to total manufacturing exports is slightly lower than those of the other two countries.

As mentioned previously, Indonesia has regained its relative importance in GPS as a production hub of certain electrical appliances and automotive parts since 2000, so the share of these six products is around 6%. Brunei Darussalam, Cambodia, the Lao PDR, and Myanmar are at early stages in participating in GPSs.

As presented in Table 3, ASEAN Member States account for a sizable share of the world export of these six products, although performance varies across countries. For hard disk drives, Thailand accounted for 16.0% of world exports between 2018 and 2019; China had 25.0%. This is similar to air conditioners, whose export value accounted for 22.7%, followed by Malaysia. Television exports from Viet Nam accounted for 3.2% of world exports, followed by Malaysia, Thailand, and Indonesia, whose shares were 2.6%, 1.6%, and 1.4%, respectively. Malaysia and Thailand also exported microwaves, accounting for 9.5% and 5.0%, respectively. Thailand and Vietnam exported washing machines, as well, 4.2% and 1.1% to world exports, respectively. Thailand and Indonesia were automotive production hubs in ASEAN, accounting for 1.9% and 0.4%, respectively.

Table 3: Percentage Share to World Exports, 2018–2019

	Air Conditioners	Hard Disk Drives	Microwaves	Tele- visions	Vehicles	Washing Machines
Brunei Darussalam	0.0	0.0	0.0	0.0	0.0	0.0
Cambodia	0.0	0.0	0.0	0.0	0.0	0.0
China	56.6	25.0	68.4	29.0	1.6	28.9
Indonesia	0.1	0.0	0.0	1.4	0.4	0.0
Japan	0.2	0.5	0.1	0.2	11.4	0.1
Korea	2.6	4.0	0.4	1.0	4.3	0.8
Lao People's Democratic Republic	0.0	0.0	0.0	0.0	0.0	0.0
Malaysia	4.8	3.6	9.5	2.6	0.1	0.0
Myanmar	0.1	0.0	0.0	0.0	0.0	0.0
Philippines	0.2	5.3	0.0	0.0	0.0	0.0
Singapore	0.6	2.9	0.1	0.2	0.0	0.0
Thailand	22.7	16.0	5.0	1.6	1.8	4.2
Vietnam	0.1	0.2	0.0	3.2	0.0	1.1

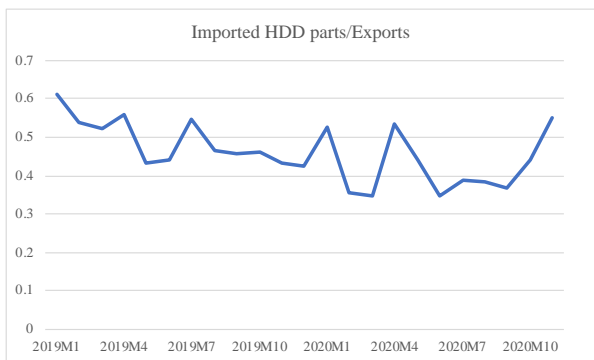
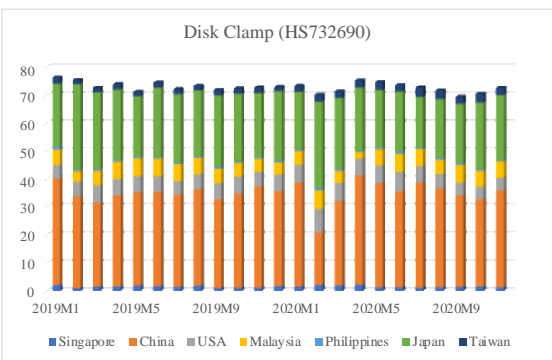
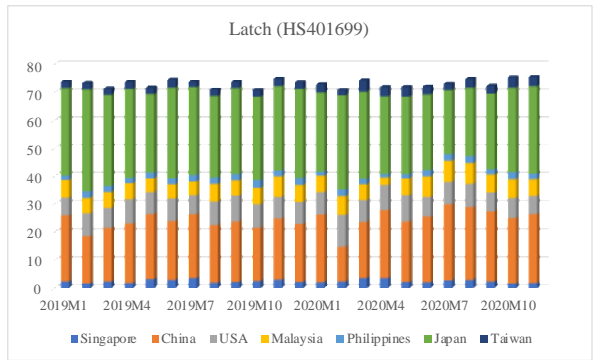
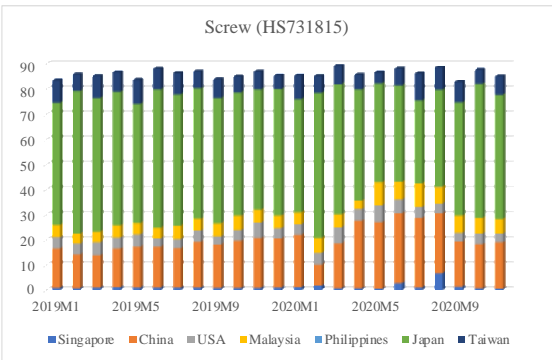
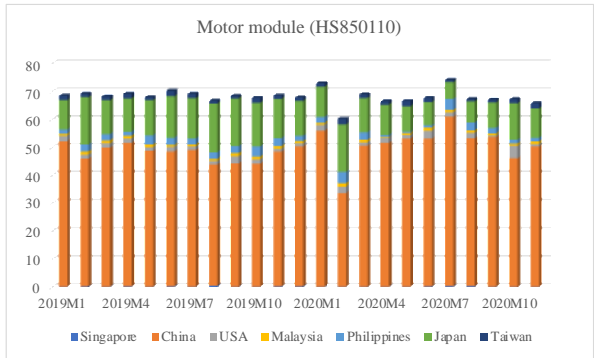
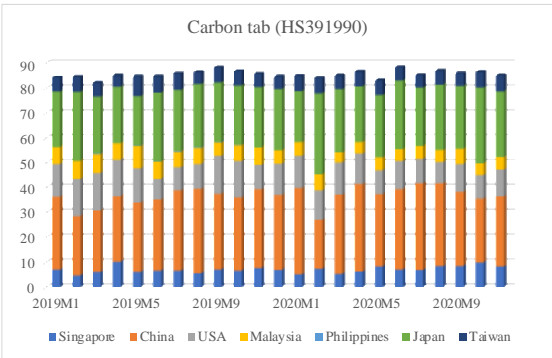
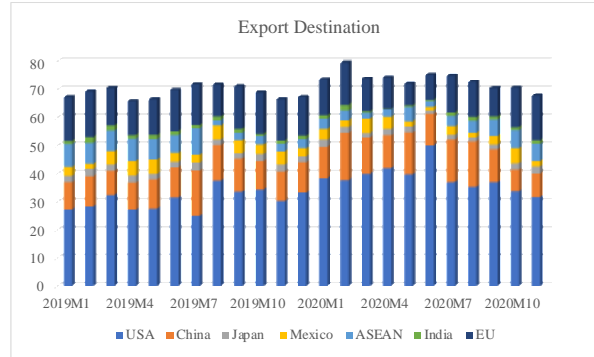
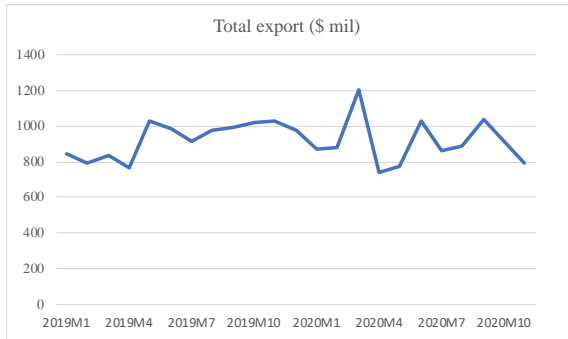
Source: UNCTAD (2021b).

For ASEAN Member States, the absolute world export share discussed above is small, especially compared to China, but it is still reasonably large as opposed to their economies. In addition, when the role of ASEAN Member States in global exports is combined with the three North-East Asian economies, it points to the role of East Asia as the global factory centre supplying these products worldwide.

4.1 Hard Disk Drives

Among ASEAN Member States, Thailand is the largest hard disk drive exporter, so the COVID-19 pandemic impact on hard disk drives is only examined through the Thai experience. The export value of hard disk drives fluctuated during the strict lockdown period, largely due to such measures in China, the major export destination of Thai exports of hard disk drives (Figure 3). Nonetheless, the fluctuation seemed to be short-lived and did not have a long-lasting impact on total export demand.

Figure 3: Thailand's Hard Disk Drives



ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.

Source: Authors' calculations from GTI (2021).

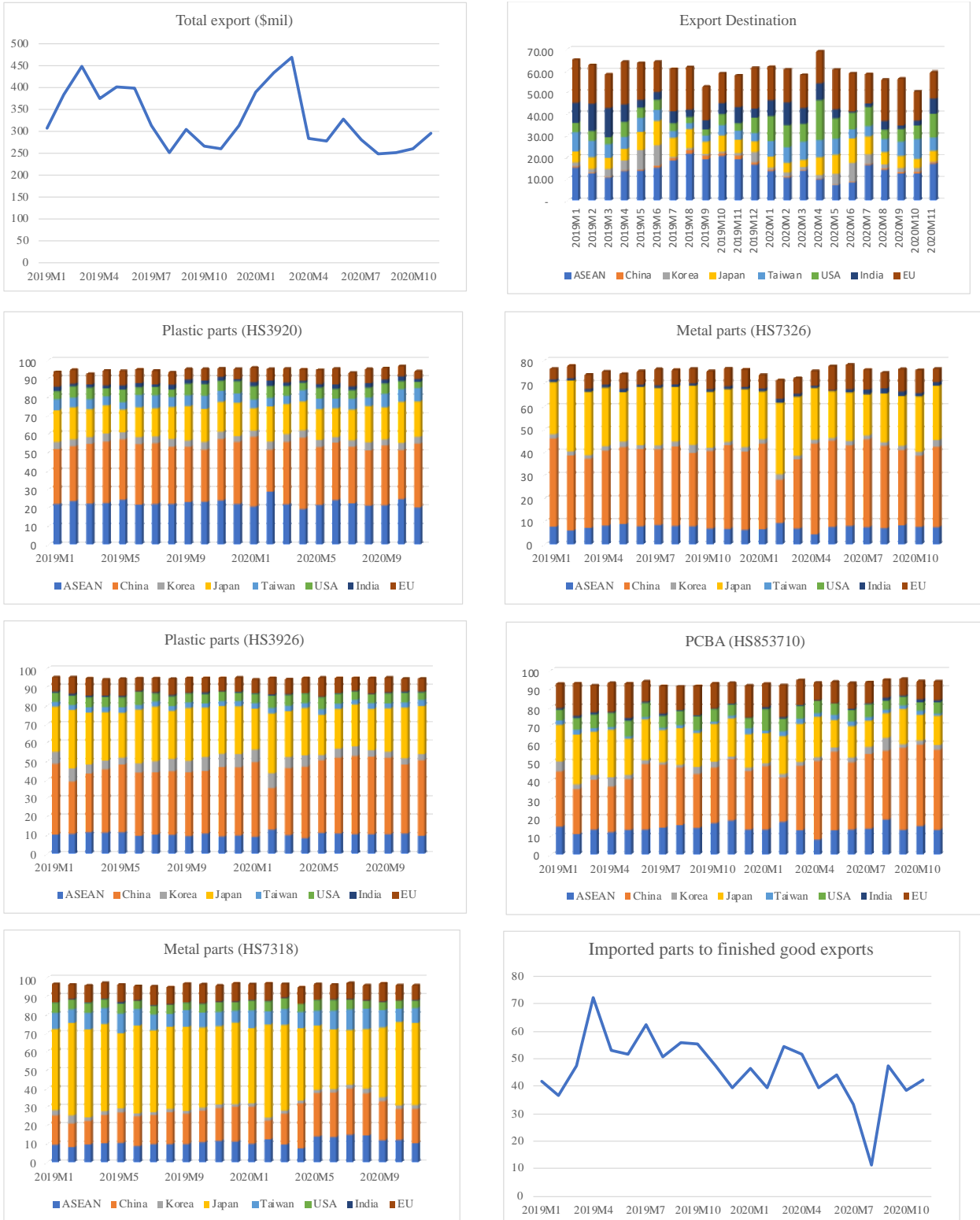
When considering key imported parts like motors, screws, disk clamps, and carbon tabs, the COVID-19 pandemic did not significantly impact the sourcing of these key parts and components of hard disk drives. There were minor interruptions during January and February 2020, when China imposed strict lockdown measures, on parts like disk clamps and carbon tabs that are largely imported from China. To overcome the shortage of such parts and components, hard disk drive makers in Thailand switched to suppliers in, for instance, Japan. The share of disk clamps from China thus dropped from 37.4% in January 2020 to 19.1% in February 2020, and then returned to 30.0% in March 2020. The share of those from Japan increased from 20.6% in January 2020 to 30.7% in February 2020, then fell again to 25.3% in March 2020.

Interestingly, the ratio between imported parts to finished good exports exhibits a declining trend from January 2019 to October 2020, indicating that some imported parts were sourced domestically. Many foreign suppliers were hard hit by the COVID-19 pandemic, so companies switched more orders to domestic ones, although domestic suppliers were not immediately located in response to a parts shortage risk. This seems to be consistent with the key feature in GPS literature about tailor-made nature of parts and components used in GPSs.

4.2 Air Conditioners

Two ASEAN members, Thailand and Malaysia, exported air conditioners to the world market. In both countries, the COVID-19 pandemic did have a mild demand contraction effect of these exports. In Thailand, air conditioner exports dropped noticeably beginning in April 2020, reflecting a demand contraction effect (Figure 4).

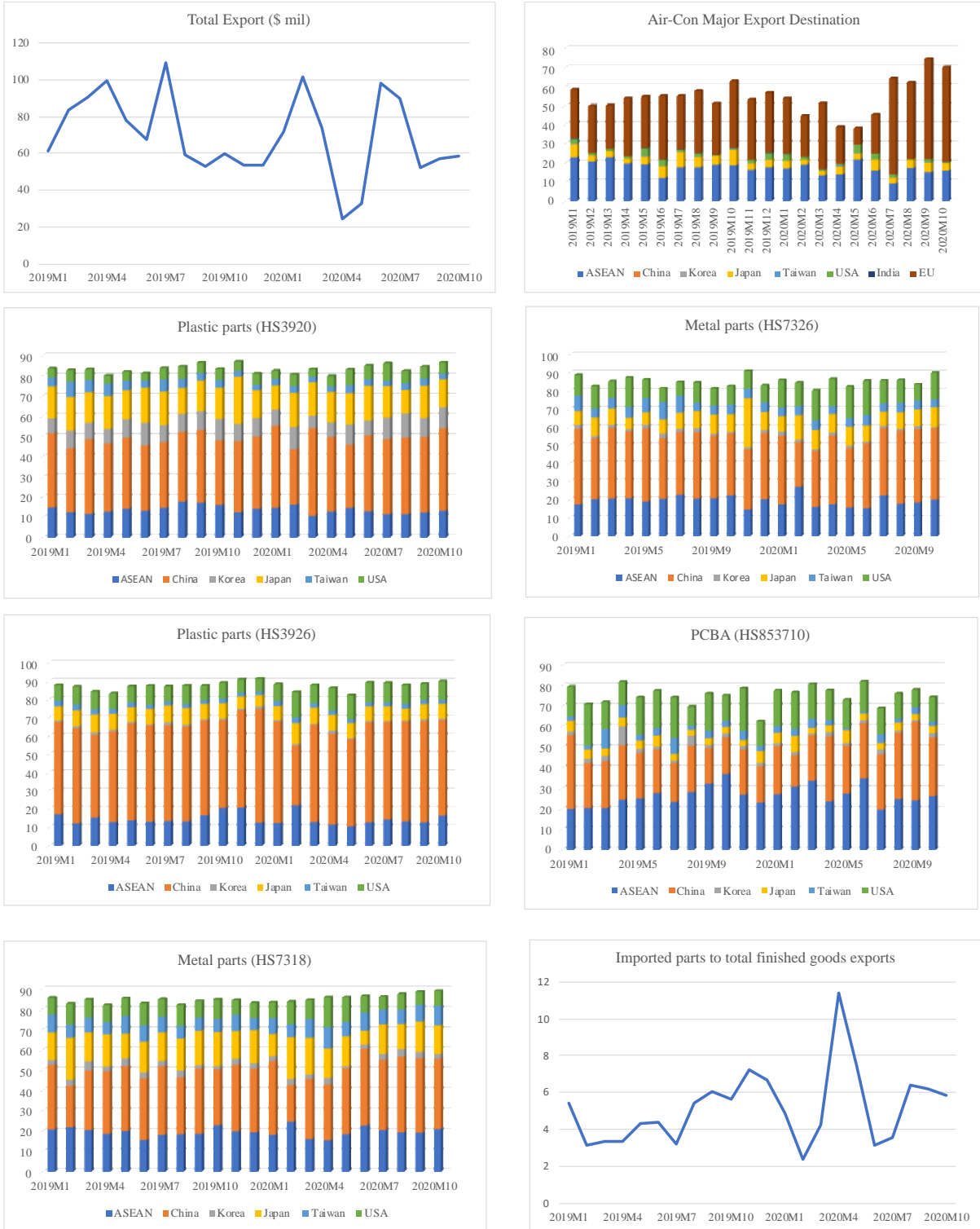
Figure 4: Thailand's Air Conditioners



ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.
 Source: Authors' calculations from GTI (2021).

For Malaysia, there was a demand contraction effect on air conditioner exports together with export fluctuation. In particular, monthly exports of air conditioners from Malaysia dropped noticeably in April 2020 and May 2020 to \$24 million and \$33 million, respectively, from \$73 million in March 2020. The export value returned sharply to \$98 million in June 2020 and \$90 million in July 2020. From then on, the monthly export value remained stable at around \$50 million. It did not experience changes in export destinations nor in parts and components imports over that period. Changes were temporary during the strict lockdown period, as the major sources of key imported parts accounted for nearly 80% of total imported parts during this period.

Figure 5: Malaysia's Air Conditioners



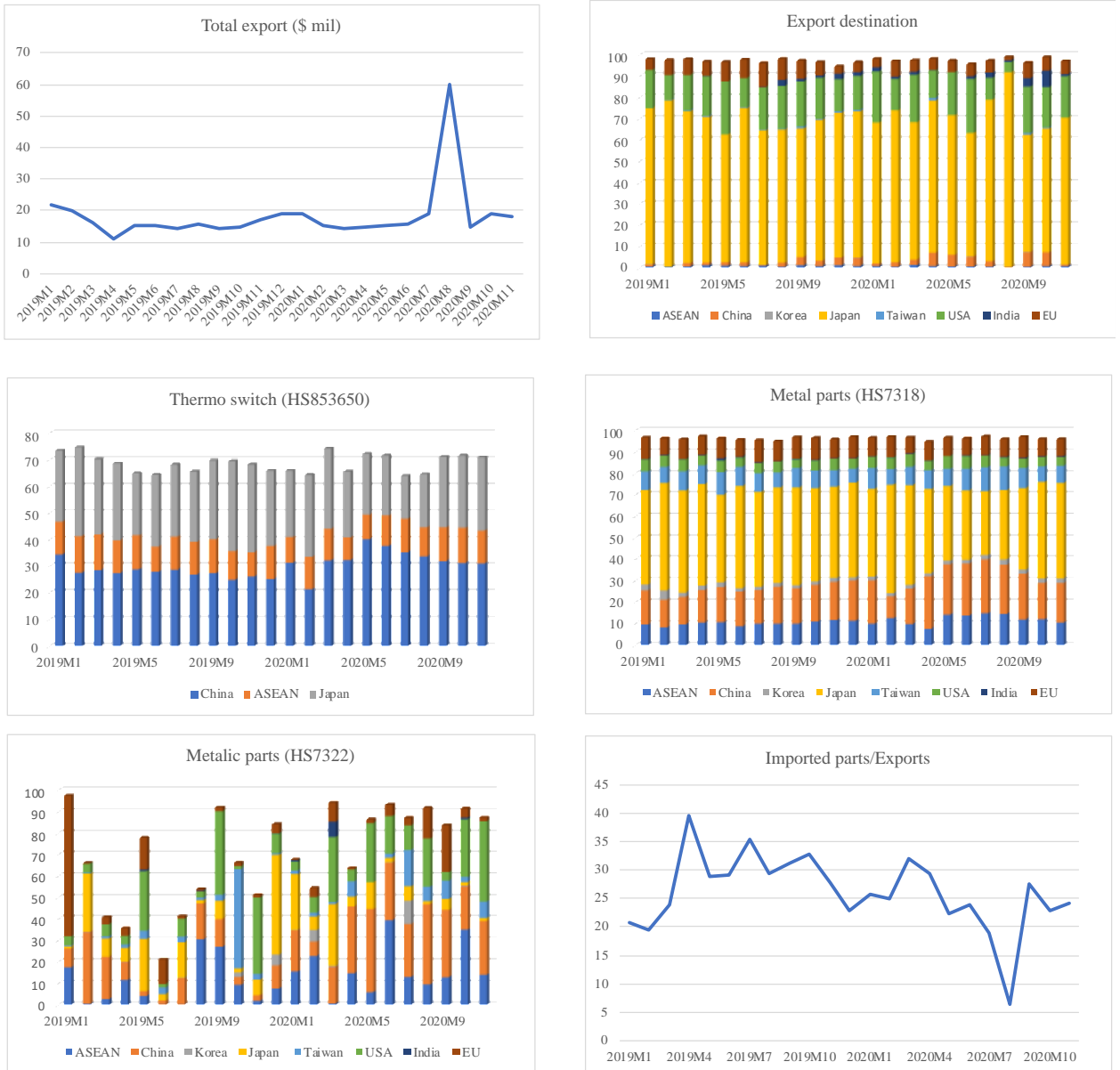
ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.
 Source: Authors' calculations from GTI (2021).

4.3 Microwaves

As argued in Kohpaiboon and Jongwanich (2020), the export unit value of microwaves from Thailand was persistently higher than that from Malaysia from 2006 to 2018. In Thailand, demand contraction of microwave exports did not occur, except in August 2020 (Figure 6). Similarly, there was no change in imported parts for microwave production in Thailand except a short-lived interruption in the sourcing of certain parts.

Thermo switches were sourced from China, ASEAN, and Japan, all of which accounted for 80% of total imports. The noticeable change in the sourcing pattern was found from January to September 2020, beginning with the switch between China and Japan from January to February 2020 and then between ASEAN and Japan from March to September 2020. Nonetheless, the switching effect seemed to be mild. For Malaysia, microwave exports fluctuated significantly when the export value dropped from \$22.7 million in March 2020 to \$9.0 million in April 2020 (Figure 7). From then, the export value returned to \$44 million on average between May and October 2020. There was a switch between China and other developed country (i.e. Italy, the United Kingdom, and the United States) suppliers in metallic parts used in microwaves; from May 2020, sourcing patterns returned to pre-pandemic levels.

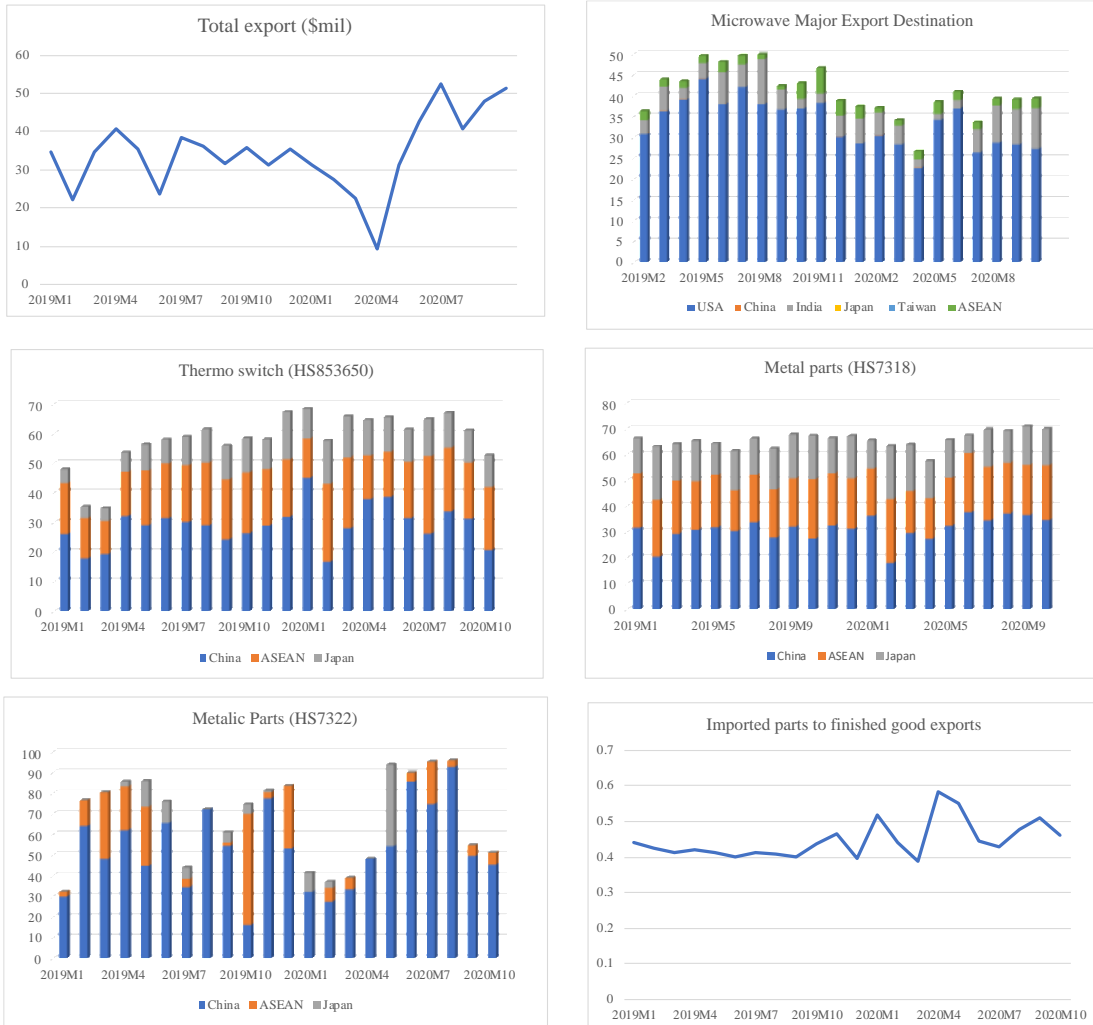
Figure 6: Thailand's Microwaves



ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.

Source: Authors' calculations from GTI (2021).

Figure 7: Malaysia's Microwaves



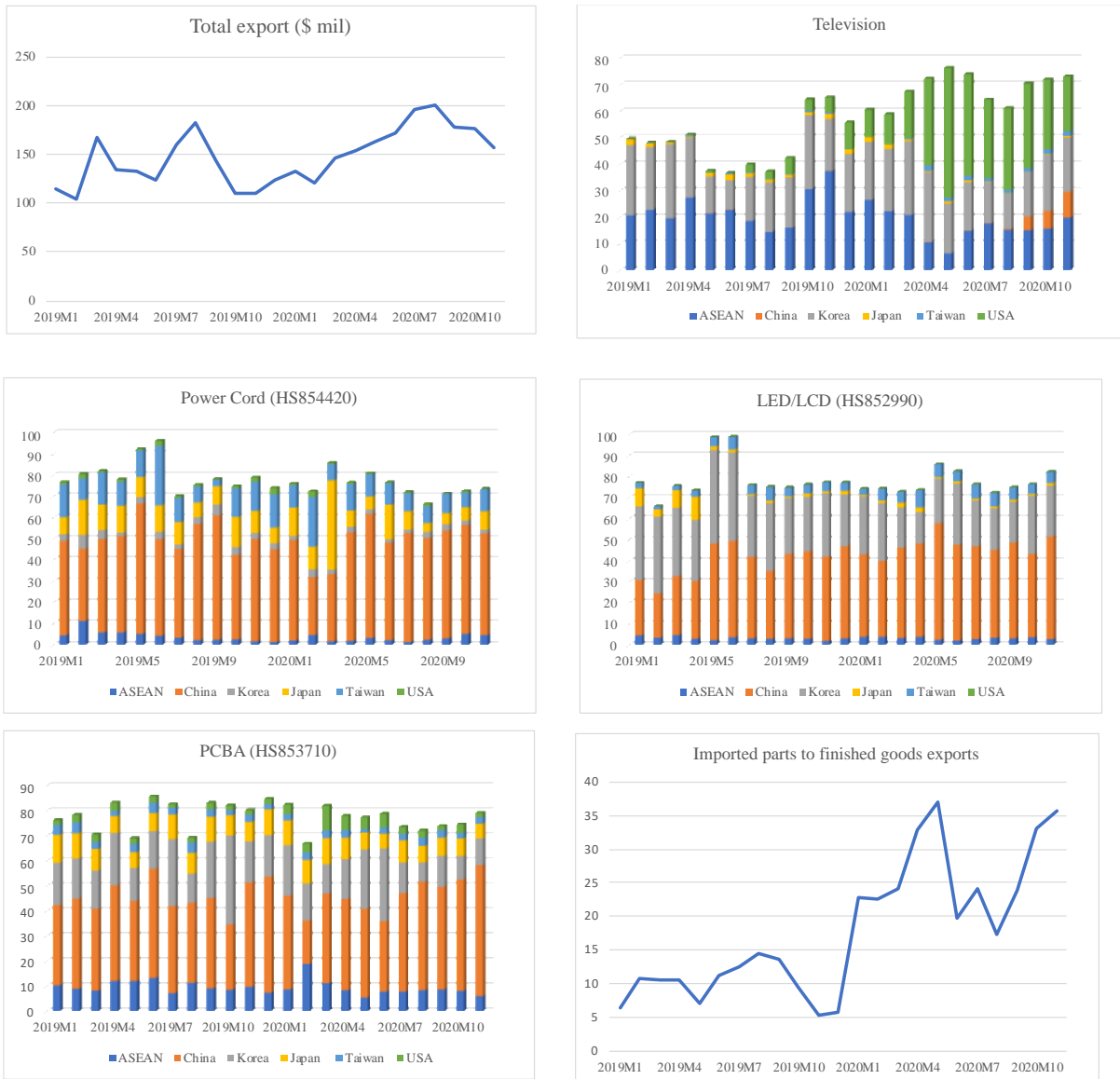
ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.
 Source: Authors' calculations from GTI (2021).

4.4 Televisions

As illustrated in Kohpaiboon and Jongwanich (2020), television manufacturing in Viet Nam and Indonesia has rapidly expanded as a result of technological changes and competition amongst MNEs. Cathode ray tube televisions have morphed into digital flat screens, making manufacturing more labour-intensive as flat screens require workers to assemble imported parts, which is in line with the comparative advantage of Viet Nam and Indonesia. In addition, the predominant players, Japanese MNEs like Sony and Panasonic, have lost their market share to Korean rivals like Samsung and LG. Indeed, by the end of 2011, Samsung and LG were the biggest sellers of televisions worldwide (*Financial Times*, 2011). As Korean firms shift their television manufacturing facilities to Indonesia and Viet Nam, these two countries have become key television exporters. Thus, television exports from Thailand, which was the production base of Japanese-made televisions, has begun declining. Interestingly, while Malaysia has highest income per capita amongst these four countries, Japanese MNEs are still running production lines there.

Figure 8 presents the effect of the COVID-19 pandemic on television manufacturing in Viet Nam. The pandemic did have a positive effect on television exports from Viet Nam, which is associated with export diversification, as the United States has gained a relative importance as an export destination, reflecting the trade war between it and China. Noticeably, there was a mild interruption in sourcing parts. In particular, imports of key parts like power cords, assembled printed circuit boards, and LED panels from China slightly dropped in January and February 2020. After April 2020, pre-pandemic sourcing patterns resumed. The upward trend of imported parts to finished goods exports indicates the increasing import content of television exports.

Figure 8: Viet Nam's Televisions

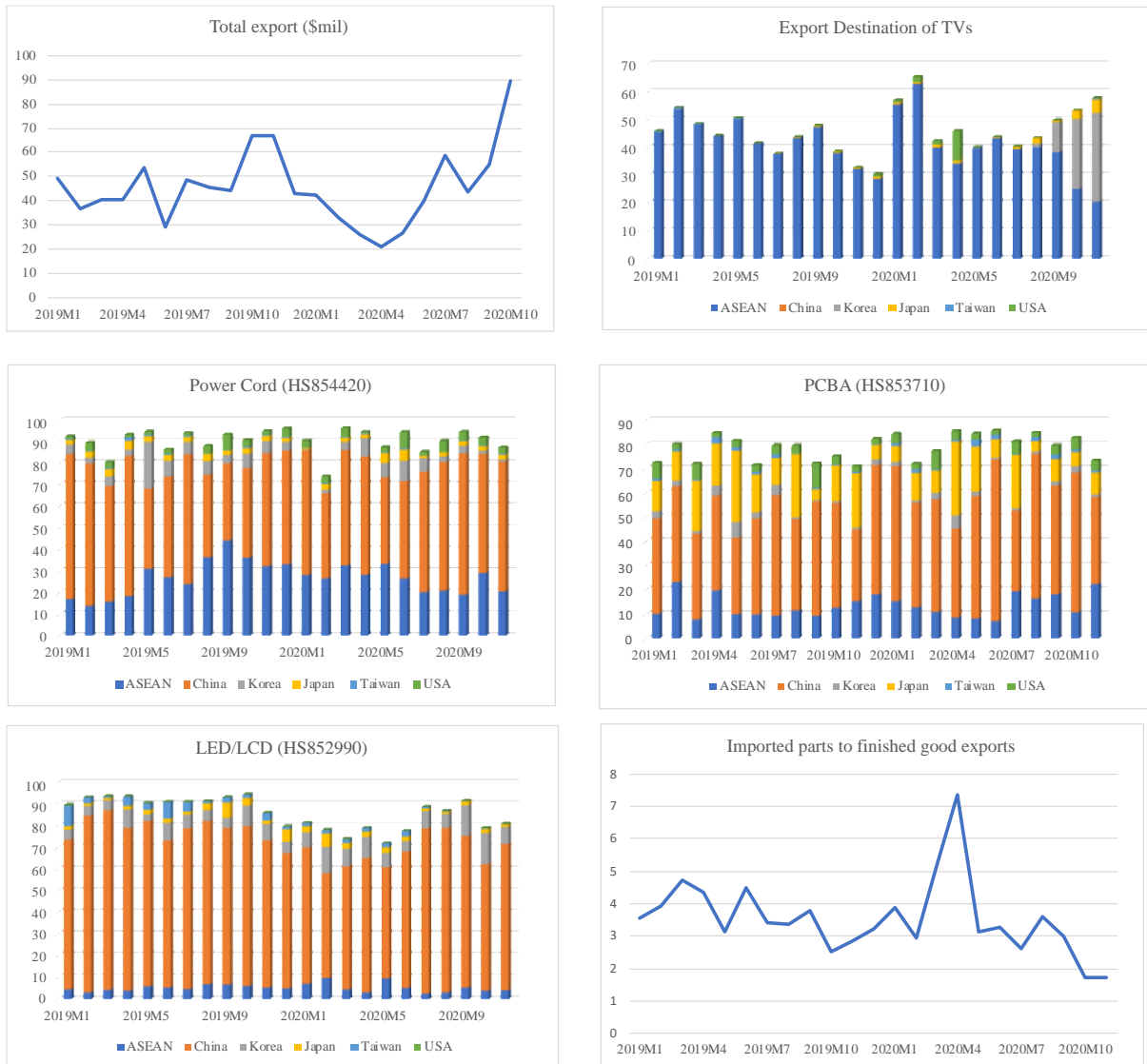


ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.
 Source: Authors' calculations from GTI (2021).

The effect of the COVID-19 pandemic on television manufacturing in Indonesia, Malaysia, and Thailand is slightly different (Figures 9, 10, 11). The supply chain interruption during the strict lockdown period caused an export value plunge, reaching a minimum around April 2020. From then on, the export value rapidly recovered; the interruption seemed to be short-lived. Indeed, the export value surpassed the pre-COVID-19 level by August 2020.

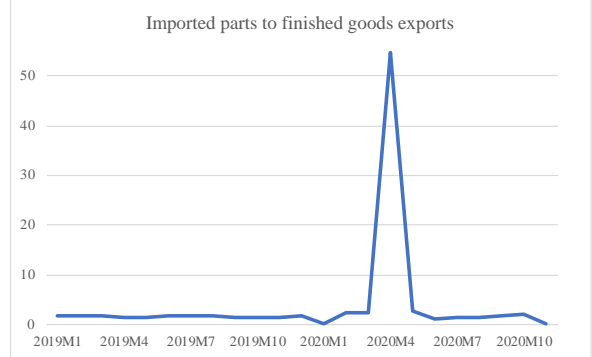
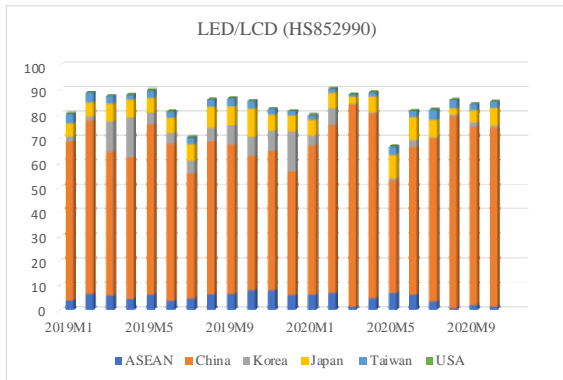
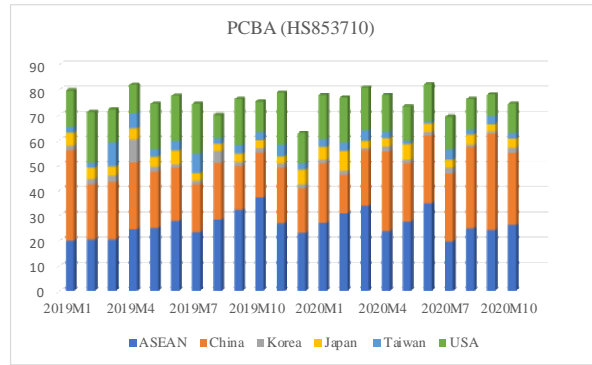
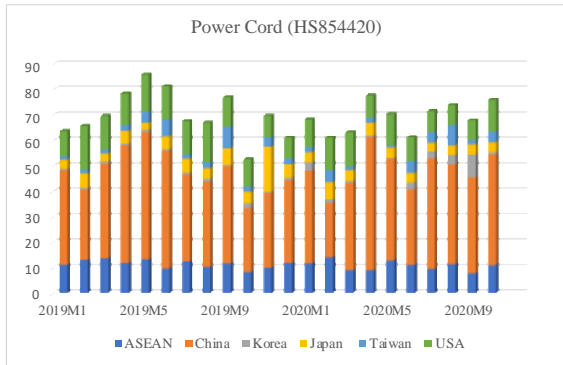
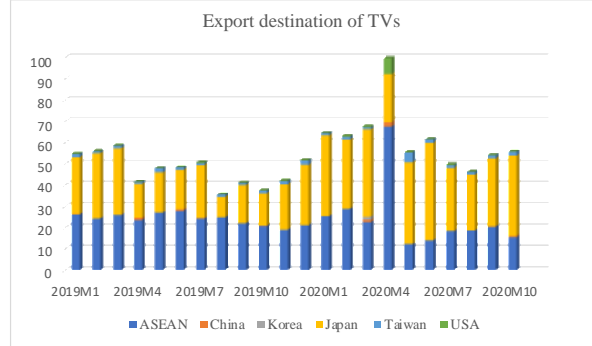
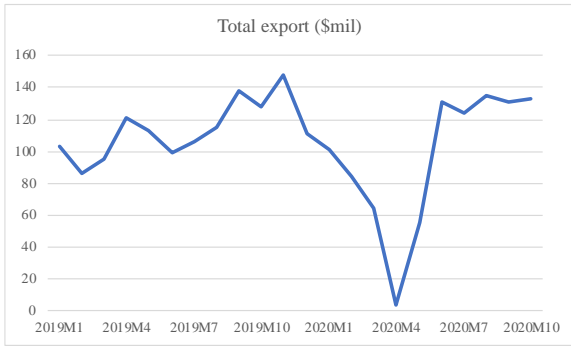
The export recovery is associated with export diversification in Indonesia and Malaysia. More television exports from Indonesia and Malaysia went to Korea and Japan, respectively. Another different pattern from Viet Nam is that exports from Indonesia relied more on local parts and components.

Figure 9: Indonesia's Televisions



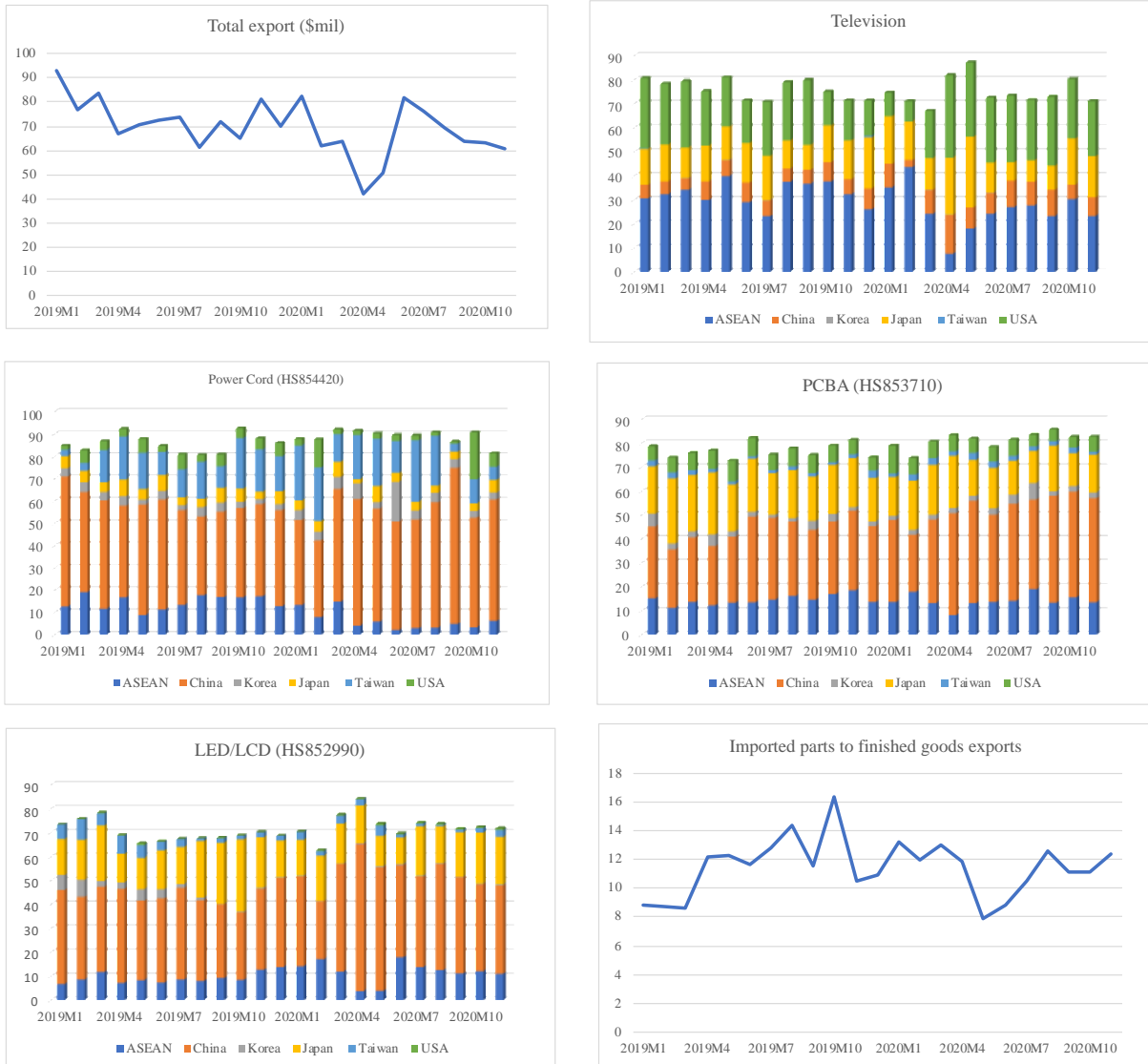
ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.
 Source: Authors' calculations from GTI (2021).

Figure 10: Malaysia's Televisions



ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.
 Source: Authors' calculations from GTI (2021).

Figure 11: Thailand's Televisions



ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.

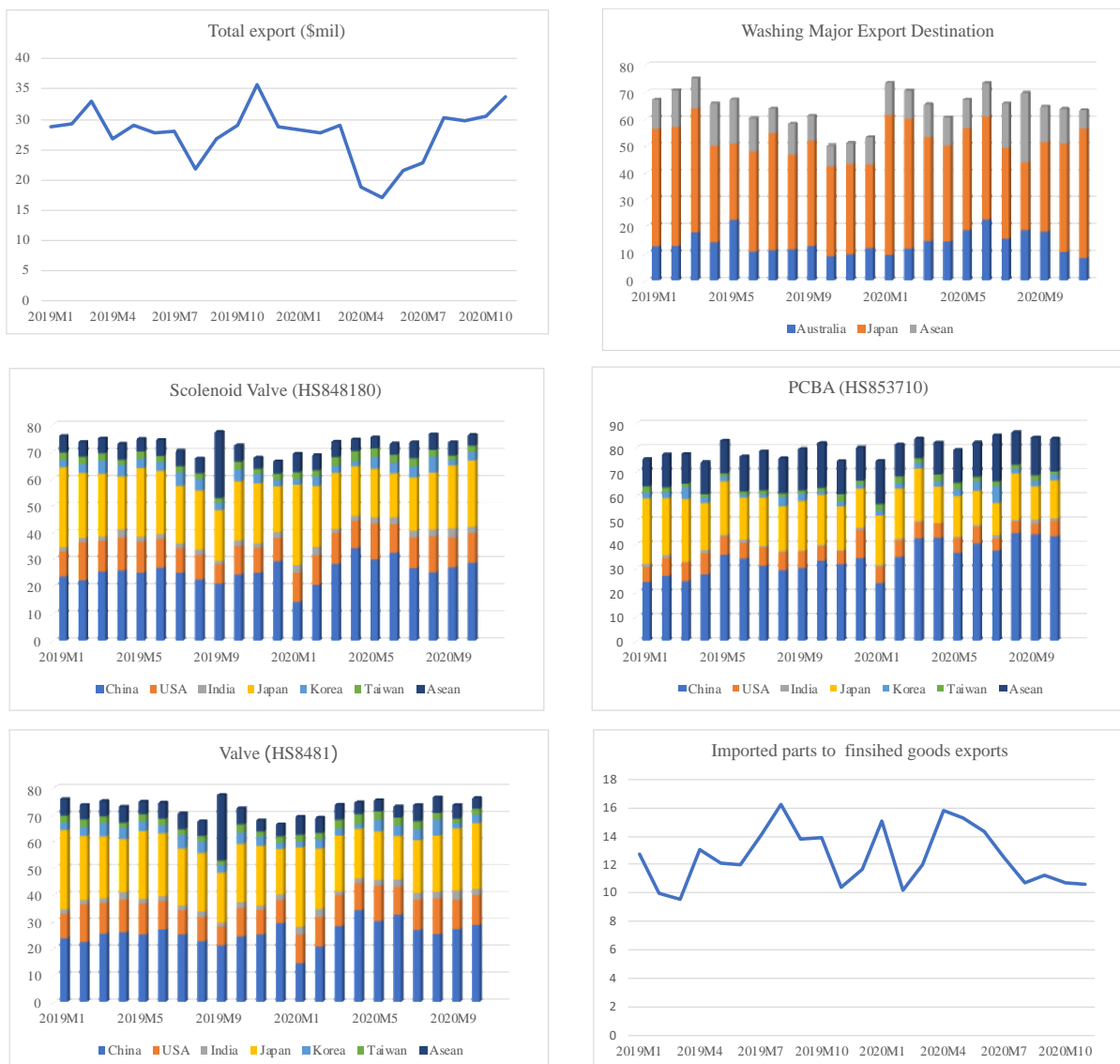
Source: Authors' calculations from GTI (2021).

4.5 Washing Machines

Similar to televisions, the GPS of washing machine production in Thailand was affected by the COVID-19 pandemic due to the interruption of the export of finished products stemming from the strict lockdown in China (Figure 12). For example, solenoid valve imports from China accounted for around one-fourth of total imports of washing machine parts during the pre-pandemic period. Its share dropped to around 10% in January, bottoming out in April 2020. Since May 2020, the sourcing pattern has returned to its pre-pandemic levels. There is no change in

sourcing patterns between domestic and foreign suppliers as indicated by the virtually constant trend of imported parts to finished goods exports.

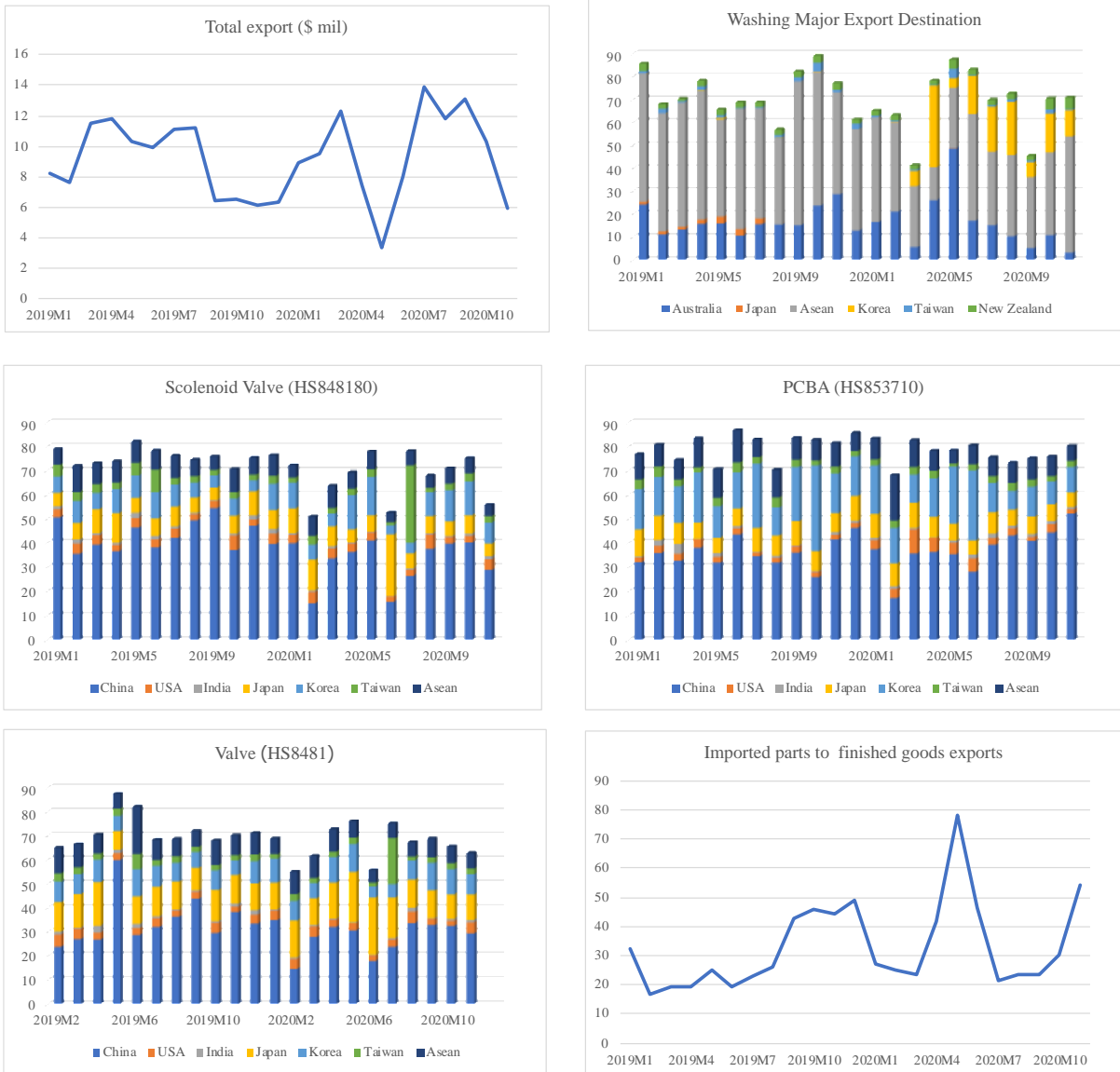
Figure 12: Thailand's Washing Machines



ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.
 Source: Authors' calculations from GTI (2021).

A similar impact of the COVID-19 pandemic is also found in Viet Nam (Figure 13). That is, there was an interruption in the supply of parts imported from China that resulted in an export slowdown. The effect was short-lived, so the sourcing pattern returned to pre-pandemic levels after May 2020. The only difference between Thailand and Viet Nam is that Viet Nam began diversifying export market destinations, particularly to Korea.

Figure 13: Viet Nam's Washing Machines



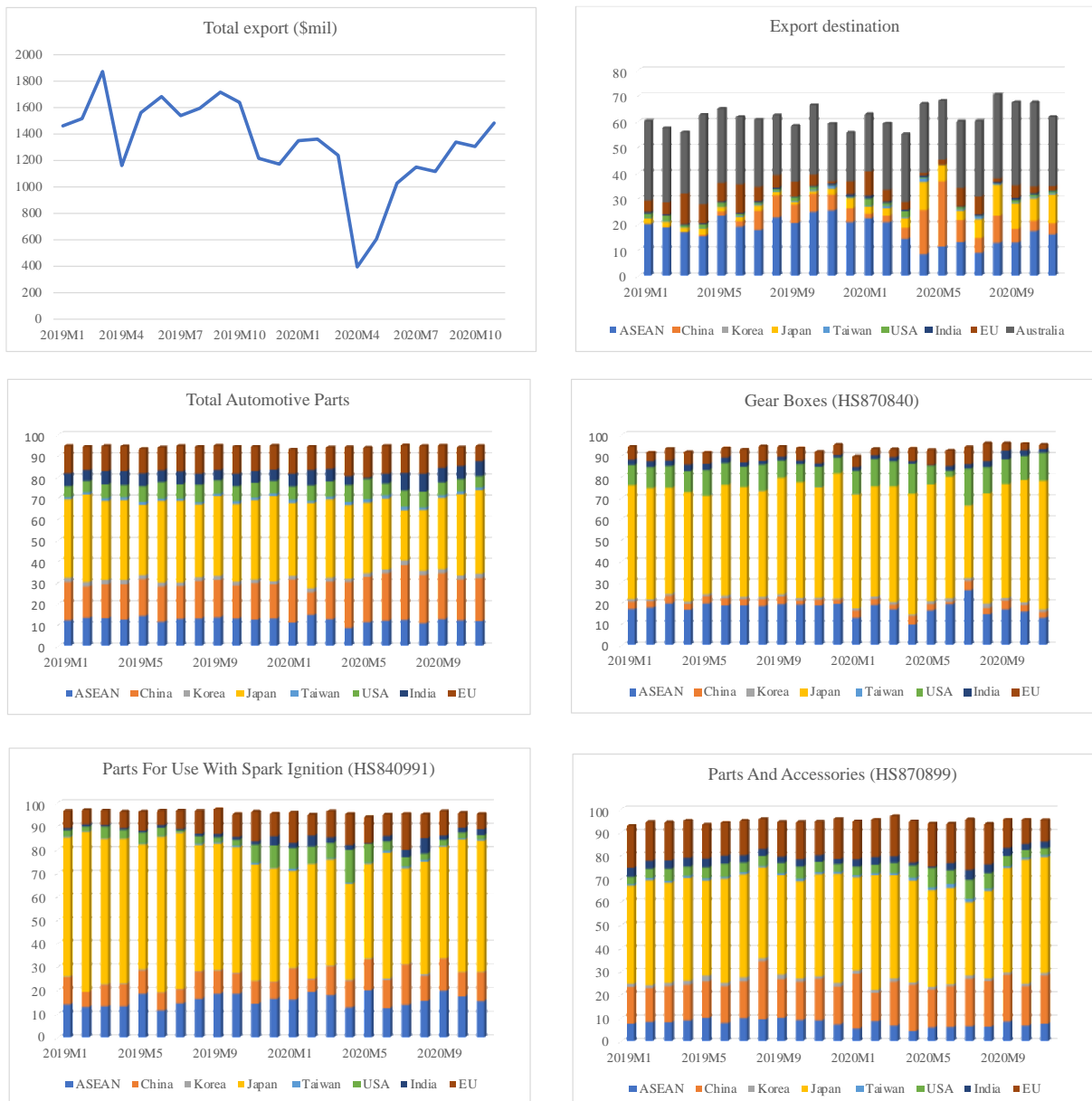
ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.
 Source: Authors' calculations from GTI (2021).

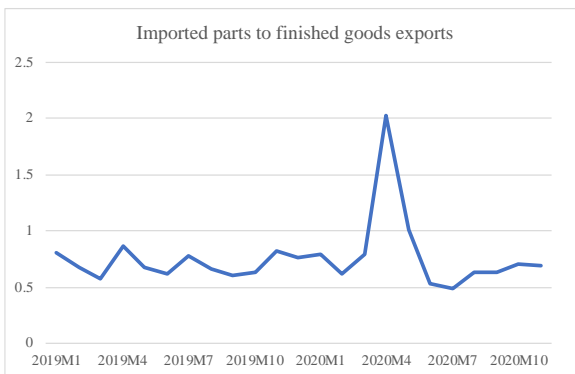
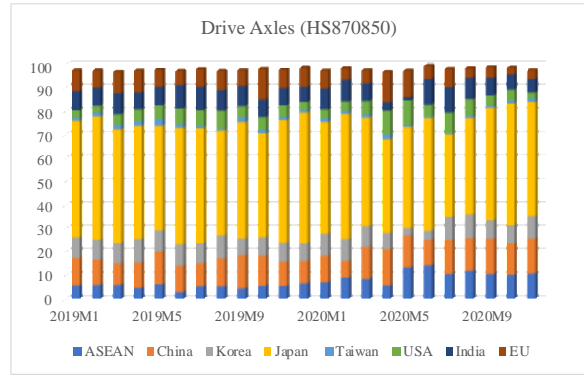
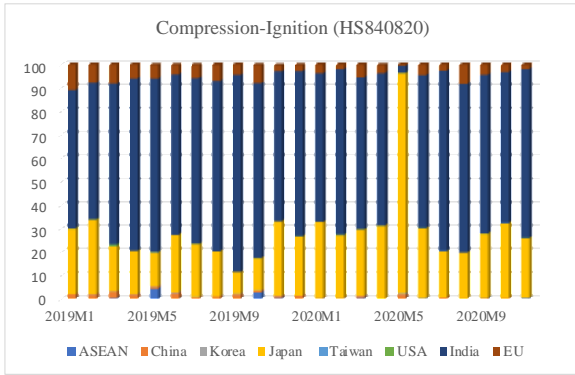
4.6 Automotive Parts

The automotive industry, including parts, components, and vehicles, of Thailand is the largest in ASEAN in terms of production and export. By 2019, vehicle production in Thailand was the 11th largest in the world; Indonesia was ranked 18th in the world (OICA 2021). A substantial share of vehicle production in both countries is exported.

Figures 14 and 15 illustrate the impact of the pandemic on the GPS in the automotive industry of Thailand and Indonesia. The pandemic caused a huge demand contraction as indicated in the export value of vehicles. In the case of Thailand, the monthly export value dropped sharply from \$1,400 million during the pre-pandemic period to \$400 million in April 2020 (Figure 14).

Figure 14: Thailand's Automotive Industry

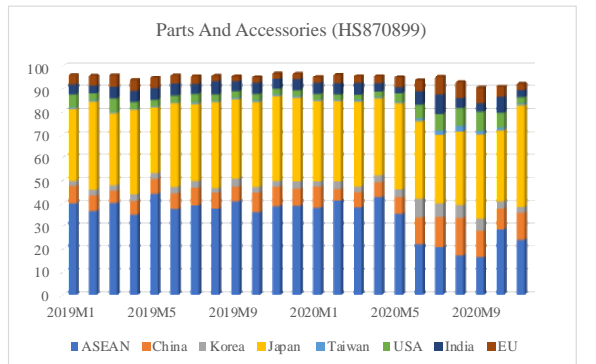
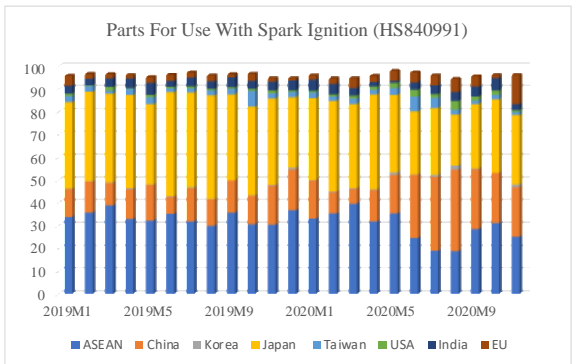
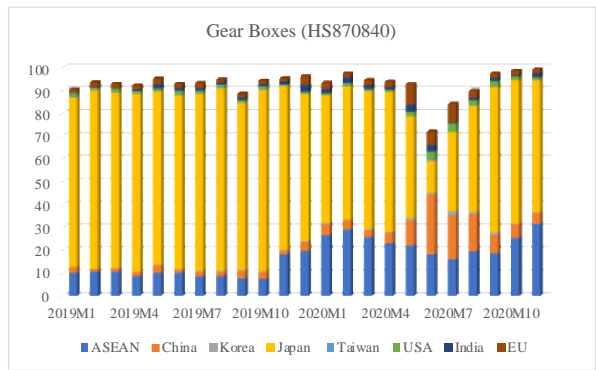
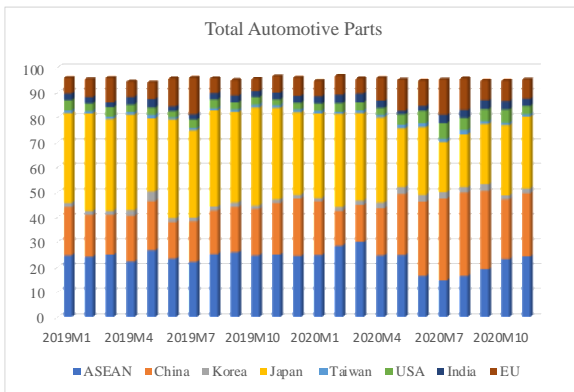
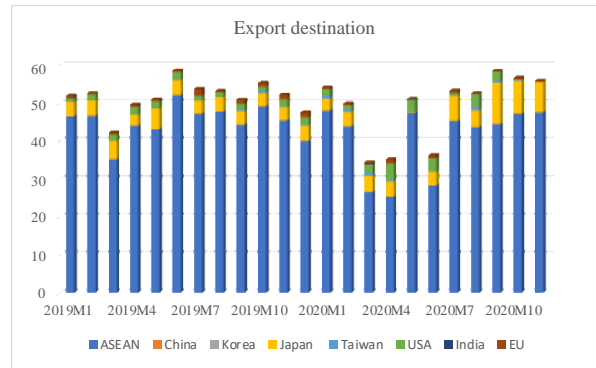
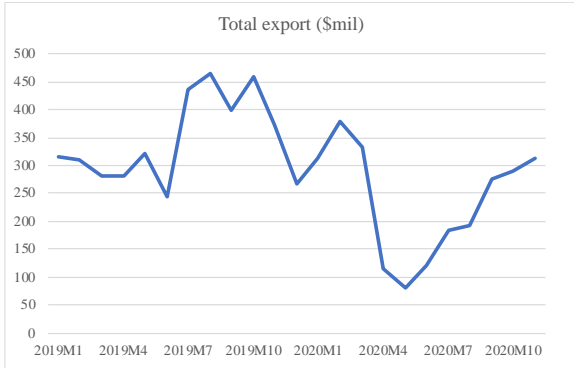


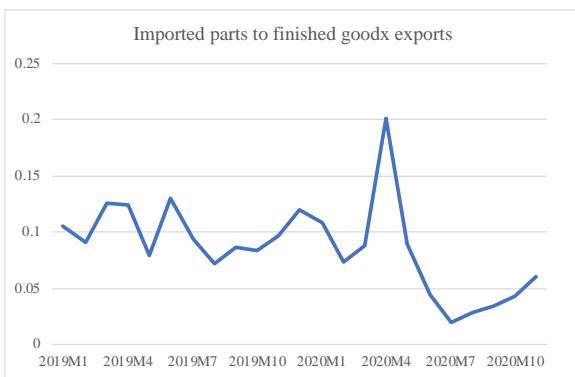
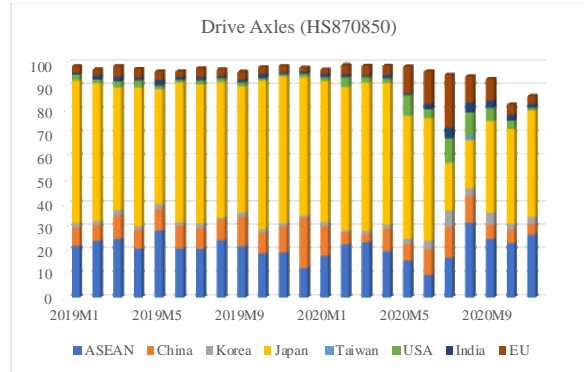
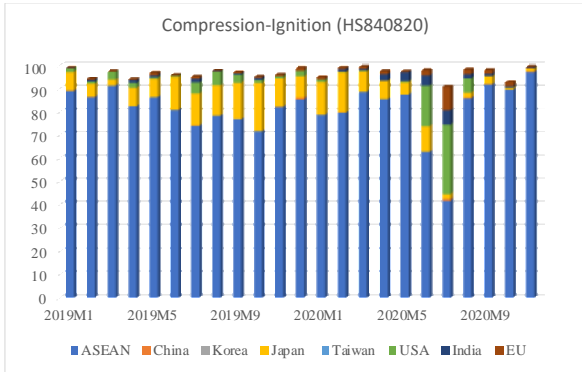


ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.
 Source: Authors' calculations from GTI (2021).

A similar pattern is also found in Indonesia (Figure 15). Such a demand contraction was due to the strict lockdown measures imposed on export market destinations, so export shipment was delayed. When the measures were eased, vehicle exports rebounded quickly. Averaging the export value over the first 10 months of 2020 suggests that the pandemic lowered overall export demand for vehicles. This seems sensible, as vehicles are quasi-durable goods whose demand is negatively affected by global economic recessions.

Figure 15: Indonesia's Automotive Industry





ASEAN = Association of Southeast Asian Nations, EU = European Union, USA = United States.
 Source: Authors' calculations from GTI (2021).

In contrast, the pandemic's impact on sourcing parts and components in the automotive sector seems limited. When all automotive parts are combined, mild changes are noted in sourcing patterns over the first 10 months of 2020. Regarding some parts like compression ignition engines, a significant change is seen.

Interestingly, in Indonesia, no changes are seen in sourcing patterns in which car manufacturers sourced more parts from China. Those from ASEAN – Thailand in particular – decreased. From January to May 2020, parts that Indonesia imported from ASEAN accounted for 26.7%, dropping to 16.8% between June and September 2020 and then returning to 23.8% in the next 2 months. Such a decrease was largely due to the capacity constraints of part suppliers in Thailand. Many firms in the automotive sector cut off their production capacity at the onset of crisis and terminated their workers, with the expectation that the pandemic would not result in substantial demand for vehicles in both domestic and foreign markets. When lockdown measures were eased, domestic demand ramped up. Hence, these firms could not match their production capacity

with the demand surge. As a result, Indonesian car manufacturers switched to parts from China as a temporary cushion.

5. Conclusions and Policy Inferences

This paper examined the effect of the COVID-19 pandemic on GPS in ASEAN Member States. Product-level analysis was undertaken where input–output mapping illustrated the effect. For six products, monthly actual trade data between January 2019 and October/November 2020 were used to detect an effect and any possible changes in GPS.

The key finding suggests that when the COVID-19 pandemic began in China, interruptions in the GPS of these products occurred. The common pattern found across products is that they experienced parts shortages and ceased their export activities. While firms producing these products could source parts elsewhere, the substitution was far from ideal. Hence, in most cases, their exports dropped sharply. The greater the reliance on Chinese-made parts, the larger the effect was on export contraction. Nonetheless, the effect was short-lived, found only January and February 2020. From then on, sourcing patterns returned to pre-pandemic levels.

From January to November 2020, there is no strong evidence that MNEs altered their supply chains and sourcing of parts and components due to the pandemic. As discussed above, altering GPS incurs sizable fixed costs, especially for parts and components. It is difficult in the current situation – where uncertainty is high and the global economy has entered a deep recession – to reconsider GPS. This seems to be consistent with the global FDI pattern observed recently.

There were few cases where domestic suppliers were able to cushion parts shortages. In Thailand, hard disk drive makers switched more parts and components orders to domestic ones, who had already been in contact with the company instead of recruiting brand-new local suppliers instantaneously. This confirms the literature regarding the tailor-made nature of parts and components used in GPS, as substantial costs are incurred for firms to establish trusted suppliers.

The pandemic also affected GPS through demand contraction, as illustrated by air conditioners and automotive parts. Interestingly, as GPS becomes more complex in ASEAN, how firms respond to demand contraction and recovery expectation may create another round of parts shortage. In particular, Thailand's automotive industry quickly cut off its production capacity during the onset of the crisis, resulting in an automotive parts shortage in Indonesia.

As illustrated by the GPS of televisions and washing machines, the COVID-19 effect has also acted as a catalyst for MNEs to move away from China. As the trade war between China and the United States began in 2018, many MNEs began to move their production facilities out of China. Given the huge sunk costs incurred by direct investment abroad, the moving-out process takes time, but the pandemic has accelerated this process. In particular, Viet Nam started diversifying its export of televisions and washing machines to the United States and Korea, respectively. Similar evidence was found for Malaysia's exports of televisions to Japan and Indonesia's to Korea.

The key policy inference is that a once-in-a-century event like the COVID-19 pandemic may not be sufficient to alter supply chain management in GPS. This is especially true when the sourcing of parts and components is concerned. By contrast, diversifying the market destinations of finished products is more likely, as this does not incur substantial costs to firms. Hence, creating resilient supply chains does not simply imply diversifying supplier bases.

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