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Demand and Supply Shocks of COVID-19 and International Production Networks: Evidence from Japan's Machinery Trade

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Abstract: *This paper investigated the impacts of COVID-19 on international production networks in machinery sectors by shedding light on negative supply shocks, negative demand shocks, and positive demand shocks. Specifically, we examined changes in trade in the periods of falling trade during the first wave of COVID-19 using Japan's machinery trade at the most disaggregated level and decomposed them into two intensive margins, i.e. the quantity effect and the price effect, and two extensive margins, i.e. the entry effect and the exit effect. Our empirical results demonstrated that i) trade relationships for parts and components are robust, and international production networks are almost intact, so far; ii) the intensive margin, mostly the negative quantity effect, induces the largest negative effects in the transport equipment sector amongst four machinery sectors; iii) positive demand shocks for specific products that are related to teleworking, disinfection, and stay-home activities partially explain sectoral differences; iv) direct negative supply shocks from China, suggested by a negative quantity effect and a positive price effect, exist in February 2020, with possible indirect negative supply shocks and substitution*

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of source countries; and v) negative demand shocks are confirmed from negative quantity and price effects in many cases. As of October 2020, Japan's machinery trade seems to have largely recovered. If the COVID-19 pandemic lasts long, however, prolonged negative demand shocks would hurt production networks in East Asia.
Keywords**:** COVID-19, International Production Networks, Demand and Supply Shocks, Intensive and Extensive Margins
JEL Classification**:** F14; F15; F23

1. Introduction

How have international production networks responded to the incredibly serious COVID-19 pandemic? International production networks in East Asia involve many countries, mainly in the region. Due to this extensive nature of production networks, the negative impacts of any shock, regardless of whether it is a demand shock or supply shock, can be transmitted to those countries involved, rather than being limited to the specific countries at the origin of the shock. During the last decade or so, we experienced a typical demand shock from the 2008–2009 global financial crisis (GFC) and negative supply shocks from the 2011 Great East Japan Earthquake (EJE) and the 2011 Thailand floods. The 2008–2009 GFC was a worldwide economic crisis that primarily started as a demand shock due to drastic falls in demand in the United States (US) and European Union (EU) markets and seriously affected the world economy as well as international production networks.[1] The 2011 EJE generated a supply shock due

[1] For instance, Behrens, Corcos, and Mion (2013) used Belgian firm-level data and demonstrated that changes in firm-country-product trade in the 2008–2009 GFC period occurred mostly at the

to the devastation of production plants located in the disaster areas and had negative impacts on domestic and international production networks in East Asia. Another natural disaster, which occurred in Thailand in October 2011 (the 2011 Thailand floods), also brought about a supply shock because many Japanese and other nationalities' firms had operations in the disaster areas of Thailand, playing important roles in supply chains. Some firms directly suffered from the damage of the floods, whilst others were indirectly affected through supply chains.[2]

Some studies, however, have demonstrated the resilient and robust nature of the production networks towards the crises, whilst negative shocks were extended to many countries involved in the networks temporarily.[3] For instance, Ando and Kimura (2012) examined the impacts of the 2008–2009 GFC and the 2011 EJE on international production networks using finely disaggregated data on Japan's exports and emphasised their resilience, including the robustness of trade relationships for parts and components.[4] Todo, Nakajima, and Matous (2015) investigated how supply chain networks affected the recovery of firms from the 2011 EJE and revealed the positive effects of supply chains that exceed the negative effects.

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intensive margin and that the fall in trade was mostly driven by the fall in demand for tradables.

[2] See Ando (2015) for some discussion on the impacts of the 2011 Thailand floods on regional production networks.

[3] Miroudot (2020) emphasised that the risk management literature makes an important distinction between resilience and robustness in supply chains; resilience can be defined as the ability to return to normal operations over an acceptable period of time, post-disruption; robustness is the ability to maintain operations during a crisis.

[4] With decomposition of the trade fall and recovery into intensive and extensive margins as well as logit estimation and survival analysis on the probability of the exits and re-entries, they found that for the production networks in East Asia, trade in machinery parts and components are robust and the trade relationships tend to be maintained, and recover even if they stop. Other studies that show the resiliency of international production networks in East Asia include Obashi (2011) for the 1997 Asian Financial Crisis and Okubo, Kimura, and Teshima (2014) for the 2008–2009 GFC.

The COVID-19 pandemic is more complicated, compared to the above-mentioned crises. It is not simply either a negative supply shock or a negative demand shock. Rather, the lockdown policies, states of emergency, and social distancing may cause both negative supply shocks (not only upstream supply disruption but also downstream supply disruption) and negative demand shocks, sometimes at the same time.[5] Multiple negative supply/demand shocks can even emerge simultaneously in many countries in the world. Moreover, the impacts on the demand side may vary amongst products due to the nature of the pandemic; it may create new demand for some specific products.[6] COVID-19 has forced us to introduce teleworking or stay home to maintain social distancing. It has also induced us to adopt new behaviour to avoid its infection; for example, non-contact thermometers have been newly introduced to check health conditions. Thus, products related to such activities could enjoy positive demand shocks due to COVID-19.

An additional complicated aspect of COVID-19 is that the timing and the degree of suffering from the pandemic are different amongst countries. Whether a country is more affected or less affected changes over time.[7] Figure 1 shows the COVID-19 situation in Japan and its major trading partners, which are also major players in international production networks. China had an outstanding peak in

[5] Hayakawa and Mukunoki (2020a) analysed the impacts of COVID-19 on global value chains using accumulated monthly trade data from January to June and demonstrated the negative supply effects through supply chains. Also, Meier and Pinto (2020) focused on the US–China production link and revealed that the industries with extensive exposure to intermediate goods imports from China experienced a large drop in production and trade.

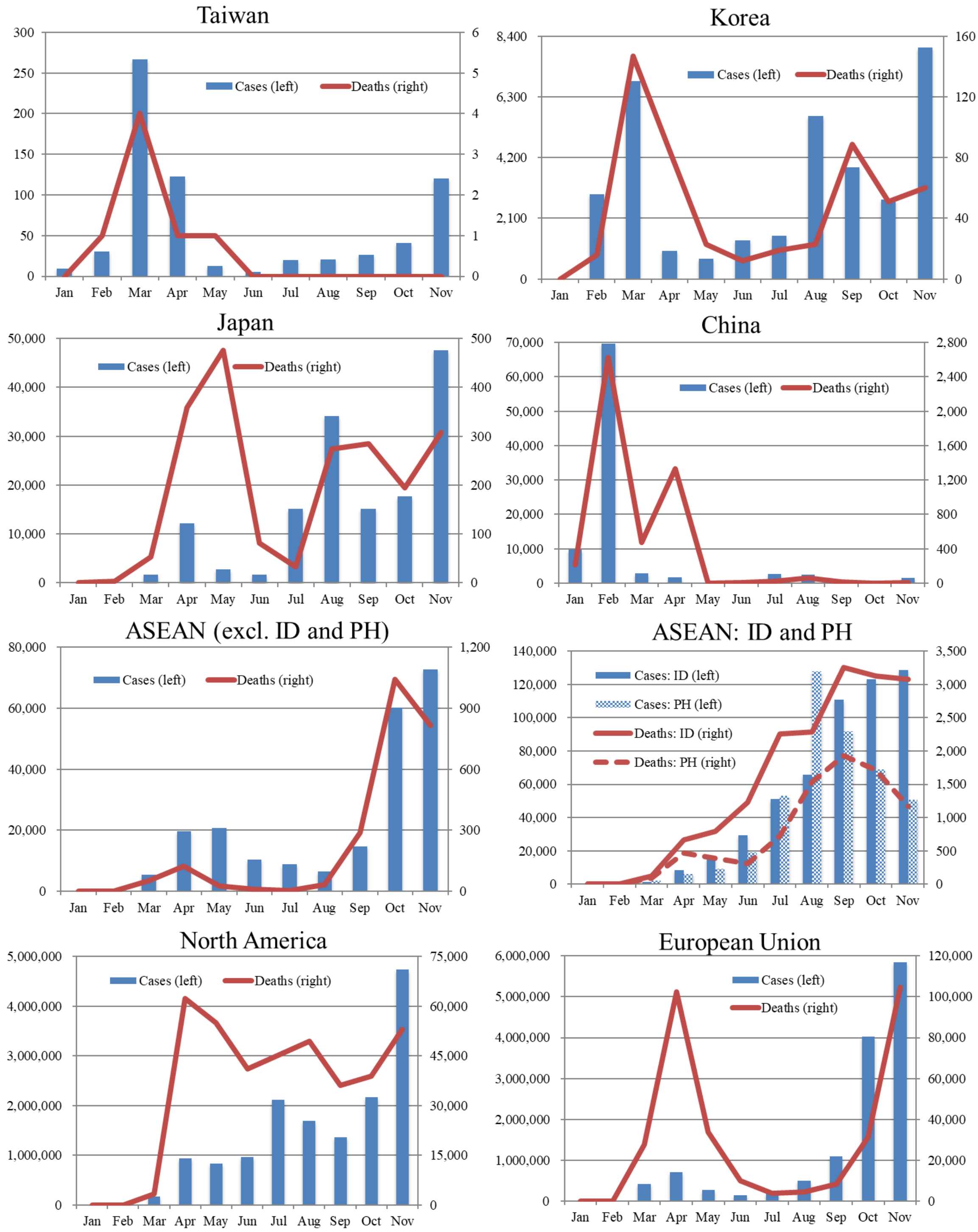
[6] Whether e-commerce can be easily used without worrying about social distancing or in the 'stay-home' environment may also influence the diversion of the demand side at the product level.

[7] The BBC News website provides interesting figures that summarise changes in restricted movement from 15 January to 1 April 2020 in each country by region (https://www.bbc.com/news/world-52103747). It also clearly shows the variety in the timing and the degree of the infection's spread in the world before April 2020.

February, and the Republic of Korea (hereafter, Korea) experienced its first peak in March, whilst Taiwan has maintained a much lower level. Association of Southeast Asian Nations (ASEAN) countries were less affected until August, except for Indonesia and the Philippines for which the situation was getting worse and which were recording increasing numbers of cases and deaths.[8] For Japan, the first wave came in April and May when the government declared a state of emergency. Compared to these East Asian countries, the COVID-19 pandemic has been much worse in North America and Europe, particularly since April.

[8] Amongst ASEAN countries other than Indonesia and the Philippines, Malaysia and Myanmar experienced a rapid expansion of COVID-19 from September, and particularly from October.

Figure 1. The Number of COVID-19 Cases and Deaths in 2020



ID = Indonesia, PH = Philippines, Korea = Republic of Korea.
Notes: The number of cases in China in December 2019 was 27. No cases were reported for Hong Kong. The European Union is comprised of 27 current members plus the United Kingdom.
Source: Author's calculations using Our World in Data COVID-19 Database (https://ourworldindata.org/coronavirus).

Any negative shock can be transmitted to less-affected countries through supply chains. For instance, a decline in demand for a final product in a seriously affected country (due to a drop in income) may reduce imports of that product from a less-affected country and, accordingly, reduce the demand for parts and components to be used for production that are supplied from another less-affected country. A supply disruption of a final product in a seriously affected country can reduce exports of that product to a less-affected country and also reduce the demand for its parts and components that are imported from another less-affected country. Conversely, a supply disruption of parts and components in a seriously affected country can reduce the production of the final product in a less suffered country that uses inputs imported from that country and may reduce exports of that final product to another less-affected country. Baldwin and Freeman (2020) emphasised the story of supply-chain contagion and reinfection in the COVID-19 period, resulting from a change in affected countries as follows: *while the supply side shock was first originated in China, it is now working its way back via China's dependence on inputs supplied from other countries*.

Considering the above-mentioned features of the COVID-19 pandemic, this study investigates the impacts of COVID-19 on international production networks in machinery sectors from the perspective of Japan's trade by shedding light on negative supply shocks, negative demand shocks, and positive demand shocks. Specifically, we examine changes in trade in the trade-declining period of the first wave of COVID-19 using Japan's machinery trade at the most disaggregated level and decompose them into two intensive margins, i.e. the quantity effect and the price effect, and two extensive margins, i.e. the entry effect and the exit effect.

Based on the decomposed results with some additional analyses, the paper discusses the impacts of COVID-19, focusing on the following points: i) robust trade relationships for parts and components, ii) sectoral differences, iii) positive demand shocks for specific products, iv) direct and indirect negative supply shocks in February, and v) negative demand shocks.

The rest of the paper is organised as follows. The next section briefly introduces the features of Japan's machinery trade and trade changes in 2020. Section 3 explains the data and methodology. Section 4 reports our empirical results and discussion, and Section 5 concludes the paper.

2. Japan's Machinery Monthly Trade Since 2017

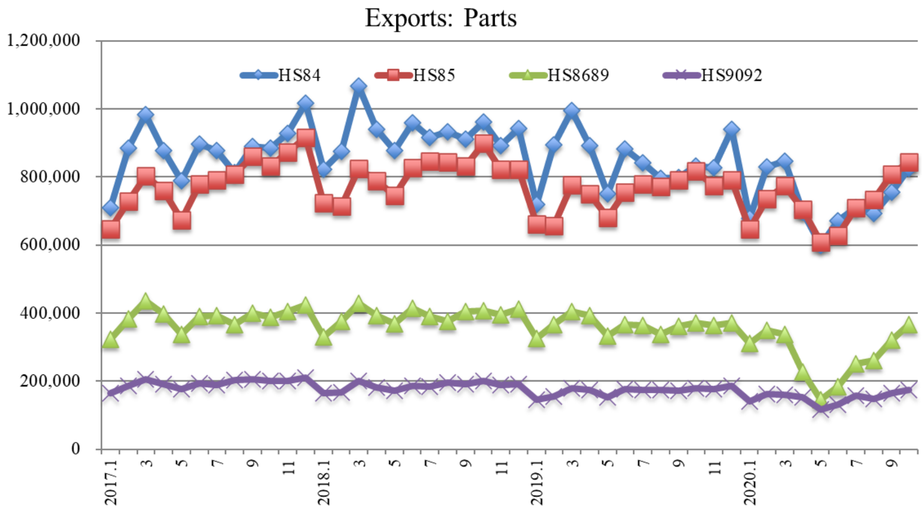
How has Japan's machinery trade changed in the COVID-19 period? As monthly trade tends to fluctuate, reflecting seasonality, if any, Figure 2 presents by-sector machinery exports and imports since 2017, with a distinction between parts and components and final products.[9] The four machinery sectors are general machinery (Harmonized System (HS) 84), electric machinery (HS85), transport equipment (HS86 to HS89: HS8689 hereafter), and precision machinery (HS90 to HS92: HS9092 hereafter). Figure 2 also shows imports in HS85 final products, excluding HS851712 (cell phones and smartphones), which has the largest import values amongst HS85 final products, considering their huge fluctuation.[10] As for

[9] See Kimura and Obashi (2010) for the definition of parts and components. Machinery goods other than parts and components are regarded as final products.

[10] See Figure A.1 in the Appendix for regional imports in HS85 final products and those in only HS851712. Figure A.1 also includes a chart that shows imports in HS85 final products from the world, imports in HS85 final products from China, and imports in HS851712 from China for a direct comparison. It apparently indicates that imports in HS851712, particularly those from China, cause an extreme fluctuation of imports in HS85 final products. For instance, iPhone 8 started to

parts and components, general machinery and electric machinery sectors are dominant for both exports and imports. On the other hand, the major sectors are different for exports and imports of final products. Whilst the transport equipment sector occupies the majority of exports in machinery final products, general machinery and electric machinery sectors have larger shares of imports in final products, though the variation amongst the four sectors becomes relatively small when HS851712 is excluded. Note that the trade balance is predominantly positive for both parts and components and final products.

Figure 2. Japan's Machinery Trade by Sector: Trade Value (¥ million)



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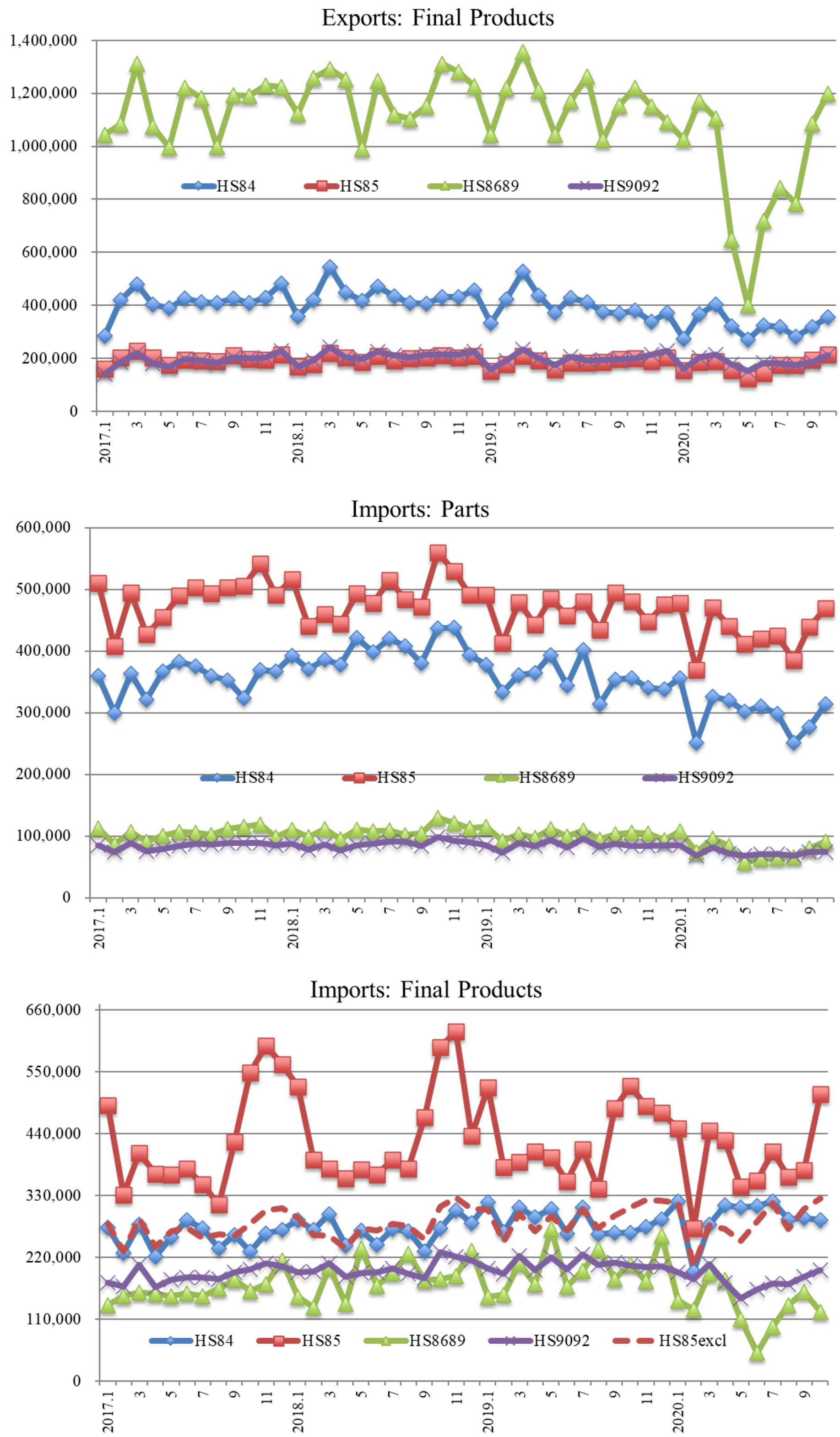
be sold from September 2017 and iPhone XS and iPhone XR from September and October 2018, respectively. The article in the following website mentions that many mobile shops carried out cash-back campaigns on the iPhone8/8 Plus particularly around September and October 2018, which were applied when people transferred to them from other mobile carriers with an iPhone8/8 Plus; https://www.itmedia.co.jp/mobile/articles/1811/28/news071.html. The same article also mentioned that the iPhone 8 remained the best-selling model for Docomo, au, and SoftBank in 2018, followed by new models of iPhones, because of the high cost-performance of the model and such campaigns. Furthermore, the production of iPhones has been conducted mostly in China, using parts and components that are supplied from the United States; https://iphone-mania.jp/news-276820/. These facts suggest that the extreme fluctuation of imports in HS85 final products largely reflects a fluctuation of imports in HS851712 from China due to a start of the sales of new iPhone models or sales strategies.



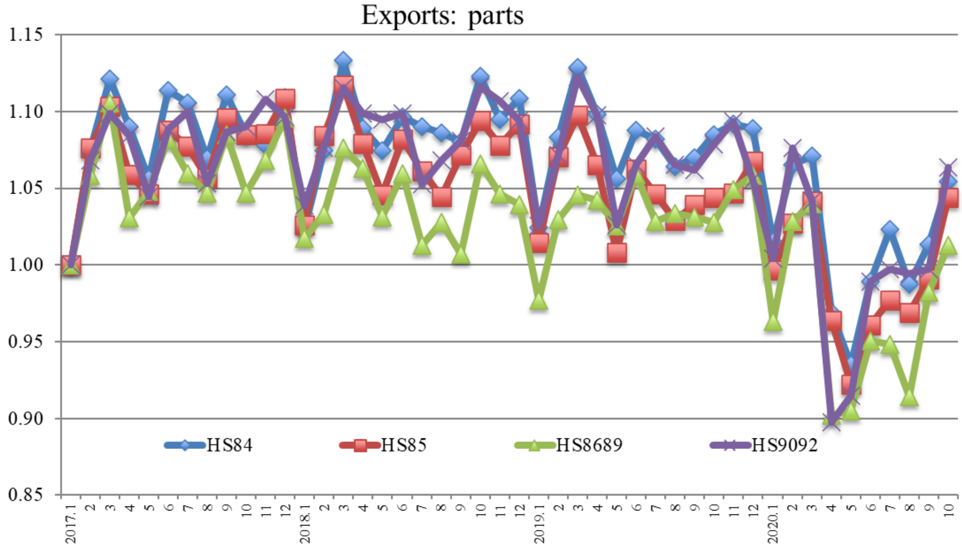
Note: HS85excl is the case excluding HS851712.
Source: Author's calculations.

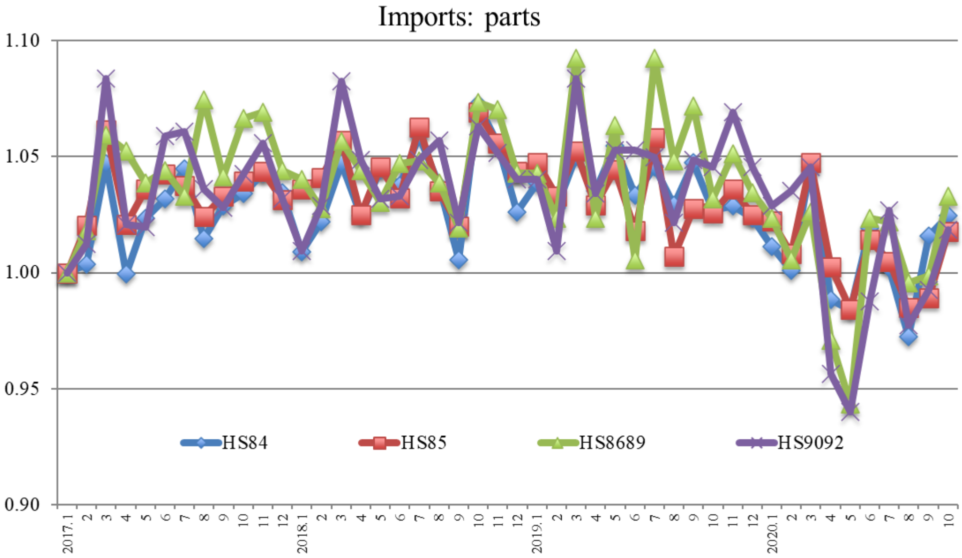
Apparently, exports in 2020 declined with a bottom in May for both parts and components and final products and started to recover in June. We can say that exports largely returned to normal levels by October 2020. The trade relationships in terms of the number of traded product-country pairs also reveal a similar pattern for exports. The number of exported product-country pairs, which is indexed to January 2017, significantly declined with a bottom in around May 2020 and began to recover in June (Figure 3). To confirm trade patterns more clearly by considering seasonal patterns, let us check monthly exports expressed as those indexed to January of each year: a) indices based on export values and b) indices based on the number of exported product-country pairs (Figure A.2 in the Appendix). Whilst the 3 years from 2017 to 2019 seem to have a similar seasonal fluctuation, monthly exports in 2020 tended to be lower than the levels of the past few years with a bottom in May.[11] These findings imply that it is worth highlighting January to May as a trade-drop period of the first wave of COVID-19.

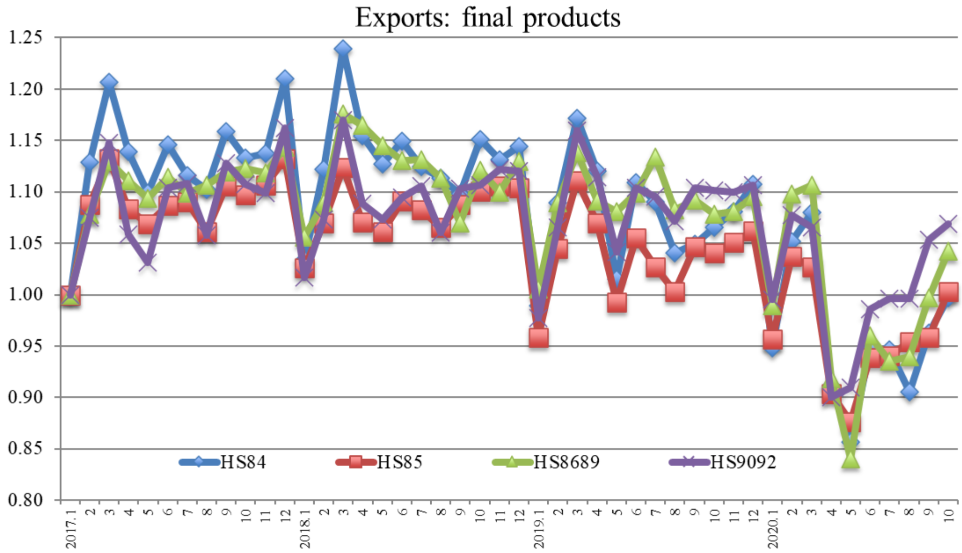
[11] For exports in HS8689 parts, HS9092 parts, and HS9092 final products, both April and May are the bottom in terms of the number of trade relationships.

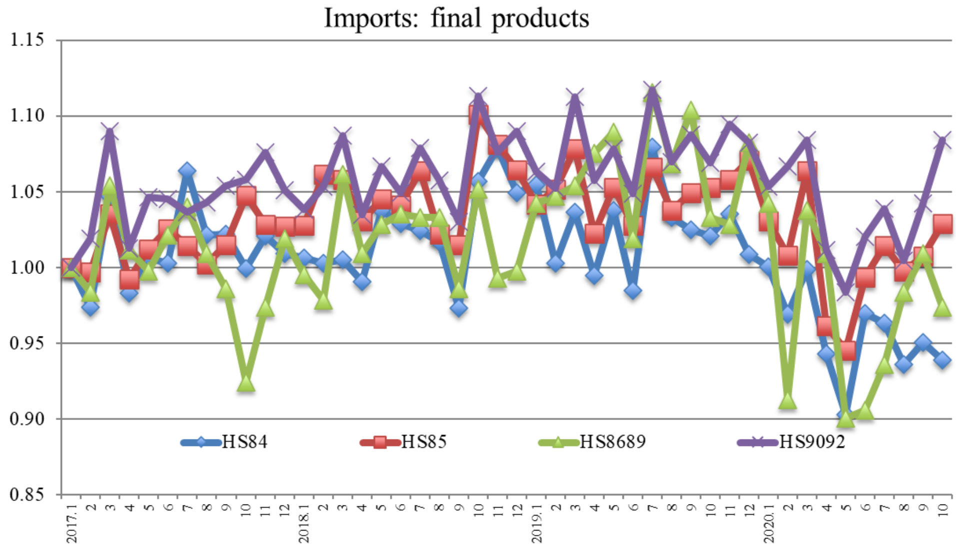
Figure 3. Japan's Machinery Trade by Sector:

Number of Exported/Imported Product-Country Pairs (Jan 2017=1)









Source: Author's calculations.

On the other hand, on the import side, the first drop is observed in February. Import values in Figure 2 as well as the number of imported product-country pairs in Figure 3 did sharply decline in February, particularly for the final products of most of the machinery sectors.[12] In addition, the number of imported product-country pairs also significantly fell with a bottom in around May 2020,

[12] Import indices in Figure A.3 are particularly low for HS84 parts and components, HS84 final products, and HS85 final products in terms of import values and HS8689 final products in terms of trade relationships.

particularly for the final products of most of the machinery sectors (Figure 3), though the pattern of the second drop in terms of import values is not so clear (Figure 2), partly because the seasonal pattern of imports is not so stable, unlike in the case of exports (Figure A.3a). These facts indicate that it is worth investing both periods from January to February and January to May as trade-fall periods of the first wave of COVID-19 on the import side.

Moreover, the negative impacts seem to be different amongst machinery sectors; the magnitude of the negative effects seems to be much larger in the transport equipment sector for both exports and imports in parts and components and final products. For instance, the export value index is close to 0.4 in May in this sector, whilst the corresponding indices are greater than 0.8 in other machinery sectors (Figures A.2a). Similarly, the import value index for final products is as low as 0.4 at the bottom in the transport equipment sector, whilst the corresponding indices are larger than 0.6 in other sectors (Figure A.3a).[13] Considering such sectoral differences, this paper examines the impacts by sector.

Before moving to our detailed analysis, let us discuss the major destinations and origins of Japan's machinery trade because they are different amongst the four machinery sectors and two types of products (Figures A.4 and A.5). On the export side, the major destinations of parts and components are China and North America for HS84; China, followed by ASEAN, for HS85; North America for HS8689; and China for HS9092. As for final products, the major destinations are China and North America for HS84 and HS85; North America and the rest of the world

[13] Imports in HS84 final products display an irregular pattern in April and May 2020; indices based on import values exceed those for the past 3 years, whilst indices based on the number of imported product-country pairs are much lower than those in the normal periods (Figure A.3). We will discuss this puzzle later.

(ROW), followed by the EU by far, for HS8689; and China, North America, and the EU for HS9092. Note that important destinations in ROW for HS8689 final products include Australia, New Zealand, Russia, Middle Eastern countries, Liberia, and Panama.[14] On the import side, the major origins of parts and components are China and North America for HS84; China, ASEAN, and Taiwan for HS85; and China, North America, ASEAN, and the EU for HS8689 and HS9092. Regarding final products, China is the most significant origin and is much far from other regions for HS84; China is an important origin, followed by ASEAN, for HS85; the EU and North America are major origins for HS8689 (the EU is the most important origin for HS87 only); and the EU and North America are major origins, followed by Taiwan, China, and ASEAN, for HS9092. Imports from China sharply declined in February in many cases.

3. Data and Methodology

This section explains how to investigate the trade drop by using a decomposition approach proposed by Haddad, Harrison, and Hausman (2010).[15] The first step is to identify the category of a product exported to or imported from a given partner country: 'continuing', 'entry', and 'exit'. If a product is exported to or imported from a given country in both period $t-1$ and period t, the category of the product for the corresponding country (the product-country pair) is

[14] See Figure A.6 for exports and imports in only HS87 final products or automobiles. Whilst the export patterns for HS87 final products are not so different from those for HS8689 final products (Figure A.4), the import patterns are slightly different between them; imports from ROW are lower than imports from North America. The top-10 destinations of exports in HS8689 include Liberia and Panama, but the top 10 destinations of exports in automobiles do not; these countries import vessels from Japan.

[15] Their approach is inspired by an earlier work by Bernard et al. (2009), who analysed the 1997 Asian crisis using trade data of US firms.

defined as 'continuing'. Similarly, the category of a product for a given country is defined as 'entry' if the product is exported or imported only in t. The category is defined as 'exit' if the product is exported to or imported from the corresponding country only in $t-1$.

The second step is to decompose changes in trade values from period $t-1$ to period t into extensive and intensive margins based on the categories defined above. The total value in t, v_t, can be written as the sum of the value of each product i:

$$v_t = \sum_{i=1}^{I} p_t^i q_t^i, \qquad (1)$$

where p_t^i and q_t^i denote the price and quantity of product i in t, and I is the total number of products. The percentage change in the total value, dv_t / v_{t-1}, is expressed as follows:

$$dv_t / v_{t-1} = (v_t - v_{t-1}) / v_{t-1} = \left(\sum_{i=1}^{I} p_t^i q_t^i - \sum_{i=1}^{I} p_{t-1}^i q_{t-1}^i \right) / v_{t-1}. \qquad (2)$$

The intensive margin is composed of effects due to changes in quantity and price; the rate of change in trade values for product-country pairs is classified as 'continuing' due to changes in quantity (quantity effect, hereafter) and changes in price (price effect). The extensive margin consists of an effect due to exiting products (exit effect) and an effect due to new products (entry effect); the rate of change in trade values resulting from a decrease in trade values due to no trade in t for product-country pairs is classified as 'exit', and an increase in trade values due to new trade in t for product-country pairs is classified as 'entry'. By rewriting equation (2), the percentage change in the total value of trade can be expressed as the sum of quantity effect, price effect, entry effect, and exit effect:

$$\frac{dv_t}{v_{t-1}} = \frac{\sum_{c=1}^{C} \frac{p_t^c + p_{t-1}^c}{2} \Delta q_t^c}{v_{t-1}} + \frac{\sum_{c=1}^{C} \Delta p_t^c \frac{q_t^c + q_{t-1}^c}{2}}{v_{t-1}} + \frac{\sum_{n=1}^{N} p_t^n q_t^n}{v_{t-1}} - \frac{\sum_{x=1}^{X} p_{t-1}^x q_{t-1}^x}{v_{t-1}}$$

$$(I = C + N + X)$$

(3)

where c is for product-country pairs with trade in both $t-1$ and t (in the category 'continuing'), n is for product-country pairs with trade only in t (in the category 'entry'), and x is for product-country pairs with trade only in $t-1$ (in the category 'exit'). I expresses the total number of product-country pairs; C the total number of product-country pairs in the category 'continuing'; N the total number of product-country pairs in the category 'entry'; and X the total number of product-country pairs in the category 'exit'.[16] As equation (3) suggests, the quantity and price effects here are the price-weighted quantity effect and the quantity-weighted price effect, respectively.

We could use the symmetric rate of change, $g = (v_t - v_{t-1}) / \frac{1}{2}(v_t + v_{t-1})$, instead of the standard rate of change $g = dv_t / v_{t-1}$.[17] By using this symmetric rate of change, the positive change rate and the negative change rate can be treated as a parallel.[18] Therefore, it would be better to use the symmetric rate of change if we conduct a study on both trade fall and trade recovery. As we focus on

[16] Haddad, Harrison, and Hausman (2010) provide detailed explanation of how to obtain equation (3) by rewriting equation (2).

[17] See Davis, Haltiwanger, and Schuh (1996) for discussion on the symmetric type of change rates, and Meier and Pinto (2020) for an example of studies using symmetric rates of growth.

[18] The symmetric rate of change takes a value between–2 and 2 (–200% and 200%). It also allows us to avoid extreme figures when a value drops close to zero.

trade declines in the following sections, however, we employ the standard rate of change.

Furthermore, we can also incorporate the concept of net and gross change rates in the literature on the job creation (JC) and job destruction (JD) method and connect them with the above-mentioned four effects.[19] The relationship between the net and gross rates of change for a concerned variable is in general shown as follows:

Net change rate = gross increase rate (GI) – gross decrease rate (GD),

where the terms 'gross increase rate' and 'gross decrease rate' are used instead of the gross change rate for JC and the gross change rate for JD. As the rate of changes in trade values on the left-hand side of the equations (2) and (3) is the net change rate, we can rewrite them by using the concept of net and gross change rates as follows:

$$\frac{dv_t}{v_{t-1}} = \sum\nolimits_{c\,(v_t^c - v_{t-1}^c > 0)} \frac{v_t^c - v_{t-1}^c}{v_{t-1}} - \sum\nolimits_{c\,(v_t^c - v_{t-1}^c < 0)} \frac{|v_t^c - v_{t-1}^c|}{v_{t-1}} + \sum\nolimits_{n} \frac{v_t^n}{v_{t-1}} - \sum\nolimits_{x} \frac{v_{t-1}^x}{v_{t-1}},$$

where the first term is *GI* for product-country pairs in the category 'continuing' (*GI*: intensive); the second term *GD* is for product-country pairs also in the category 'continuing' (*GD*: intensive), the third term is *GI* for product-country pairs in the category 'entry' (*GI*: extensive), and the fourth term is *GD* for product-country pairs in the category 'exit' (*GD*: extensive). Thus, *GI* (extensive)

[19] See Davis, Haltiwanger, and Schuh (1996) for the JC/JD method.

is equal to the entry effect, *GD* (extensive) is equal to the exit effect, and *GI* (intensive) minus *GD* (intensive) is equal to the total intensive margin, i.e. the sum of quantity effect and price effect. We basically employ the first-mentioned methodology to decompose the percentage change in the total value of trade into four effects (quantity effect, price effect, entry effect, and exit effect), but this type of decomposition into gross changes is also used in a necessary case.

This paper employs monthly data on Japan's bilateral exports and imports at the most disaggregated level, or the HS nine-digit level. The monthly data of Japan's trade at the product-country level in Japanese yen is available from the Trade Statistics of Japan, the Ministry of Finance, Japan.[20] Note that prices for some products in the category 'continuing' are missing due to a lack of data on quantity. Thus, changes in trade due to these product-country pairs are included in calculating the intensive margins, but they are excluded when the intensive margins are further decomposed into quantity and price effects.[21]

Our methodology is applied to exports to and imports from the world and their components of subgroupings by four machinery sectors and by two types of products. The subgroups are the following countries and regions: China (China and Hong Kong), Taiwan, Korea, ASEAN (10 ASEAN Member States), North America (the US, Canada, and Mexico), the EU (27 current EU member countries and the United Kingdom), and the rest of the world (ROW). The methodology is also applied to trade with a specific country in a necessary case.

[20] http://www.customs.go.jp/toukei/info/index.htm

[21] In addition to missing data on prices due to the lack of quantity data, there are some cases where changes in prices in absolute terms are extremely high. These are likely to occur when commodity composition in the category drastically changed. So, the product-country pairs with unreasonably large gaps in prices are excluded when intensive margins are further decomposed into quantity and price effects. Here, we use a criterion of outliers as the price changes by over 10 times.

4. Results and Discussion

Tables 1 and 2 summarise the decomposed results for a drop in exports to/imports from the world and their regional components during the first wave of the COVID-19 pandemic period from January to May 2020.[22] The figures for January–May 2019 are also shown for comparison. Based on these tables, Figure 4 depicts a decline in exports to the world, and Figure 5 a corresponding picture of a decline in imports from the world. These tables and figures provide interesting findings. For instance, the exit effect tends to be smaller for parts and components than for final products for both exports and imports, even in the COVID-19 pandemic period. Moreover, the magnitude of the negative impact is much larger in the transport equipment sector for both exports and imports, compared with other machinery sectors. On the other hand, the rate of change in imports in HS84 final products is almost equal to the rate in the same period of the previous year. Considering these facts, we can highlight several features of the impacts of COVID-19 on machinery trade in the periods of falling trade of the first wave of COVID-19: i) robust trade relationships for parts and components, ii) sectoral differences, iii) positive demand shocks for specific products, iv) direct and indirect negative supply shocks in February, and v) negative demand shocks.

[22] The results only for HS87 final products are shown separately to focus on automobiles (built-up cars) amongst HS8689 final products.

Table 1. Decomposition of the Rate of Change in Exports to the World, January-May 2020 (%)

	Parts and components								Final products							
	2020				2019				2020				2019			
	Total	Intens.	Extens.		Total	Intens.	Extens.		Total	Intens.	Extens.		Total	Intens.	Extens.	
			Entry	Exit			Entry	Exit			Entry	Exit			Entry	Exit
HS84																
World	**-11.4**	**-11.0**	**2.0**	**-2.3**	**4.3**	**4.1**	**1.8**	**-1.6**	**-1.8**	**0.5**	**8.1**	**-10.3**	**12.4**	**13.1**	**8.1**	**-8.8**
China	5.5	5.2	0.3	0.0	6.0	6.0	0.0	0.0	11.9	12.2	0.5	-0.8	9.4	9.4	0.6	-0.5
Korea	3.4	3.4	0.0	0.0	-1.8	-1.8	0.0	0.0	-0.3	-0.2	0.2	-0.3	-0.4	-0.3	0.2	-0.4
ASEAN	-4.3	-4.2	0.2	-0.4	-0.2	-0.3	0.2	-0.1	-2.6	-1.4	1.4	-2.7	0.0	1.0	1.4	-2.3
Taiwan	-0.5	-0.4	0.0	-0.1	-1.8	-1.7	0.0	-0.1	0.8	0.8	0.3	-0.3	0.6	0.2	0.6	-0.2
N. America	-8.7	-8.5	0.0	-0.3	2.6	2.6	0.1	-0.1	-5.4	-5.2	0.7	-0.8	1.1	1.2	0.6	-0.7
EU	-4.8	-4.7	0.3	-0.5	-0.7	-0.6	0.3	-0.4	-3.4	-3.4	1.8	-1.7	1.0	1.2	2.4	-2.6
ROW	-1.9	-1.8	1.1	-1.1	0.2	-0.1	1.1	-0.9	-2.7	-2.3	3.2	-3.6	0.8	0.4	2.4	-2.1
HS85																
World	**-6.1**	**-5.1**	**0.6**	**-1.5**	**2.9**	**3.1**	**0.4**	**-0.7**	**-20.6**	**-20.7**	**3.0**	**-3.0**	**4.5**	**3.9**	**3.0**	**-2.4**
China	5.4	5.3	0.1	0.0	4.1	4.1	0.0	0.0	5.1	4.7	0.4	0.0	3.1	3.0	0.2	-0.1
Korea	-1.6	-1.6	0.0	0.0	-0.5	-0.5	0.0	0.0	-0.7	-0.6	0.1	-0.3	0.3	0.1	0.3	-0.1
ASEAN	-2.7	-2.6	0.1	-0.1	-2.2	-2.2	0.0	0.0	-3.5	-3.7	0.7	-0.5	-1.9	-1.8	0.2	-0.3

Taiwan	2.2	2.2	0.0	0.0	2.3	2.3	0.0	0.0	1.2	1.2	0.0	-0.1	0.1	0.1	0.0	-0.1
N. America	-5.8	-5.5	0.0	-0.3	0.2	0.2	0.0	0.0	-12.3	-12.5	0.4	-0.2	3.3	3.2	0.2	-0.2
EU	-1.7	-1.6	0.2	-0.3	-0.5	-0.6	0.1	-0.1	-7.2	-6.9	0.6	-0.8	0.3	0.3	0.7	-0.7
ROW	-1.9	-1.2	0.2	-0.8	-0.5	-0.2	0.2	-0.5	-3.2	-2.8	0.8	-1.1	-0.8	-1.2	1.3	-0.9
HS8689																
World	**-53.2**	**-52.7**	**0.2**	**-0.6**	**2.2**	**2.4**	**0.5**	**-0.7**	**-61.0**	**-56.5**	**1.1**	**-5.7**	**0.0**	**-0.7**	**4.1**	**-3.4**
China	2.1	2.0	0.0	0.0	1.3	1.3	0.0	0.0	-1.1	-1.0	0.2	-0.2	1.6	1.9	0.0	-0.3
Korea	-0.5	-0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.2	0.0	0.0	0.3	0.3	0.0	0.0
ASEAN	-8.8	-8.7	0.0	-0.1	-0.4	-0.5	0.0	0.0	-4.1	-2.1	0.1	-2.0	-1.7	-1.7	0.2	-0.1
Taiwan	0.4	0.4	0.0	0.0	0.1	0.1	0.0	0.0	-1.2	-0.6	0.0	-0.6	0.6	0.3	0.3	0.0
N. America	-28.0	-28.0	0.0	-0.1	2.2	2.2	0.0	0.0	-25.4	-25.2	0.0	-0.2	-1.6	-1.6	0.0	0.0
EU	-10.6	-10.6	0.1	-0.1	-0.4	-0.6	0.3	0.0	-7.0	-6.4	0.4	-1.0	-1.8	-2.2	0.5	-0.1
ROW	-7.7	-7.4	0.1	-0.4	-0.7	-0.3	0.1	-0.6	-22.4	-21.2	0.4	-1.6	2.7	2.5	3.0	-2.8
HS87																
World									**-62.3**	**-60.2**	**0.9**	**-3.0**	**0.7**	**0.5**	**1.2**	**-1.0**
China									-1.5	-1.4	0.2	-0.3	1.6	1.7	0.0	-0.1
Korea									0.2	0.2	0.0	0.0	0.3	0.3	0.0	0.0
ASEAN									-3.1	-2.8	0.1	-0.3	0.6	0.5	0.2	-0.1
Taiwan									-0.8	-0.7	0.0	-0.1	0.3	0.3	0.0	0.0
N. America									-29.9	-29.6	0.0	-0.3	-1.9	-1.9	0.1	0.0

EU									-7.5	-7.1	0.1	-0.5	-2.5	-2.6	0.1	-0.1
ROW									-19.8	-18.7	0.4	-1.5	2.3	2.1	0.8	-0.6
HS9092																
World	**-16.7**	**-16.4**	**0.5**	**-0.9**	**4.9**	**4.7**	**0.7**	**-0.5**	**-5.0**	**-4.7**	**3.1**	**-3.4**	**11.2**	**11.0**	**2.7**	**-2.5**
China	0.2	0.2	0.0	0.0	2.1	2.0	0.0	0.0	5.7	5.7	0.4	-0.4	6.5	6.5	0.1	0.0
Korea	-0.3	-0.3	0.0	0.0	0.8	0.8	0.0	0.0	2.5	2.5	0.0	0.0	1.5	1.6	0.0	-0.1
ASEAN	-3.0	-3.0	0.2	-0.1	0.0	0.0	0.1	0.0	-1.4	-1.6	0.5	-0.3	2.0	1.7	0.5	-0.3
Taiwan	0.4	0.4	0.0	0.0	0.5	0.5	0.0	0.0	1.8	1.9	0.0	-0.1	0.8	0.8	0.0	0.0
N. America	-7.1	-7.0	0.0	-0.1	1.1	1.1	0.0	0.0	-8.5	-8.5	0.1	-0.1	1.1	1.2	0.2	-0.3
EU	-5.6	-5.3	0.1	-0.3	0.5	0.3	0.3	-0.1	-3.2	-3.0	0.5	-0.7	-0.6	-0.7	0.5	-0.4
ROW	-1.4	-1.3	0.2	-0.3	0.0	-0.1	0.3	-0.2	-1.9	-1.7	1.5	-1.7	0.0	-0.1	1.5	-1.4

Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Notes: The cases with rates that are higher in 2020 than in 2019 are highlighted; yellow/green is used for positive/negative rates in 2020. Intens.and Extens. denote the intensive margin and extensive margin, respectively.
Source: Author's calculations.

Table 2. Decomposition of the Rate of Change in Imports from the World, January-May 2020 (%)

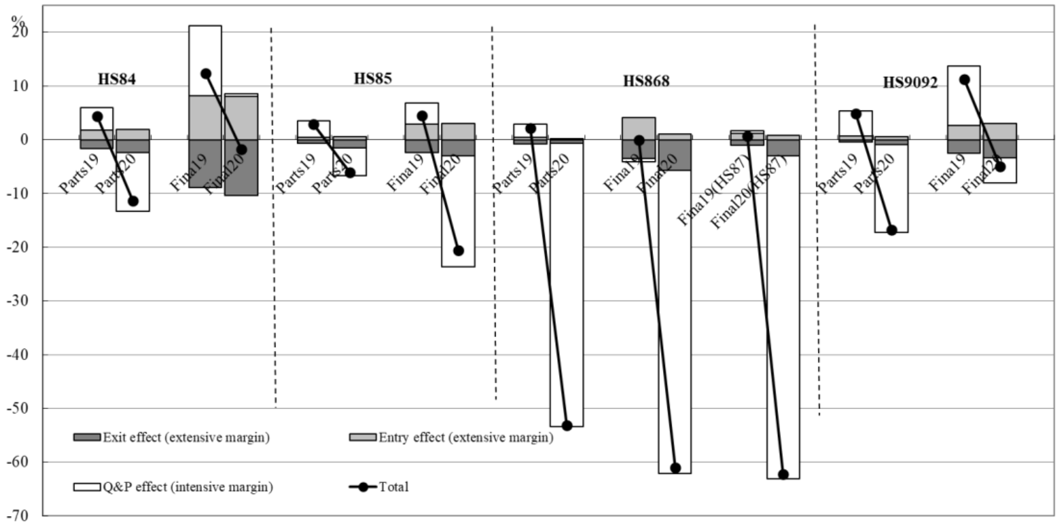
	Parts and components								Final products							
	2020				2019				2020				2019			
	Total	Intens.	Extens.		Total	Intens.	Extens.		Total	Intens.	Extens.		Total	Intens.	Extens.	
			Entry	Exit			Entry	Exit			Entry	Exit			Entry	Exit
HS84																
World	**-15.3**	**-13.3**	**1.8**	**-3.8**	**4.3**	**3.5**	**2.2**	**-1.4**	**-3.5**	**-1.5**	**2.0**	**-4.0**	**-3.9**	**-3.4**	**3.0**	**-3.5**
China	-3.9	-3.7	0.0	-0.2	0.2	0.2	0.0	0.0	8.1	8.3	0.1	-0.2	-5.5	-5.5	0.1	-0.1
Korea	-0.9	-0.9	0.0	0.0	0.7	0.7	0.0	0.0	-0.6	-0.6	0.2	-0.1	-0.5	-0.5	0.1	-0.1
ASEAN	-1.2	-1.1	0.1	-0.2	2.7	2.8	0.1	-0.2	-2.3	-2.2	0.2	-0.2	2.3	2.1	0.3	-0.1
Taiwan	-0.5	-0.5	0.0	-0.1	0.0	0.2	0.1	-0.3	-0.9	-0.8	0.0	-0.2	0.0	0.0	0.1	-0.1
N. America	-2.9	-2.7	0.1	-0.3	-0.2	0.0	0.3	-0.4	-2.5	-2.3	0.1	-0.3	0.5	0.5	0.2	-0.2
EU	-5.0	-3.9	1.5	-2.6	1.7	0.5	1.6	-0.3	-4.8	-3.4	1.0	-2.4	-0.7	-0.3	1.8	-2.2
ROW	-1.0	-0.6	0.1	-0.4	-0.9	-0.9	0.2	-0.1	-0.5	-0.4	0.4	-0.5	0.0	0.2	0.4	-0.6
HS85																
World	**-13.9**	**-13.8**	**0.2**	**-0.3**	**-1.4**	**-1.5**	**0.4**	**-0.3**	**-21.6**	**-23.1**	**2.5**	**-0.9**	**-3.9**	**-3.3**	**0.8**	**-1.4**
China	-5.9	-5.9	0.0	0.0	-1.6	-1.6	0.0	0.0	-6.8	-6.8	0.0	0.0	-4.5	-4.5	0.0	0.0
Korea	-0.2	-0.2	0.0	0.0	0.5	0.5	0.0	0.0	-0.5	-0.5	0.1	0.0	0.3	0.4	0.0	-0.1

ASEAN	-7.9	-7.9	0.0	-0.1	-0.2	-0.3	0.1	0.0	-11.1	-11.0	0.1	-0.2	0.8	1.4	0.2	-0.7
Taiwan	1.2	1.2	0.0	0.0	-2.7	-2.7	0.0	0.0	-0.4	-0.5	0.1	0.0	0.3	0.2	0.0	0.0
N. America	-1.3	-1.3	0.0	0.0	1.0	1.0	0.1	0.0	-2.3	-2.3	0.1	-0.1	-0.5	-0.5	0.0	0.0
EU	0.2	0.2	0.1	-0.1	1.5	1.5	0.2	-0.2	-1.0	-1.9	1.2	-0.4	-0.3	-0.1	0.4	-0.5
ROW	0.0	0.0	0.1	-0.1	0.0	0.0	0.1	0.0	0.6	-0.2	0.9	-0.1	0.0	-0.1	0.2	-0.1
HS8689																
World	**-47.0**	**-46.9**	**0.2**	**-0.4**	**-2.8**	**-4.4**	**1.9**	**-0.3**	**-23.2**	**-29.5**	**16.3**	**-10.0**	**79.4**	**57.5**	**28.9**	**-7.1**
China	-17.1	-17.1	0.0	0.0	-5.7	-5.7	0.0	0.0	-2.0	-1.3	0.0	-0.8	-1.8	-1.0	0.0	-0.8
Korea	-5.1	-5.1	0.0	0.0	-0.3	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.2	0.0
ASEAN	-8.5	-8.5	0.0	0.0	0.3	0.3	0.0	0.0	-1.1	-2.1	2.3	-1.3	0.4	0.4	0.1	-0.1
Taiwan	-0.3	-0.3	0.0	0.0	-0.2	-0.2	0.0	0.0	-0.1	-0.1	0.0	0.0	-0.1	-0.1	0.0	0.0
N. America	-9.2	-9.2	0.0	0.0	4.6	2.9	1.7	-0.1	-9.1	-9.1	1.4	-1.4	20.3	17.6	2.9	-0.1
EU	-5.5	-5.6	0.2	-0.1	-1.2	-1.2	0.2	-0.2	-8.4	-16.6	12.3	-4.1	60.1	40.0	25.7	-5.6
ROW	-1.3	-1.2	0.0	-0.1	-0.2	-0.2	0.1	-0.1	-2.5	-0.3	0.1	-2.3	0.2	0.4	0.1	-0.4
HS87																
World									**-33.3**	**-30.6**	**3.1**	**-5.8**	**44.2**	**43.0**	**2.4**	**-1.3**
China									-1.3	-1.3	0.0	-0.1	-1.1	-1.1	0.1	0.0
Korea									0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
ASEAN									-1.2	-2.3	2.5	-1.4	0.6	0.6	0.1	-0.1
Taiwan									-0.1	-0.1	0.0	0.0	-0.1	-0.1	0.0	0.0

N. America									-10.3	-9.4	0.1	-1.0	6.0	5.6	0.5	-0.1
EU									-18.6	-17.3	0.4	-1.8	38.3	37.3	1.5	-0.5
ROW									-1.8	-0.3	0.1	-1.5	0.2	0.6	0.1	-0.5
HS9092																
World	**-19.1**	**-18.6**	**0.2**	**-0.8**	**9.4**	**9.3**	**0.6**	**-0.5**	**-23.9**	**-23.3**	**0.8**	**-1.5**	**10.1**	**9.8**	**1.2**	**-0.9**
China	-6.1	-6.1	0.0	0.0	0.9	0.9	0.0	0.0	-3.9	-3.9	0.0	-0.1	-1.9	-1.9	0.0	-0.1
Korea	-0.2	-0.2	0.0	0.0	-0.2	-0.2	0.0	0.0	-0.4	-0.4	0.0	-0.1	-0.1	-0.1	0.1	0.0
ASEAN	-3.5	-3.4	0.0	-0.2	0.9	0.9	0.1	-0.1	-1.2	-1.1	0.1	-0.3	-0.3	-0.4	0.1	-0.1
Taiwan	-1.1	-1.1	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0
N. America	-6.2	-6.2	0.0	0.0	5.7	5.6	0.0	0.0	-6.1	-6.0	0.0	-0.2	4.5	4.5	0.1	0.0
EU	-1.3	-1.0	0.1	-0.5	1.3	1.1	0.3	-0.1	-4.8	-4.5	0.3	-0.6	2.8	2.8	0.6	-0.5
ROW	-0.7	-0.6	0.0	-0.1	1.0	1.0	0.1	-0.2	-7.4	-7.4	0.3	-0.3	4.9	4.7	0.3	-0.1

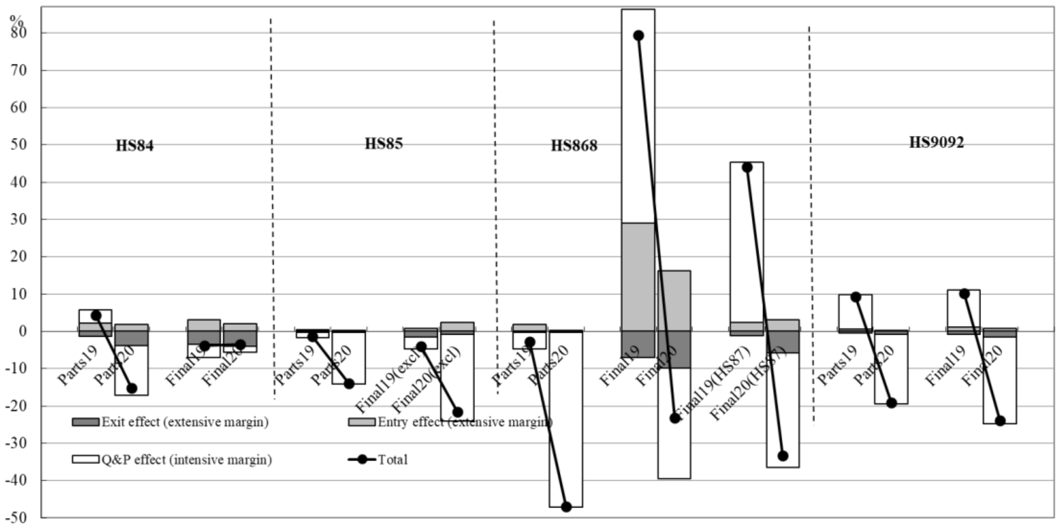
Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Notes: The cases with rates that are higher in 2020 than in 2019 are highlighted; yellow/green is used for positive/negative rates in 2020. Intens.and Extens. denote the intensive margin and extensive margin, respectively.
Source: Author's calculations.

Figure 4. Export Decline in the COVID-19 Pandemic Period, January-May 2020



Notes: The Q&P effect is the sum of the quantity effect, price effect, and unidentified effect. Parts20 (Parts19), for instance, denotes machinery parts in the period from January to May 2020 (2019). Parts and Final denote machinery parts and components and machinery final products. Data is based on Japanese yen.
Source: Author's calculations.

Figure 5. Import Decline in the COVID-19 Pandemic Period, January-May 2020



Notes: The Q&P effect is the sum of quantity effect, price effect, and unidentified effect. Parts20 (Parts19), for instanec, denotes machinery parts in the priod from January to May 2020 (2019). Parts and Final denote machinery parts and components and machinery final products. HS85 Final products excludes HS851712. Data is based on yen.
Source: Author's calculations.

i) <u>Robust trade relationships for parts and components</u>

The exit effect tends to be smaller for parts and components than final products for both exports and imports, even in the COVID-19 pandemic period. The exit effect (the absolute value) is larger for final products than for parts and components in the normal period, and becomes even larger in the COVID-19 pandemic period, particularly for HS84 exports (from 9% in 2019 to 10% in 2020 in absolute terms), HS87 exports (from 1% to 3%), and HS87 imports (from 1% to 6%). On the other hand, the exit effect for parts and components tends to stay at a low level. Whilst the exit effect (the absolute value) on the export side becomes slightly larger for all sectors other than HS8689, the difference between the COVID-19 period and the normal period is less than only 1% for each sector.[23] Similarly, the corresponding difference in the exit effect on the import side is only less than 0.5% for all sectors excluding HS84.[24] Combined with the fact that the number of traded product-country pairs is likely to drop by a lesser extent for parts and components than for final products (Figure 3), these figures suggest that trade relationships for parts and components tend to be robust, even in the COVID-19 period.

If negative demand shocks for final products continue for long, they can hurt trade and trade relationships for parts and components as well, resulting in permanent damage to the production system. By October 2020, however, Japan's machinery trade had tended to recover in most cases. At least in the period of the

[23] The exit effect (the absolute value) in 2020 (2019) on the export side is 2.3% (1.6%) for HS84, 1.5% (0.7%) for HS85, 0.6% (0.7%) for HS8689, and 0.9% (0.5%) for HS9092.
[24] The exit effect (the absolute value) in 2020 (2019) on the import side is 3.8% (1.4%) for HS84, 0.3% (0.3%) for HS85, 0.4% (0.3%) for HS8689, and 0.8% (0.5%) for HS9092.

trade drop, as of October 2020, trade relationships for parts and components tended to be maintained in the production networks, and international production networks were resilient.

ii) <u>Sectoral differences</u>

The negative impacts are the largest in the transport equipment sector. The rate of total change in this sector is –53%/–47% for 2020 (2%/–3% in 2019) for exports/imports in parts and components and –61%/–23% (0%/79%) for exports/imports in final products. Considering the fact that the corresponding rates in other machinery sectors are not lower than –20% for parts and components or –25% for final products, this confirms that the negative impacts are much larger in the transport equipment sector.

In the case of final products, for instance, in addition to the enlarged exit effect, the significantly lower intensive margin (mostly the quantity effect) explains the large fall in trade as Figures 4 and 5 clearly present. On the export side, the negative quantity effect was substantially expanded, causing a huge negative rate of total change. The quantity effect/total effect was –58%/–61% in 2020 (–2%/0% in 2019) for HS8689 and –58%/–62% (–3%/0.7%) for HS87 only (Figure 3 and Table 3). On the import side, the quantity effect declined significantly from positive to negative rates, which explains a large part of the trade drop; the quantity effect/total effect was –29%/–23% in 2020 (49%/79% in 2019) for HS8689 and –30%/–33% (47%/44%) for HS87 only (Figure 4 and Table 3).

Table 3. Quantity and Price Effects for Exports from/Imports to the World, January-May 2020 (%)

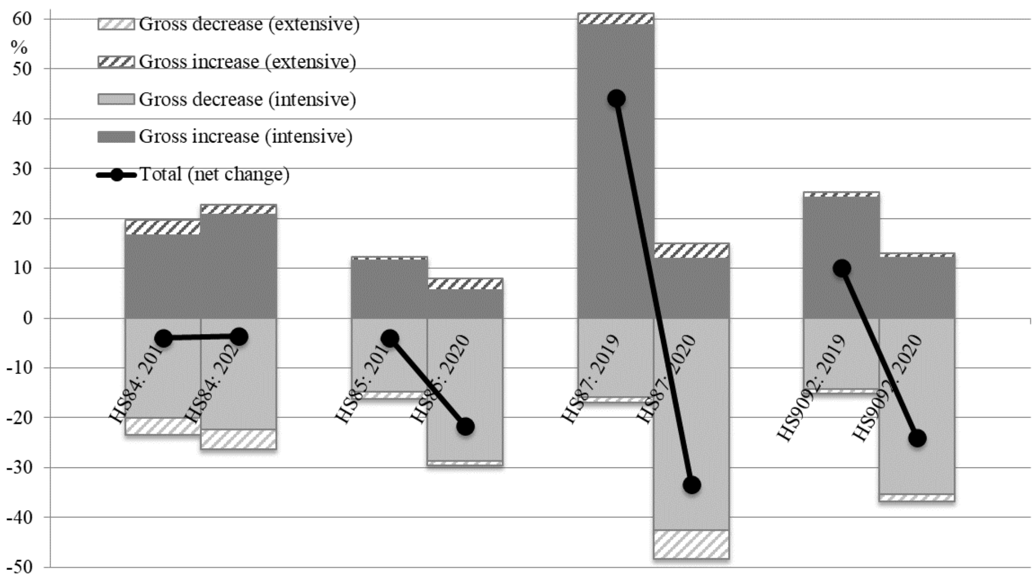
		Parts and components			Final products			Final products (HS87 only)		
		Intensive margins			Intensive margins			Intensive margins		
			Quantity	Price		Quantity	Price		Quantity	Price
Exports										
HS84	2020	-11.0	-14.2	3.2	0.5	2.5	-1.6			
	2019	4.1	6.0	-1.8	13.1	11.9	1.1			
HS85	2020	-5.1	-1.6	-3.3	-20.7	-18.2	-1.5			
	2019	3.1	4.1	-1.0	3.9	3.2	0.7			
HS8689	2020	-52.7	-54.3	1.6	-56.5	-57.7	1.2	-60.2	-58.4	-1.8
	2019	2.4	1.0	1.4	-0.7	-1.8	1.1	0.5	-2.5	3.0
HS9092	2020	-16.4	-9.6	-6.8	-4.7	1.4	-6.1			
	2019	4.7	11.7	-7.0	11.0	13.8	-4.0			
Imports										
HS84	2020	-13.3	-11.4	-2.0	-1.5	-6.4	5.2			
	2019	3.5	2.4	1.0	-3.4	-5.8	2.3			
HS85	2020	-13.8	-12.3	-1.5	-23.1	-14.5	-7.2			
	2019	-1.5	0.0	-1.5	-3.3	-5.8	2.6			
HS8689	2020	-46.9	-46.0	-0.6	-29.5	-28.7	-0.8	-30.6	-29.7	-1.0
	2019	-4.4	-5.5	1.1	57.5	48.5	9.0	43.0	46.8	-3.7
HS9092	2020	-18.6	-22.8	4.5	-23.3	-30.7	7.4			
	2019	9.3	-2.6	11.7	9.8	14.7	-6.7			

Notes: The sum of the quantity effect and the price effect is not equal to the intensive margin in some cases due to missing data on prices etc. HS85 final products exclude HS851712 for imports.
Source: Author's calculations.

For HS87 final products (automobiles), the major destinations of exports are North America and ROW, such as Australia, Russia, and the Middle Eastern countries, whilst major origins of imports are Europe, followed by North America, as discussed in Section 3. North America and ROW explain –30 percentage points (pp) and –20 pp out of –62% (the rate of total change) for exports, and the EU and North America explain –19 pp and –10 pp out of –33%, respectively. In general, negative demand shocks could reduce spending on durable goods more than spending on non-durable goods, because durable products are 'postponable' (Hayakawa and Mukunoki, 2020a). Most of the HS87 final products, particularly built-up cars, must be 'postponable' goods. In addition, e-commerce is not so active, unlike for some of the HS84/HS85 final products. Combined with the fact that the COVID-19 situation in April and May was serious in many countries in North America and the EU, as well as Japan (Figure 1), these must be some of the reasons for the large trade drop in this sector on the demand side.

In contrast with the transport equipment sector, no impact appears to exist for imports in HS84 final products (Figure 5); rather, the total effect increased slightly from –3.9% in 2019 to –3.5% in 2020, with a negative intensive margin that shrunk from –3.4% to –1.5%. Figure 6 presents the net and gross changes in imports in the final products of four machinery sectors. Similar to final products in other machinery sectors, the rate of gross decrease for 'continuing' product-country pairs in absolute terms expanded for HS84 final products from 20% in 2019 to 22% in 2020. This suggests that negative impacts exist for some product-country pairs of HS84 final products. On the other hand, the rate of gross increase for 'continuing' product-country pairs did rise from 17% to 21%, unlike in other machinery sectors. That indicates that positive impacts also exist for other product-country pairs of HS84 final products. The seemingly no impact on HS84 final products suggests not only differences amongst sectors but also variety amongst products in the same sector.

Figure 6. Gross and Net Changes in Imports in Machinery Final Products: January-May 2020



Notes: Intensive denotes the intensive margin and extensive denotes the extensive margin. HS85 final products excludes HS851712.
Source: Author's calculations.

iii) <u>Positive demand shocks: Special demand due to the nature of COVID-19</u>

For imports in HS84 final products, why does the net change rate stay at the same level as the previous year, and why does the gross increase rate rise, unlike in other cases (Figures 5 and 6)? China is the key to understanding this puzzle because China is the dominant origin of Japan’s imports in HS84 final products. Table 4 lists all products with the largest gaps between imports in January and May, which consist of more than 0.5% of the total gap in imports from China for all HS84 final products. Interestingly, except for products with typical seasonality or products with smaller gaps in 2020 relative to 2019, all products in this list are likely to be related with either of the following cases: teleworking, disinfection, and stay-home/do-it-yourself (DIY).[25] Laptop computers including tablets (HS84713000), input or output units of computers (HS84716000), and main memory (HS847170010) are teleworking-related products; imports in laptop computers and input/output units expanded explosively since April, whilst imports of main memory increased in April and May (Figure 7). Spray/power dispersing machines, excluding agricultural/horticultural ones (HS842489000), must be products used for disinfection. Their imports have increased dramatically since April. Freezers (HS841840000), hand-held power tools (HS846729090), dish washing machines (HS842211000), and water filtering or purifying apparatus (HS842121000) might be products with increased demand from stay-home or DIY activities. These imports grew, particularly in May and June.

[25] See Figure A.3 for imports in air conditioning machines, window/wall types (HS841510010), air conditioning machines (mainly for household use) (HS841582019), evaporative air coolers (HS847960000), and portable agricultural/horticultural sprayers. Apparently, imports in these products have typical seasonality with a peak in around May–July.

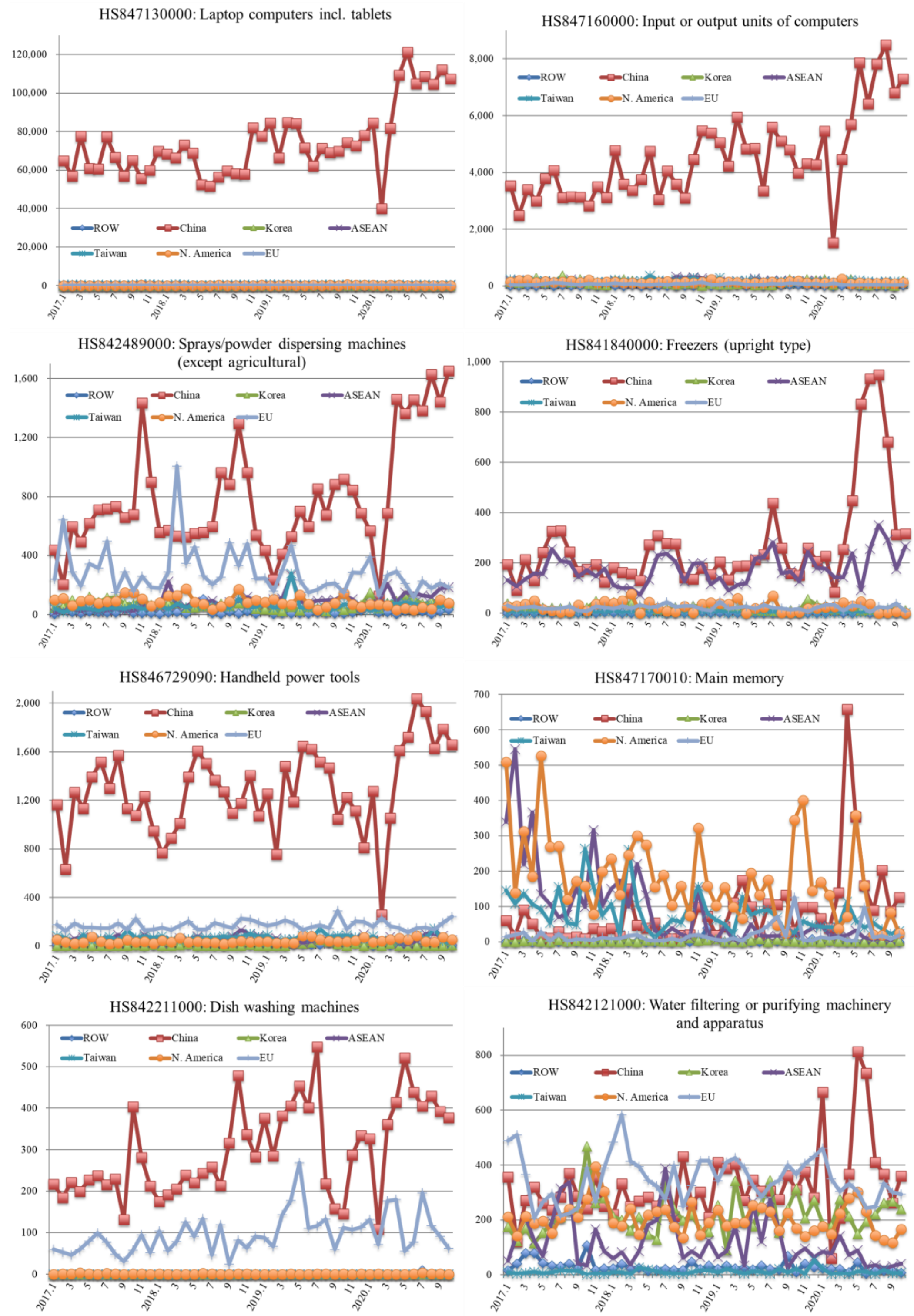
Table 4. Products Contributing to the Growth in Imports from China for HS84 Final Products, January-May 2020

HS 9-digit code	Products	Gap2020 (Jan-May) (¥'000)	Contribution to Gap 2020 (%)	Change in total imports from China for HS84 final products, 2020 (%)	Change in total imports from the world for HS84 final products, 2020 (%)	Typical seasonality	DD (Gap2020-Gap2019)	Positive demand shock products
847130000	**Laptops**	**36,920,952**	**142.1**	**18.54**	**11.54**			**TW**
841510010	Air conditioning machines, window/wall types	9,160,046	35.3	4.60	2.86	Yes	Negative	
847160000	**Input or output units of computers**	**2,411,477**	**9.3**	**1.21**	**0.75**			**TW**
842489000	**Sprays/powder dispersing machines (excl. agricultural)**	**798,470**	**3.1**	**0.40**	**0.25**			**DI**
841840000	**Freezers (upright type)**	**604,750**	**2.3**	**0.30**	**0.19**			**SH**
841582019	Air-conditioning machines, with refrigerating unit	582,325	2.2	0.29	0.18	Yes		
846729090	**Handheld power tools, with electric motor (excl. saws and drills)**	**445,521**	**1.7**	**0.22**	**0.14**			**SH**
847170010	**Main memory**	**285,739**	**1.1**	**0.14**	**0.09**			**TW**
847960000	Evaporative air coolers	248,517	1.0	0.12	0.08	Yes		
846789000	Hand tools, hydraulic or withthout electric motor (excl. chain saws)	196,148	0.8	0.10	0.06		Negative	

842211000	**Dish washing machines**	**194,821**	**0.7**	**0.10**	**0.06**			**SH?**
842951000	Front-end shovel loaders	178,596	0.7	0.09	0.06		Negative	
842441000	Portable agricultural/horticultural sprayers	165,352	0.6	0.08	0.05	Yes		
847190000	Machines for transcribing data onto data media in coded form (others)	159,576	0.6	0.08	0.05		Negative	
842121000	**Water filtering or purifying machinery&apparatus**	**148,546**	**0.6**	**0.07**	**0.05**			**SH?**
842449000	Non-portable agricultural/horticultural sprayers	143,121	0.6	0.07	0.04			
All final products in HS84 (imports from China)		25,981,938	100.0	13.04	8.12			
All final products in HS84 (imports from the world)		-11,346,315			-3.55			

Notes: The products listed here are those with contributiong ratios of more than 0.5%. DD denotes differences between Gap2020 and Gap2019, and TW, DI, and SH denote teleworking, disinfection, and stay-home.
Source: Author's calculations.

Figure 7. Imports of Products with Special Demand due to COVID19 in HS84: Examples (¥ million)



Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Source: Author's calculations.

All of the products mentioned above, and particularly laptop computers, which explain a large part of the positive gross changes, significantly contribute to compensating for negative gross changes in the whole sector. It seems that HS84 final products include many positive demand shock products, and special demand for them must be the answer for the seemingly negligible impact on imports of HS84 final products.

Positive demand shock products exist in other sectors as well. Table 5 summarises the information on the final products with the largest positive gap for HS85(excl) and HS9092, respectively, that is, monitors for computers (HS852852000) and thermometers and pyrometers (excluding the type of liquid-filled) (HS902519010).[26] Monitors for computers are teleworking-related products, and their imports expanded particularly during May–July 2020 (Figure 8). On the other hand, demand for thermometers and pyrometers (excluding the liquid-filled type) suddenly grew due to their ability to check and judge the possibility of infections of COVID-19. Their imports drastically increased from April 2020. We can regard these products as positive demand shock products due to COVID-19, and such a rise in their imports partially compensates for the negative growth of imports in HS85 and HS9092 final products.

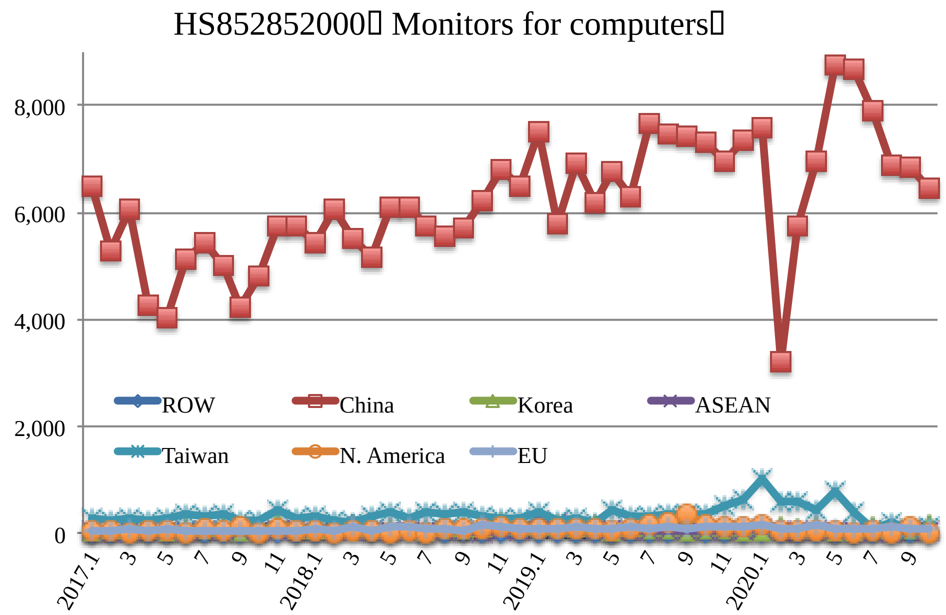
[26] HS85(excl) here refers to HS85 final products excluding HS851712.

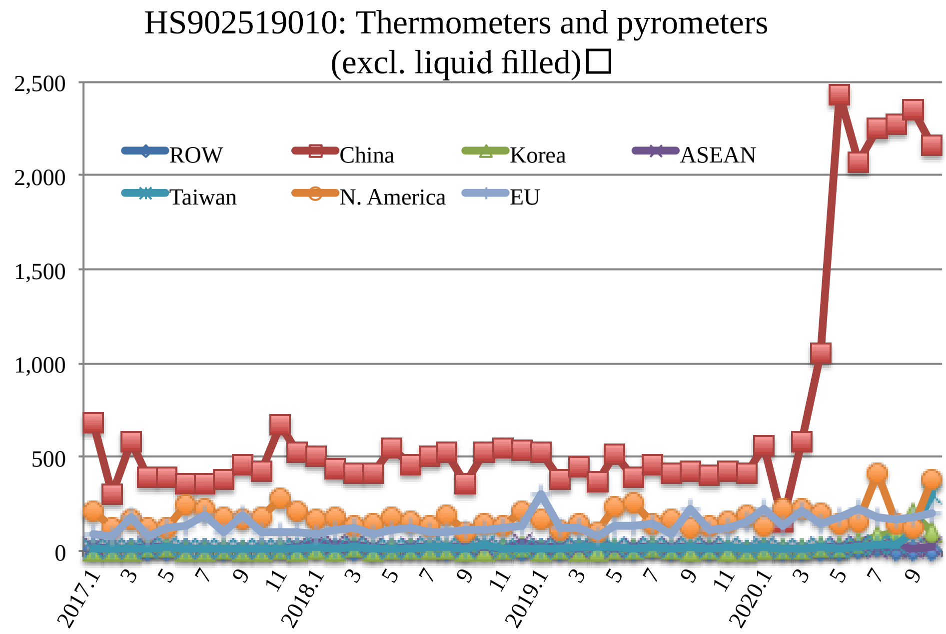
Table 5. Products with the Largest Change from January to May 2020 in Imports for HS85 (excl)/HS90-92 Final Products: Imports from China

HS 9-digit code	Products	Gap2020 (Jan-May) (¥'000)	Change in total imports from China for final products of each sector, 2020 (%)	Change in total imports from the world for final products of each sector, 2020 (%)	DD (Gap2020-Gap2019)	Positive demand shock products
HS85 (excl)						
852852000	**Monitor for computers**	**1,172,221**	**0.7**	**0.4**	Significantly positive	**TW**
	All final products in HS85 (excl) (imports from China)	-21,564,577	-12.1	-6.8		
	All final products in HS85 (excl) (imports from the world)	-68,459,238		-21.6		
HS90-92						
902519010	**Thermometers and pyrometers (excl. liquid filled)**	**1,866,488**	**5.3**	**1.0**	Significantly positive	**DI**
	All final products in HS90-92 (imports from China)	-7,627,078	-21.8	-3.9		
	All final products in HS90-92 (imports from the world)	-46,275,476		-23.9		

Notes: 'Products with the largest change' for each machinery sector are selected as country-product pairs with the largest positive change from January to May 2020 with increased imports from May 2019 to May 2020 (for HS85, cellphones and smartphones [HS851712] are excluded). DD denotes differences between Gap2020 and Gap2019, and TW and DI denote teleworking and disinfection.
Source: Author's calculations.

Figure 8. Imports of Products with Special Demand due to COVID-19 in HS85 (excl.) and HS9092: Products with the Largest Change in Each Sector (¥ million)

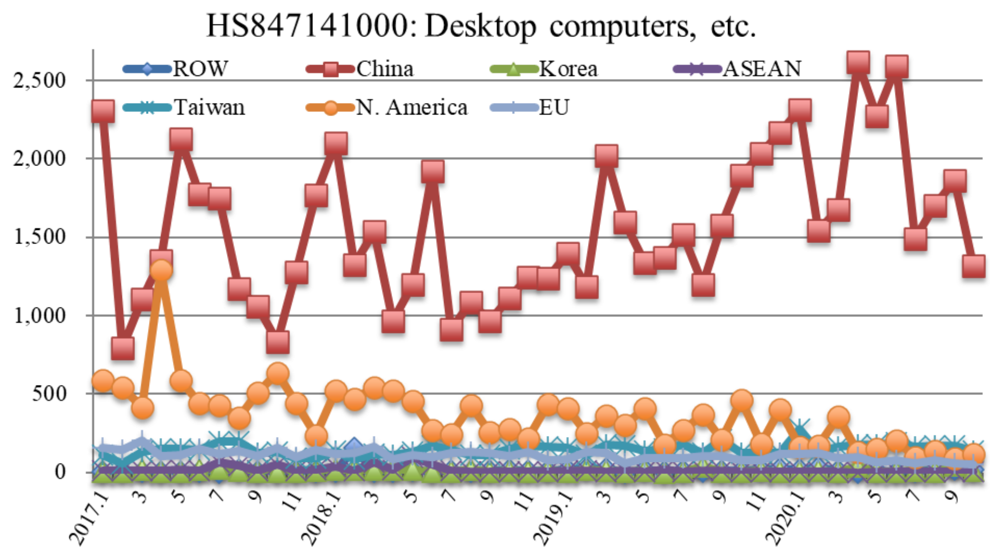


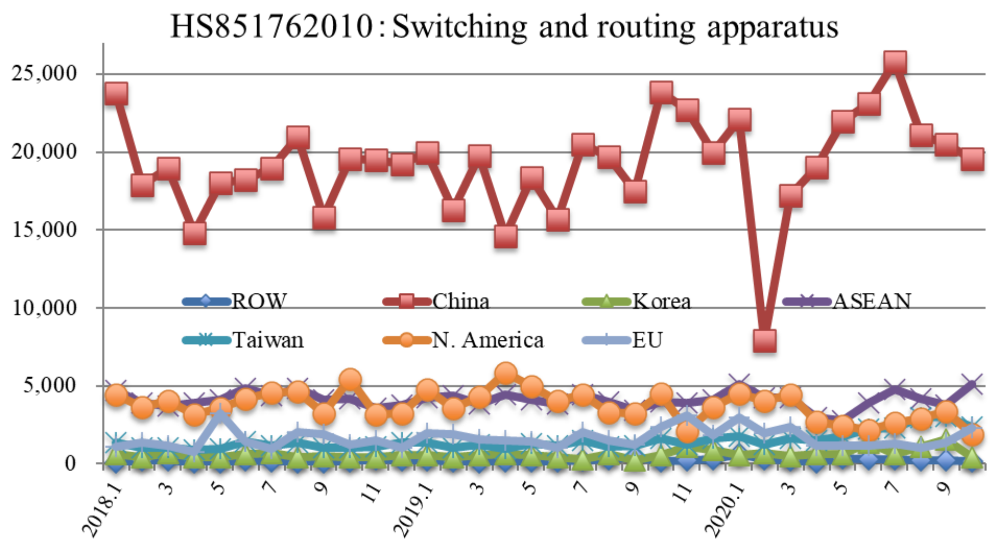


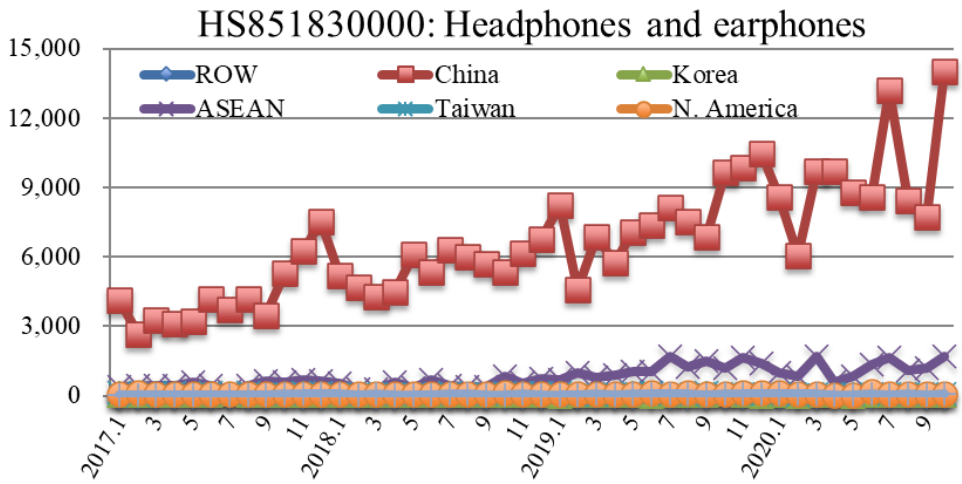
Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Source: Author's calculations.

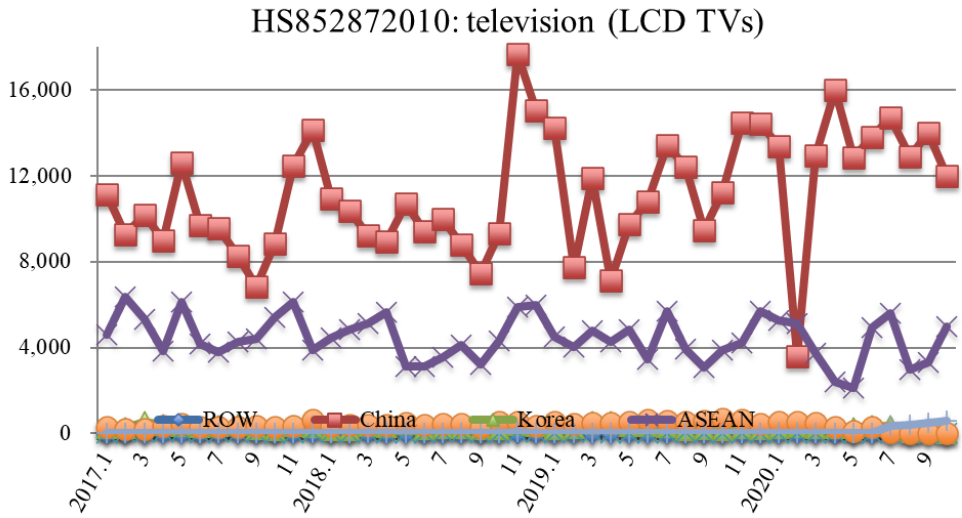
Figure 9 shows imports in more possible examples of positive demand shock products: desktop computers (HS847141000), switching and routing apparatus (HS851762010), headphones and earphones (HS851830000), and televisions (LCD televisions: HS852872010 and non-LCD televisions: HS852872090). The need for desktop computers, routing apparatus, and headphones and earphones may increase according to the expanding activities of teleworking, and demand for televisions may increase with the stay-home environment.

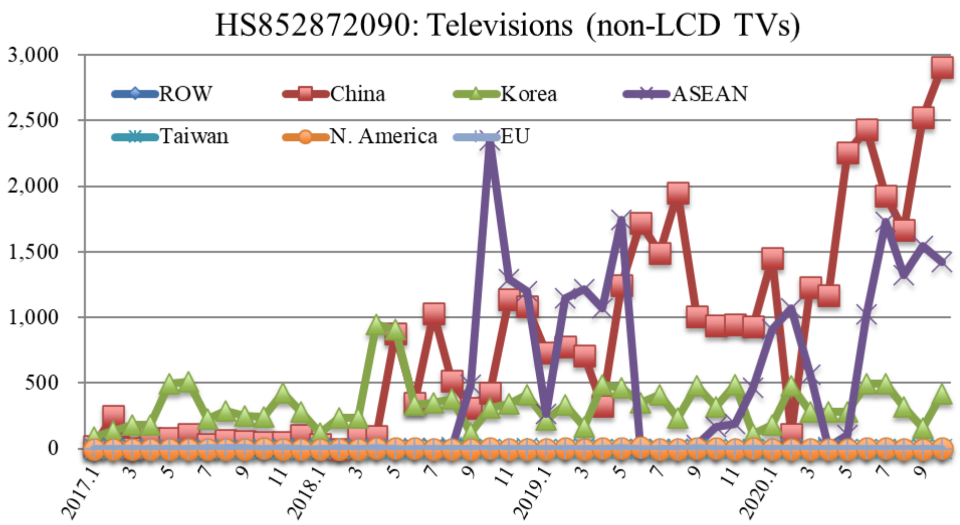
Figure 9. Imports in Products with Special Demand due to COVID-19: Other Examples (¥ million)











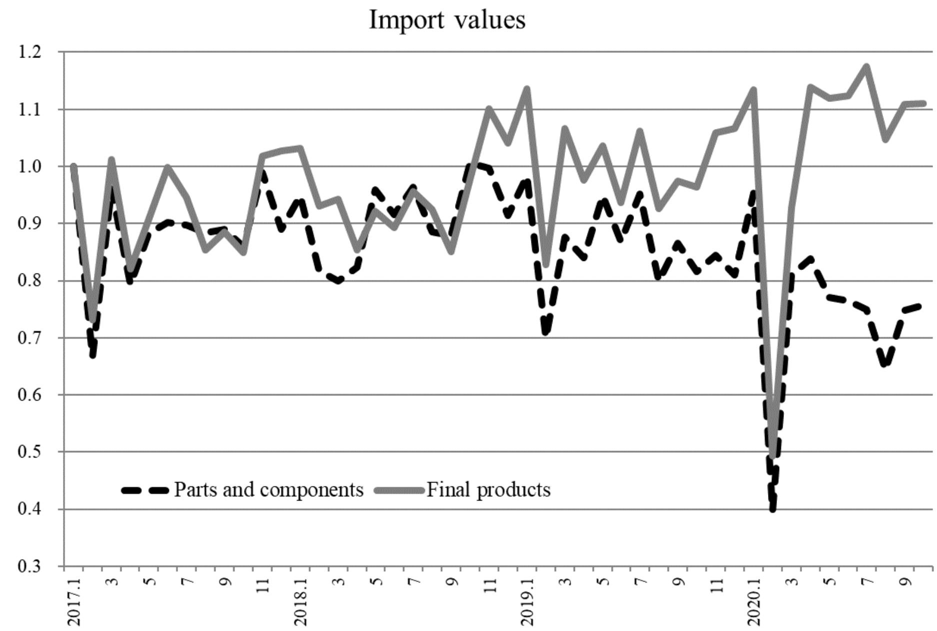
Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Source: Author's calculations.

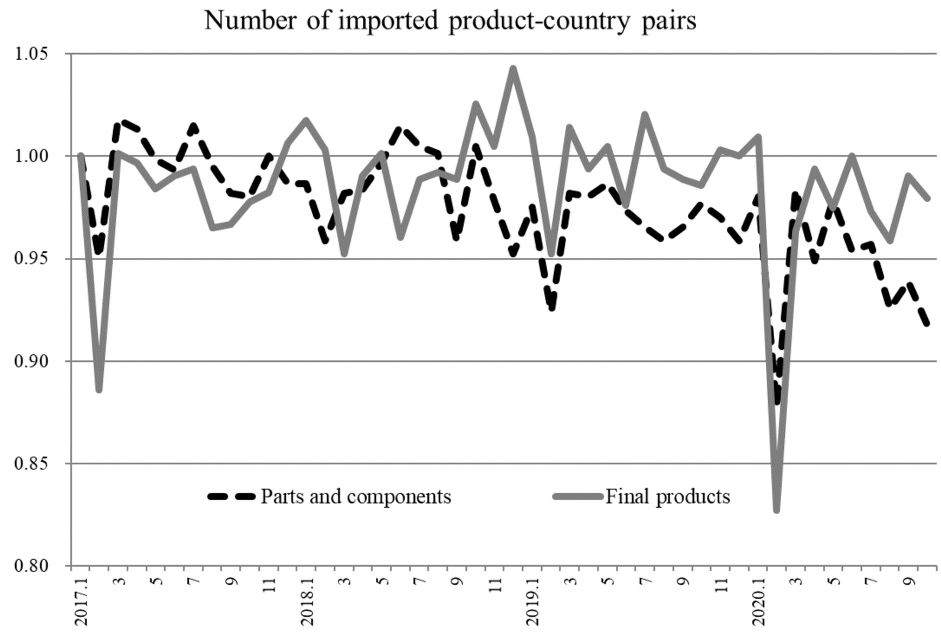
iv) Direct and indirect negative supply shocks in February

A sudden and rapid spread of COVID-19 in China in February 2020 prevented production activities in some provinces, particularly in Hubei province where there are many manufacturing factories. As a result, machinery imports from China sharply declined in February 2020 in terms of both value and the number of imported product-country pairs (Figure 10). Table 6 presents a decomposition of the drop in imports from the world in February and its regional components. It suggests that the import decline in February 2020 is mostly explained by the intensive margin.[27] In addition, except for the case of imports of final products of the transport equipment sector, China is the main source of the import decline in February (Figure 11a). China explains –21 pp out of –29% (the rate of total change) for HS84 parts and components, –33 pp out of –39% for HS84 final products, –19 pp out of –23% for HS85 parts and components, –34 pp out of –36% for HS85 final products, –18 pp out of –32% for HS8689 parts and components, and –16 pp out of –19% for HS9092 parts and components (Table 6).

[27] The exit effect for final products in HS84 and HS8689 (and HS87 only) is not small but almost at the same level as the previous year. Considering the fact that the Chinese New Year started on 5 February in 2019 and 25 January in 2020, however, we need a careful of the interpretation of the difference in trade gaps between January and February of these 2 years. The rate of changes in imports from China in 2020 relative to 2019 may underestimate the effects of COVID-19 for China in February.

Figure 10. Drastic Decline of Machinery Imports from China in February 2020 (January 2017 = 1)





Note: Final products for import values exclude HS851712.
Source: Author's calculations.

Table 6. Decomposition of the Rate of Change in Imports from the World, January-February 2020 (%)

	Parts and components								Final products							
	2020				2019				2020				2019			
	Total	Intens.	Extens.		Total	Intens.	Extens.		Total	Intens.	Extens.		Total	Intens.	Extens.	
			Entry	Exit			Entry	Exit			Entry	Exit			Entry	Exit
HS84																
World	**-29.4**	**-29.0**	**1.3**	**-1.7**	**-11.8**	**-12.5**	**1.6**	**-0.9**	**-39.2**	**-37.0**	**2.1**	**-4.3**	**-16.5**	**-14.8**	**2.4**	**-4.1**
China	**-21.4**	**-21.1**	**0.0**	**-0.3**	**-8.8**	**-8.8**	**0.0**	**0.0**	**-32.8**	**-32.3**	**0.0**	**-0.5**	**-14.9**	**-14.8**	**0.1**	**-0.1**
Korea	-0.3	-0.3	0.0	0.0	-0.5	-0.6	0.0	0.0	-0.4	-0.4	0.1	-0.2	-0.4	-0.2	0.1	-0.3
ASEAN	-1.5	-1.5	0.1	-0.2	0.6	0.7	0.1	-0.1	-0.4	-0.3	0.1	-0.2	1.8	1.7	0.2	-0.1
Taiwan	-1.2	-1.2	0.1	0.0	-0.7	-0.7	0.0	0.0	-0.2	-0.1	0.1	-0.2	-0.6	-0.6	0.1	-0.1
N. America	-2.1	-2.0	0.1	-0.1	-0.6	-0.8	0.3	-0.2	-1.9	-1.8	0.1	-0.3	-0.8	-0.8	0.2	-0.2
EU	-2.4	-2.8	0.9	-0.4	-0.4	-1.0	1.1	-0.4	-2.8	-1.6	1.5	-2.7	-1.3	-0.1	1.5	-2.8
ROW	-0.5	-0.1	0.1	-0.5	-1.3	-1.3	0.1	-0.1	-0.7	-0.5	0.2	-0.4	-0.3	0.0	0.3	-0.6
HS85																
World	**-22.9**	**-22.9**	**0.2**	**-0.2**	**-16.0**	**-16.0**	**0.3**	**-0.2**	**-35.6**	**-35.1**	**0.4**	**-0.8**	**-18.6**	**-17.9**	**0.4**	**-1.1**
China	**-19.1**	**-19.1**	**0.0**	**0.0**	**-9.8**	**-9.7**	**0.0**	**0.0**	**-34.1**	**-33.9**	**0.0**	**-0.2**	**-18.0**	**-17.9**	**0.0**	**-0.1**
Korea	-0.2	-0.2	0.0	0.0	-0.5	-0.5	0.0	0.0	0.5	0.5	0.0	0.0	-0.5	-0.4	0.0	-0.1
ASEAN	-2.9	-2.9	0.0	0.0	-2.8	-2.8	0.0	0.0	-1.2	-1.2	0.1	-0.1	2.8	2.8	0.1	-0.1

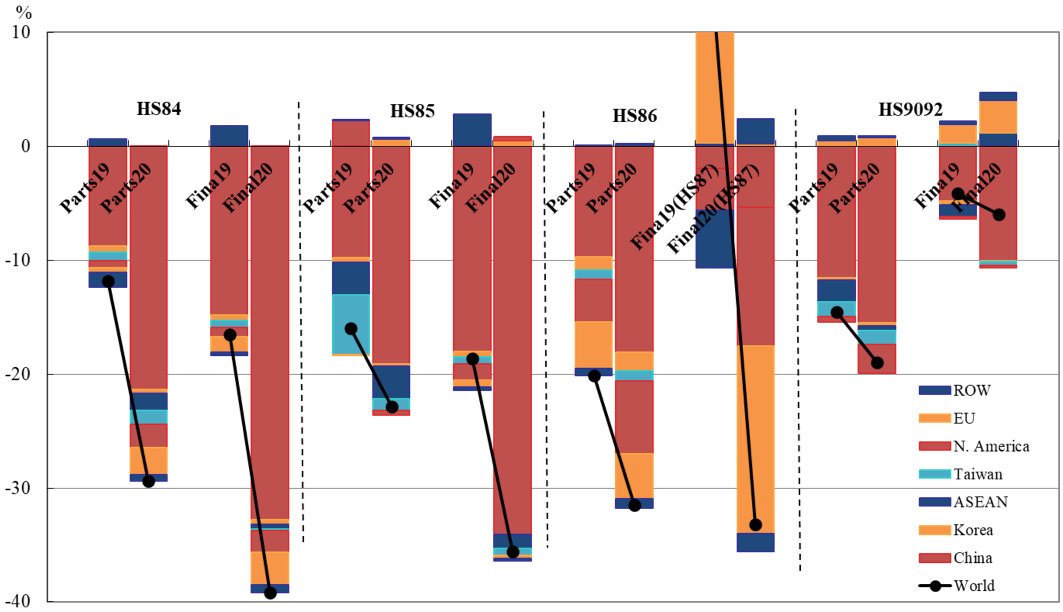
Taiwan	-1.0	-1.0	0.0	0.0	-5.3	-5.2	0.0	0.0	-0.6	-0.6	0.0	0.0	-0.6	-0.6	0.0	0.0
N. America	-0.4	-0.4	0.0	0.0	2.3	2.3	0.0	0.0	0.4	0.4	0.0	-0.1	-1.4	-1.3	0.0	-0.1
EU	0.7	0.6	0.1	-0.1	0.0	0.0	0.2	-0.1	-0.3	-0.1	0.2	-0.3	-0.6	-0.3	0.3	-0.5
ROW	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	-0.2	-0.2	0.0	-0.1	-0.3	-0.2	0.0	-0.1
HS8689																
World	**-31.5**	**-31.4**	**0.3**	**-0.4**	**-20.1**	**-19.7**	**0.2**	**-0.7**	**-10.8**	**-30.4**	**26.2**	**-6.6**	**2.2**	**4.7**	**7.2**	**-9.7**
China	**-18.1**	**-17.9**	**0.0**	**-0.2**	**-9.7**	**-9.7**	**0.0**	**0.0**	**-6.1**	**-5.2**	**0.0**	**-1.0**	**-2.7**	**-1.9**	**0.0**	**-0.8**
Korea	-1.7	-1.7	0.0	0.0	-1.1	-1.1	0.0	0.0	0.3	0.0	0.3	0.0	0.2	0.0	0.2	0.0
ASEAN	0.2	0.3	0.0	0.0	0.1	0.0	0.0	0.0	2.0	2.0	0.0	-0.1	0.1	0.1	0.1	-0.1
Taiwan	-0.9	-0.9	0.0	0.0	-0.8	-0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0
N. America	-6.4	-6.4	0.0	0.0	-3.7	-3.6	0.0	-0.2	13.0	-10.3	24.7	-1.4	-4.5	-5.9	1.6	-0.1
EU	-4.0	-4.1	0.2	-0.1	-4.1	-3.8	0.1	-0.4	-18.0	-15.3	0.9	-3.7	12.6	14.7	4.8	-6.9
ROW	-0.8	-0.7	0.0	-0.1	-0.7	-0.6	0.1	-0.1	-2.0	-1.7	0.2	-0.5	-3.7	-2.2	0.3	-1.7
HS87																
World									**-33.2**	**-31.8**	**1.1**	**-2.5**	**11.3**	**11.3**	**3.2**	**-3.2**
China									**-5.3**	**-5.1**	**0.0**	**-0.3**	**-1.9**	**-1.6**	**0.0**	**-0.3**
Korea									0.2	0.0	0.2	0.0	0.1	0.0	0.1	0.0
ASEAN									2.2	2.2	0.0	-0.1	0.2	0.2	0.1	0.0
Taiwan									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. America									-12.1	-11.4	0.0	-0.8	-3.7	-4.3	0.8	-0.2

EU									-16.5	-16.0	0.8	-1.3	21.7	20.2	2.0	-0.5
ROW									-1.6	-1.5	0.1	-0.1	-5.0	-3.0	0.2	-2.2
HS9092																
World	**-19.0**	**-18.7**	**0.5**	**-0.8**	**-14.5**	**-14.4**	**0.4**	**-0.5**	**-6.0**	**-6.0**	**1.1**	**-1.0**	**-4.1**	**-4.0**	**1.1**	**-1.2**
China	**-15.5**	**-15.5**	**0.0**	**-0.1**	**-11.6**	**-11.5**	**0.0**	**-0.1**	**-10.1**	**-9.9**	**0.0**	**-0.2**	**-4.8**	**-4.8**	**0.0**	**-0.1**
Korea	-0.2	-0.2	0.0	0.0	-0.2	-0.2	0.0	0.0	-0.1	0.0	0.0	0.0	-0.3	-0.3	0.0	0.0
ASEAN	-0.4	-0.3	0.1	-0.2	-1.9	-1.9	0.0	0.0	1.2	1.3	0.0	-0.1	-1.0	-1.0	0.1	-0.1
Taiwan	-1.3	-1.2	0.0	0.0	-1.3	-1.3	0.0	0.0	-0.3	-0.3	0.0	0.0	0.3	0.3	0.0	0.0
N. America	-2.5	-2.3	0.1	-0.2	-0.4	-0.4	0.0	0.0	-0.2	-0.2	0.1	-0.1	-0.2	-0.2	0.0	-0.1
EU	0.8	0.7	0.3	-0.2	0.5	0.4	0.2	-0.2	2.8	2.6	0.6	-0.3	1.7	1.8	0.5	-0.7
ROW	0.2	0.2	0.1	-0.1	0.4	0.5	0.1	-0.2	0.7	0.5	0.3	-0.2	0.3	0.2	0.4	-0.3

Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Notes: HS85 final products exclude HS851712. The cases with rates that are lower in 2020 than in 2019 are highlighted; yellow is used for the world and China, and green is used for other countries/regions.
Source: Author's calculations.

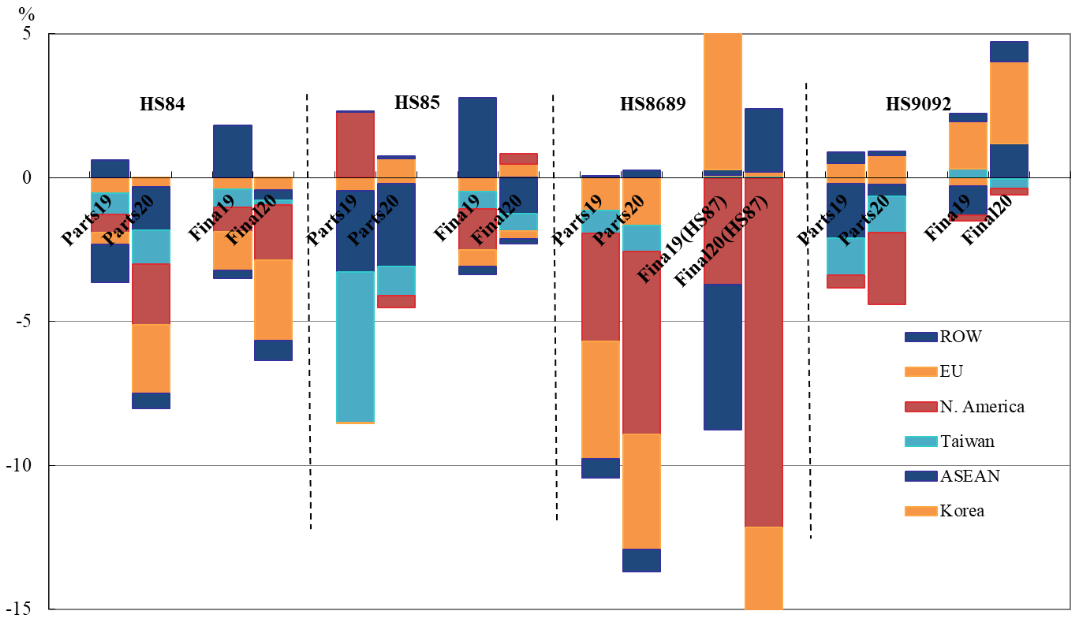
Figure 11. Decline in Imports from the World in February 2020

(a) By all origins of imports



Data: see Table 2.
Note: Q&P effect is the sum of quantity effect, price effect, and unidentified effect.

(b) By origins of imports excluding China (excerpted only from -15% to 5%)



Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Notes: Parts20 (Parts19) denotes machinery parts in the period from January to February 2020 (2019). Parts and Final denote machinery parts and components and machinery final products. HS85 final products exclude HS851712. The case of HS8689 final products is omitted here.
Source: See Table 6.

Table 7 in turn shows the decomposed results for changes in imports from China in February, with a breakdown of the intensive margin into the quantity effect and the price effect. In all cases except HS8689, the price effect in 2020 is positive and significantly greater than the effect in 2019; 10% in 2020 (0% in 2019) for HS84 parts and components, 12% (0.6%) for HS84 final products, 12% (10%) for HS85 parts and components, 9% (–2%) for HS85 final products, 19% (3%) for HS9092 parts and components, and 10% (0.7%) for HS9092 final products.[28] In addition, the quantity effect in 2020 is around –60% to –70%, which is much greater in absolute terms than the effect in 2019 in all cases.[29] The positive and increased price effects in addition to the large negative quantity effects imply direct negative supply shocks from China.

[28] The price effect is marginal in both 2019 and 2020 in the transport equipment sector.

[29] Specifically, the quantity effect is –71% in 2020 (–26% in 2019) for HS84 parts and components, –64% (–23%) for HS84 final products, –67% (–39%) for HS85 parts and components, –69% (–30%) for HS85 final products, –58% (–21%) for HS8689 parts and components, and –51% (–15%) for HS8689 final products, –73% (–42%) for HS9092 parts and components, and –66% (–27%) for HS9092 final products.

Table 7. Decomposition of the Rate of Change in Imports from China, January-February 2020 (%)

		Parts and components						Final products					
		Total	Intensive			Extensive		Total	Intensive			Extensive	
				Quantity	Price	Entry	Exit			Quantity	Price	Entry	Exit
HS84	2020	-63.0	-62.1	-71.4	9.5	0.0	-0.9	-52.7	-51.9	-64.2	12.3	0.0	-0.8
	2019	-25.8	-25.9	-25.8	0.0	0.1	0.0	-23.0	-22.9	-23.4	0.6	0.1	-0.2
HS85	2020	-55.3	-55.2	-66.6	11.5	0.0	-0.1	-60.7	-60.4	-69.1	8.7	0.0	-0.3
	2019	-29.2	-29.1	-39.4	10.3	0.0	-0.1	-32.2	-31.9	-30.0	-2.0	0.0	-0.3
HS8689	2020	-60.0	-59.3	-58.1	-0.9	0.0	-0.6	-62.0	-52.3	-51.4	-0.8	0.0	-9.7
	2019	-11.3	-7.8	-20.5	1.3	0.1	-3.5	-14.9	-12.8	-15.2	-0.7	0.2	-2.3
HS9092	2020	-54.0	-53.8	-72.5	18.8	0.1	-0.2	-55.7	-54.5	-66.3	9.7	0.1	-1.4
	2019	-38.9	-38.8	-41.5	2.8	0.0	-0.2	-26.8	-26.7	-27.3	0.7	0.1	-0.3

Note: HS85 final products exclude HS851712.
Source: Author's calculations.

There also seem to be indirect negative impacts through supply chains. Whilst the COVID-19 situation was serious in China in February 2020, the situation in other countries was not. Nevertheless, a drop in imports is observed for other East Asian countries and other regions as well (Table 6 and Figure 11b). For instance, HS84 imports from ASEAN, North America, and Europe declined: their total rates in 2020 are –1.5% (0.6% in 2019) for parts and components and –0.4% (1.8%) for final products for ASEAN, –2.1% (–0.6%) and –1.9% (-0.8%) for North America, and –2.4% (–0.4%) and –2.8% (–1.3%) for Europe.[30] In the case of HS87 final products, North America with a rate of –12% in 2020 (–4% in 2019) and Europe with –17% (22%) explain over 80% of the total decline of –33%. Table A.1 in the Appendix reports the value-added shares of direct and indirect inputs from the column country in the row country's total manufacturing output, using the Organisation for Economic Co-operation and Development's Inter-Country Input–Output Tables. This clearly reveals China's dominance in imported manufacturing intermediates. In other words, the sudden and sharp reduction of imports in parts and components from China in February caused indirect and serious negative impacts on manufacturing production in other countries. All of these facts suggest the possibility of indirect negative supply shocks from other countries/regions, besides direct negative supply shocks from China.

Furthermore, there might be the possibility of substituting source countries as well.[31] For instance, imports in HS85 final products from Korea and Taiwan

[30] Other examples include HS85 final products for ASEAN with a rate of –1% in 2020 (3% in 2019) and North America with –0.4% (2%), HS8689 part and components for North America with -6% (–4%), and HS9092 parts and components for North America with –3% (–0.4%).

[31] Hayakawa and Mukunoki (2020b) investigated the impacts of COVID-19 on trade in the first

increased by 0.5% and 0.4% in 2020 (–0.5% and –1.4% in 2019), imports in HS87 final products from ASEAN by 2.2% (0.2%), and imports in HS9092 final products from ASEAN by 1.2% (1.2%) (Table 7 and Figure 11b). Although we need further investigation of possible changes in source countries from affected countries to less-affected countries, an increase in imports from these countries may be due to a substitute for imports from China.

Finally, there do not seem to be serious negative impacts on the export side in February (Figures 2, 3, and A.2). There may have been some difficulties in the procurement of parts and components mainly due to direct negative supply shocks from China, and severe adjustments in procurement may have been required at the time. However, at least, serious negative effects are not observed on the export side in February. This may be because firms adjust exports using their stock, or they may replace suppliers to maintain production.

v) Negative demand shocks

The COVID-19 situation was severe in many countries in the world in May. Thus, it is difficult to clearly identify whether there were negative demand shocks or supply shocks. In the automobile sector, for instance, because of workplace closures, lockdown policies, and social distancing due to COVID-19 (and shrinking demand), the production lines of many plants stopped temporarily, at least in Europe,[32] the US,[33] Japan,[34] and Thailand.[35] Lockdown policies also

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quarter of 2020 and demonstrated the substituting effects from affected countries to less-affected countries.

[32] The ACEA (2020) mentions that most vehicle manufacturers in Europe have had to shut down their development centres and production sites for several weeks or even months; the jobs of more than 1.1 million Europeans working in automobile manufacturing were directly affected by factory shutdowns during the lockdown period, and EU-wide production losses amounted to more than 2.4 million motor vehicles (13% of total production in 2019) during the peak crisis months of March,

forced restricted sales activities and deprived consumers of the chance to purchase new automobiles in the US, probably because e-commerce is not active in this sector. In addition, there were cases where the procurement of parts and components was delayed, particularly when the state of emergency was issued in Japan. These are just examples but suggest the aspect of supply shocks.

Our findings, however, provide some evidence on the aspect of negative demand shocks. First, the demand side rather than the supply side in Japan is

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April, and May 2020.

[33] According to an Nikkei article (https://www.nikkei.com/article/DGXMZO59273230Z10C20A5000000), three major US automakers shut down approximately 100 of their factories for built-up cars and parts in close to 2 months, and restarted around 80 factories in the US and Canada in mid-May, followed by the delayed reopening of factories in Mexico. Moreover, JETRO Business News (https://www.jetro.go.jp/biznews/2020/07/e75b72cd55bd66eb.html and https://www.jetro.go.jp/biznews/2020/07/1907629e2c866662.html) reported that the sales amount of new automobiles in the US dropped by 34% in the period from April to June 2020 (relative to 2019), according to Motor Intelligence. It also pointed out that (i) sales activities by automobile distributors were restricted in many states since mid-March to avoid the spread of COVID-19, (ii) the stay-home environment deprived individuals of the opportunity to purchase new automobiles, and (iii) a reduction in the number of users of car rental services due to a sharp shrinkage in demand for sightseeing resulted in a drop in fleet sales (which comprise 15%–20% of total sales).

[34] A Daily Automotive News online article (https://www.netdenjd.com/articles/-/234519) shows that the amount of automobile production in April declined by 46% (relative to 2019). It also reports that according to the Japan Automobile Manufacturers Association, Inc. (JAMA), exports in May fell by 66% (relative to 2019) because of a drop in overseas demand and a disturbance in the supply of parts and components. Although it seems that a fall in demand is the most serious reason behind the shutdown of some factories or the production adjustment for many automakers, a disturbance in the procurement of parts and components is also serious for some: for instance, unstable imports from affected countries such as India or the Philippines due to lockdown policies, delayed imports from Southeast Asian countries due to COVID-19, and unstable procurement from domestic suppliers due to workers infected to COVID-19 (see the Nikkei article: https://www.nikkei.com/article/DGXMZO58087210V10C20A4I00000 and the Daily Automotive News online article: https://www.netdenjd.com/articles/-/233746). In addition, the state of emergency also forced automakers in Japan to close some factories and some production lines to protect workers' health for a short period.

[35] The JETRO Business News (https://www.jetro.go.jp/biznews/2020/05/83aeec823aba9da6.html and https://www.jetro.go.jp/biznews/2020/06/41714adbc301601b.html) reports that according to the Automotive Division of the Federation of Thai Industries (FTI), automobile production significantly dropped in April and May by 84% and 69% (relative to 2019), reflecting domestic and overseas economic recessions due to COVID-19, and the aggregated amount of production from January to May declined by 40% in total (relative to 2019), 36% for exports, and 45% for domestic sales. It also reports that Japanese automakers in Thailand, such as Toyota, Isuzu, Honda, Mitsubishi, Nissan, Mazda, and Suzuki, who produce close to 90% of domestic sales in Thailand, had to shut down their factories from the end of March to April/May. Of course, their shutdown reflects not only the adjustment to a decline in demand but also the spread of COVID-19 *per se* (https://www.nikkei.com/article/DGXMZO58568530Y0A420C2000000).

likely to influence the negative effects. Let us focus on trade with Taiwan, China, and Korea because these countries were not suffering as much from COVID-19 in April and May when the COVID-19 situation was serious in Japan with the state of emergency. Exports to these countries rose in 2020, compared with 2019, in many cases (Table 1).[36] On the other hand, imports from these countries declined in most cases (Table 2); the exceptions are HS84 final products for China, which includes many positive demand shock products (8% in 2020, –6% in 2019), and HS85 parts and components for Taiwan (1%, –3%). It suggests that the demand side in Japan is more likely to negatively influence trade than the supply side in Japan is.

Second, both the quantity effect and the price effect are negative in many cases. As Table 3 clearly shows, the quantity effect became negative in all cases except for exports in HS84 final products with a weaker positive quantity effect.[37] In addition, the price effect is basically negative particularly for final products; the price effect for final products dropped for exports in HS84, HS85, HS87, and HS9092, and imports in HS85 and HS8689.[38] These figures suggest an aspect of negative demand shocks. Note that an increase in the price effect for imports in final products of HS84 and HS9092 is probably due to positive demand shock

[36] They are HS84 parts and components for Korea (3% in 2020, –2% in 2019) and Taiwan (–0.5%, –2%), HS84 final products for China (12%, 9%), Taiwan (0.8%, 0.6%), and Korea (–0.3%, –0.4%), HS85 parts and components for China (5%, 4%), HS85 final products for China (5%, 3%) and Taiwan (1%, 0.1%), HS8689 parts and components for China (2%, 1%) and Taiwan (0.4%, 0.1%), and HS9092 final products for Korea (3%, 2%) and Taiwan (2 %, 1%).

[37] The quantity effect is positive in 2020 but does decline from 12% to 3% for exports in HS84 final products.

[38] For parts and components, the price effect became negative (or declined) for exports in HS85 and imports in HS84, HS8689, and HS9092.

products, particularly laptop computers for HS84 and expensive medical devices for HS9092. Regarding the transport equipment sector, the large negative intensive margin is mostly due to the negative quantity effect, and the price effect is marginal.

5. Conclusion

This paper investigated the impacts of COVID-19 on international production networks in machinery sectors by shedding light on negative supply shocks, negative demand shocks, and positive demand shocks. Specifically, we examined trade changes in the periods of falling trade of the first wave of COVID-19 using Japan's machinery trade at the most disaggregated level, and decomposed them into the quantity effect, the price effect, the entry effect, and the exit effect. Our empirical results demonstrated that (i) trade relationships for parts and components are robust, and international production networks are resilient so far; (ii) the intensive margin, mostly the negative quantity effect, induces the largest negative effects in the transport equipment sector amongst four machinery sectors; (iii) positive demand shocks for specific products that are related to teleworking, disinfection, and stay-home activities partially explain sectoral differences; (iv) direct negative supply shocks from China, suggested by a negative quantity effect and a positive price effect, exist in February, with possible indirect negative supply shocks and the substitution of source countries; and v) negative demand shocks are confirmed from negative quantity and price effects in many cases.

By October 2020, Japan's machinery trade had largely recovered, and production systems in East Asia seem to be almost intact so far, though the negative impacts on trade did exist temporarily. As is the case of previous shocks, such as the 2008–2009 GFC (demand shock) and the 2011 EJE (supply shock), the negative impacts were transmitted through production networks, but strong forces worked to maintain production networks, and quick adjustments for recovery were implemented amid the COVID-19 pandemic. Why do transactions of machinery parts and components within production networks tend to be sustained? Ando and Kimura (2012) claim based on their analysis on those two crises as follows: *the extended fragmentation theory states that the fragmentation of production takes advantage of the reduction in production cost within production blocks, while it should pay for the network set-up/adjustment cost and the service link cost. The latter two costs are particularly high for transactions of parts and components compared with transactions of final products. In order to respond to massive shocks, firms try to save these costs by keeping transaction channels for parts and components.* Similarly, during the COVID-19 pandemic period, there must be strong incentives for firms to maintain their transaction channels considering such costs, by sometimes using their stocks or adjusting transactions amongst their suppliers to maintain production activities.

Whilst Hayakawa and Mukunoki (2020a) demonstrated that the largest negative impacts were from supply chain effects and that no significant impact was found from demand effects, our empirical study rather emphasises the impacts from negative demand shocks, in addition to positive demand shocks for some specific products related to teleworking, disinfection, and stay-home activities and negative supply shocks. One of the ways to reduce the upstream supply disruption would be to avoid too much dependence on one country or fewer suppliers of inputs. Actually, Ando and Hayakawa (2021) demonstrated that the import diversity of inputs played a significant role in partially mitigating the negative supply-side effects of COVID-19 on worldwide exports in machinery final products, particularly in February and March. During this initial period of COVID-19, not only direct and indirect negative supply shocks from China occurred but also uncertainty due to COVID-19 rose in major countries engaged in production networks, including in other Asian countries, because the rapidly changing situation of COVID-19 made the procurement of parts and components more unstable.

As mentioned above, as of October 2020, Japan’s machinery trade had largely recovered, and production systems in East Asia seem to be almost intact. If the COVID-19 pandemic lasts long, however, prolonged negative demand shocks could be more serious and hurt production networks in East Asia.

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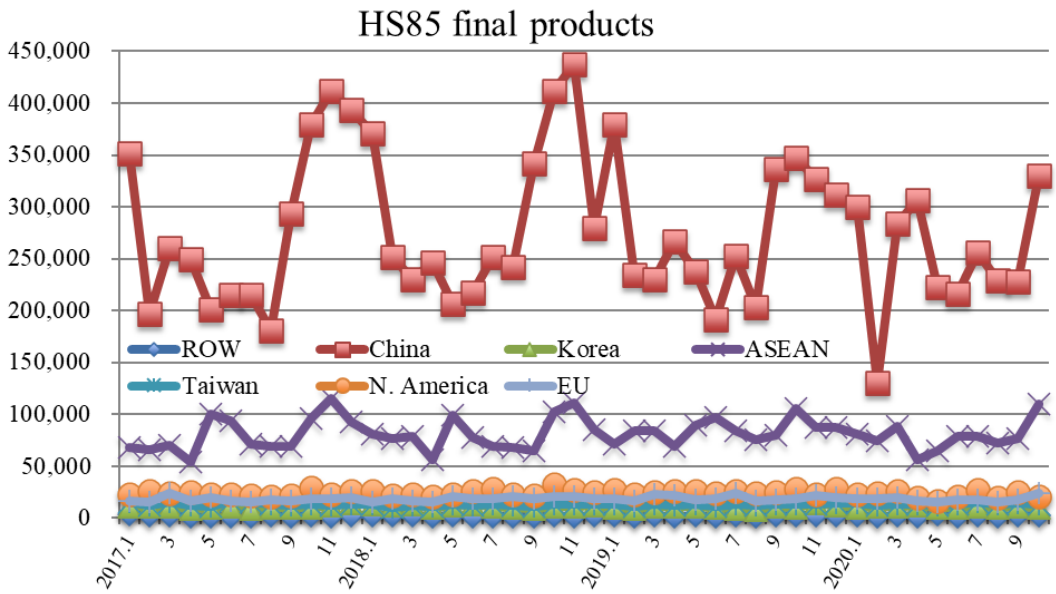
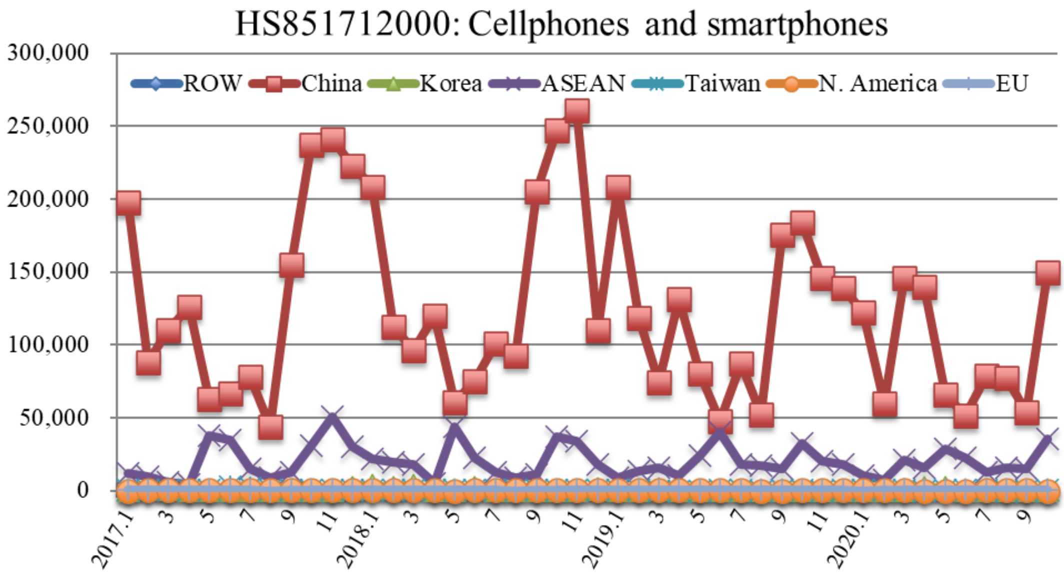
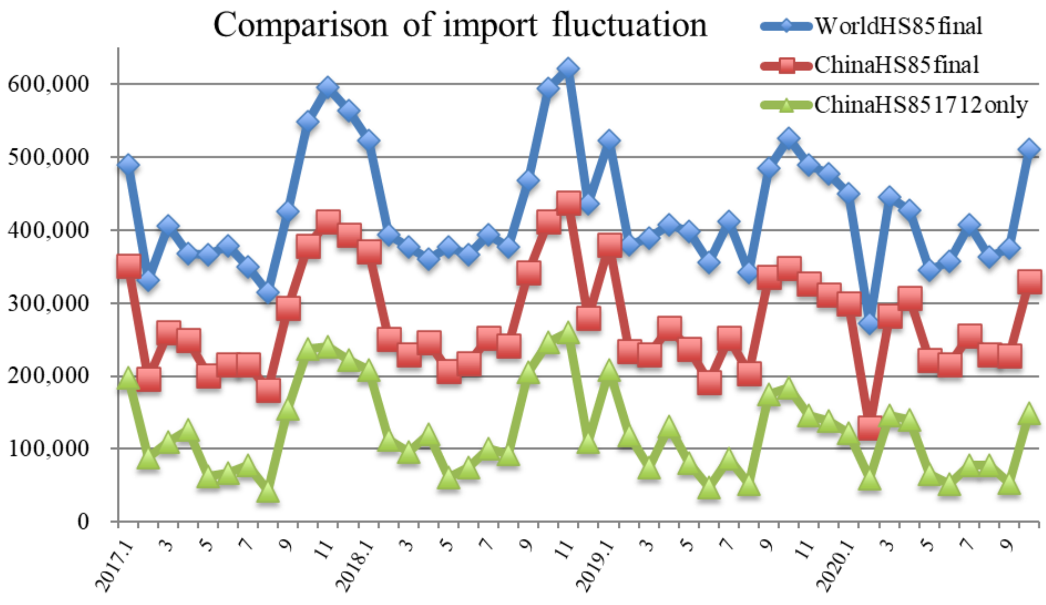
Appendix

Figure A.1. Imports in HS85 Final Products and Cell Phones and Smartphones (¥ million)



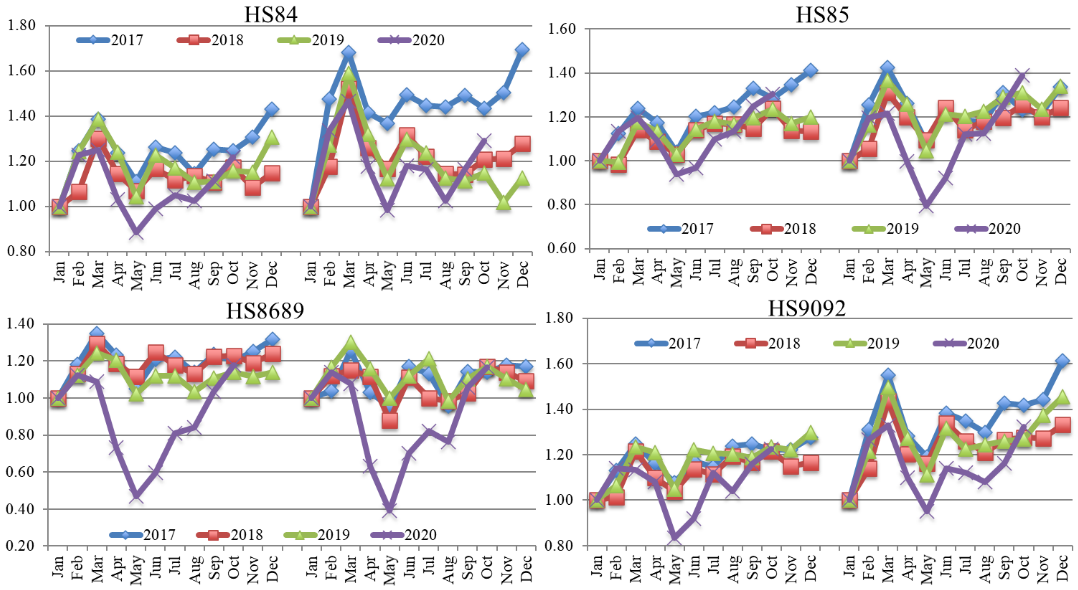




Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Source: Author's calculations.

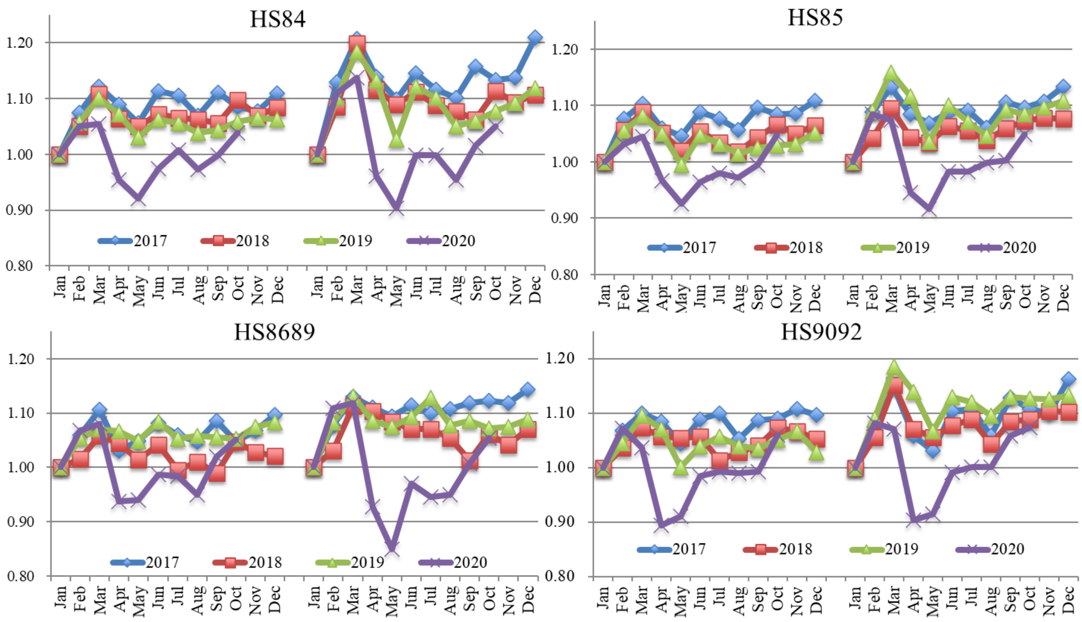
Figure A.2. Indices of Machinery Exports (Jan of Each Year = 1): Parts and Components (left) and Final Products (right)

a) Index based on export values



Source: Author's calculations.

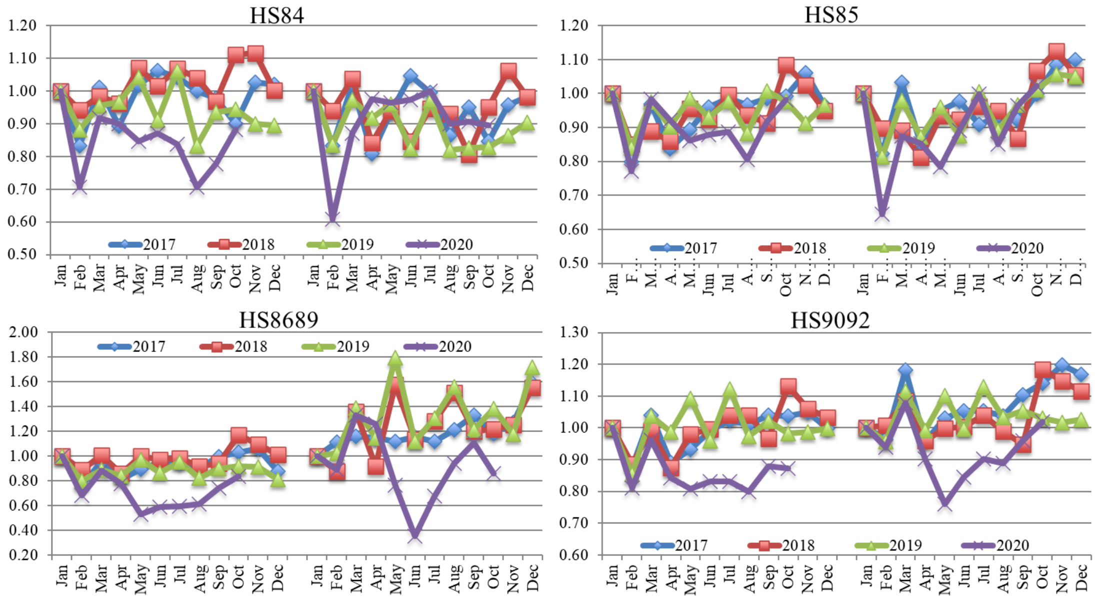
b) Index based on the number of exported product-country pairs



Source: Author's calculations.

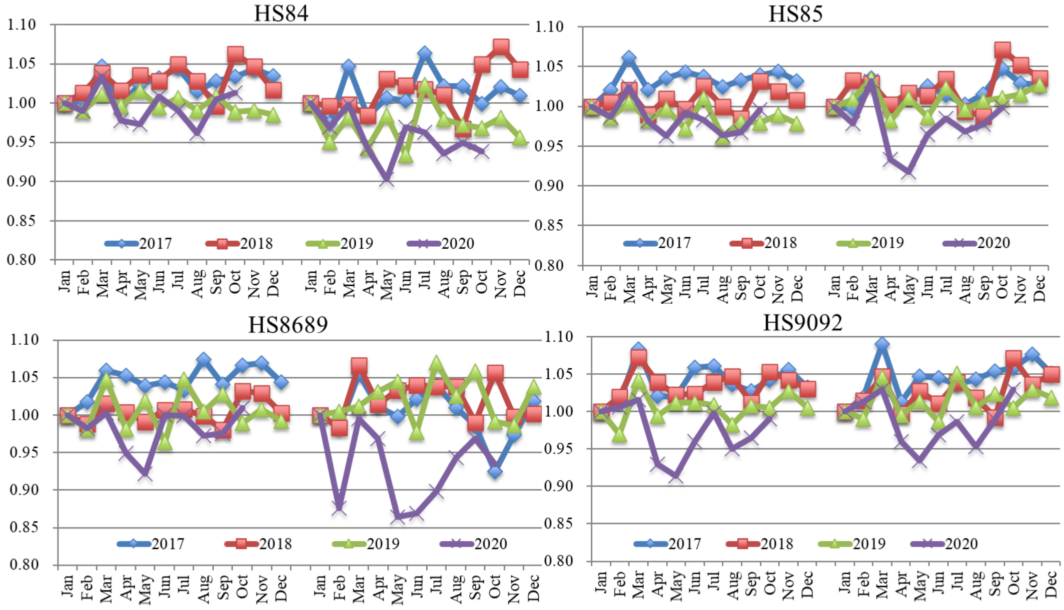
Figure A.3. Indices of Machinery Imports (Jan of Each Year = 1): Parts and Components (left) and Final Products (right)

a) Index based on import values



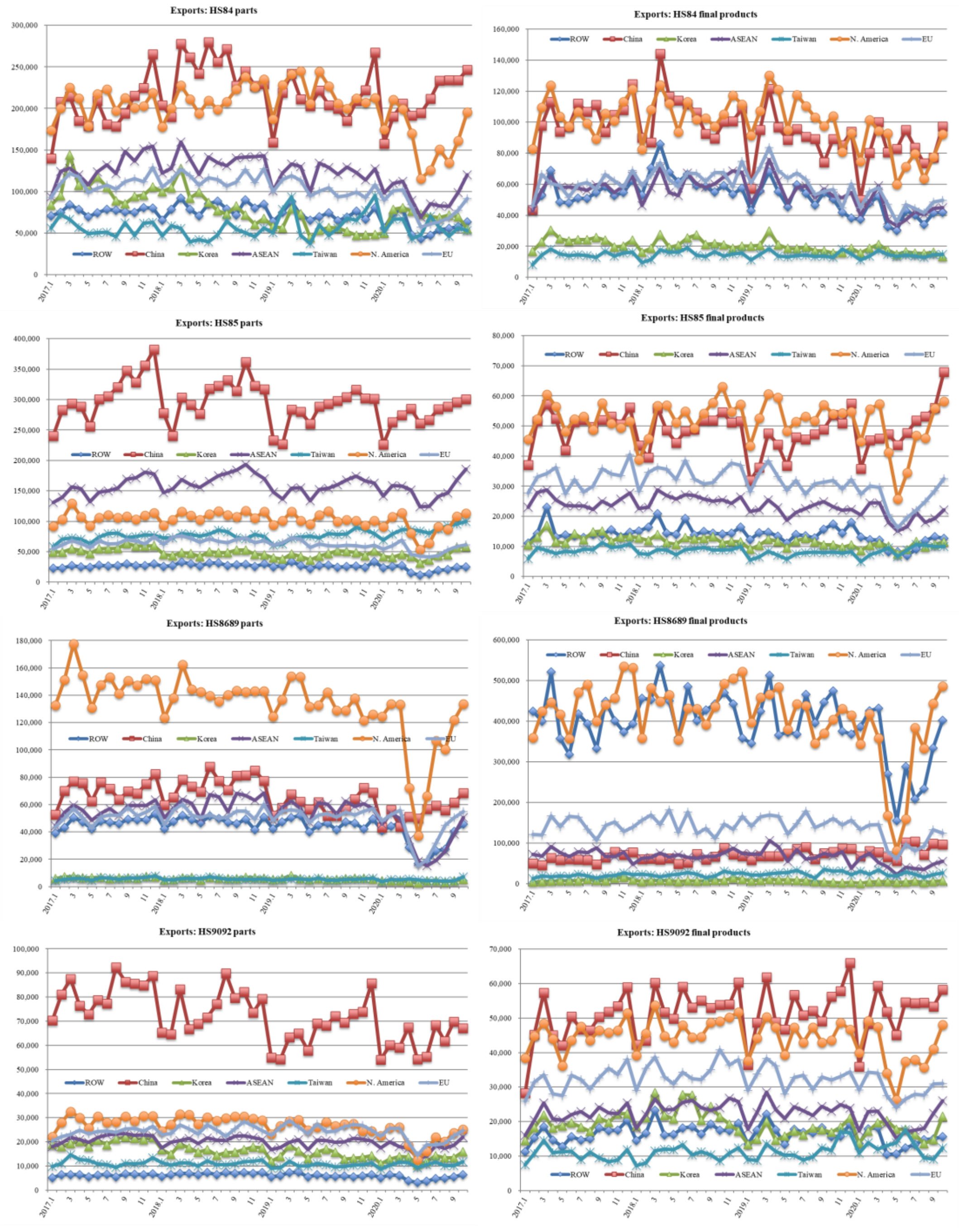
Note: HS85 is the case excluding HS851712 for import values.
Source: Author's calculations.

b) Index based on the number of imported product-country pairs



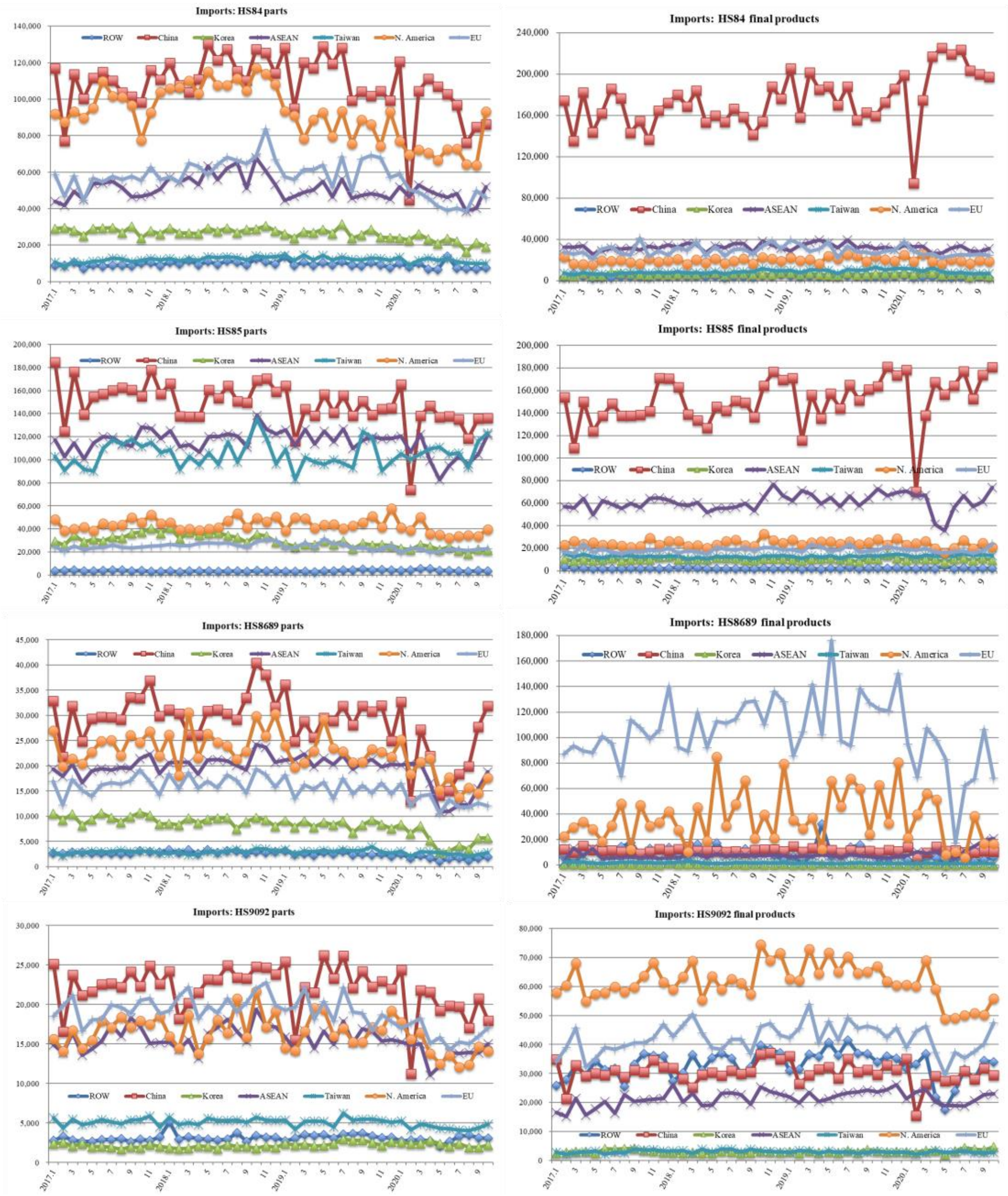
Source: Author's calculations.

Figure A.4. By-region Machinery Exports (¥ million)



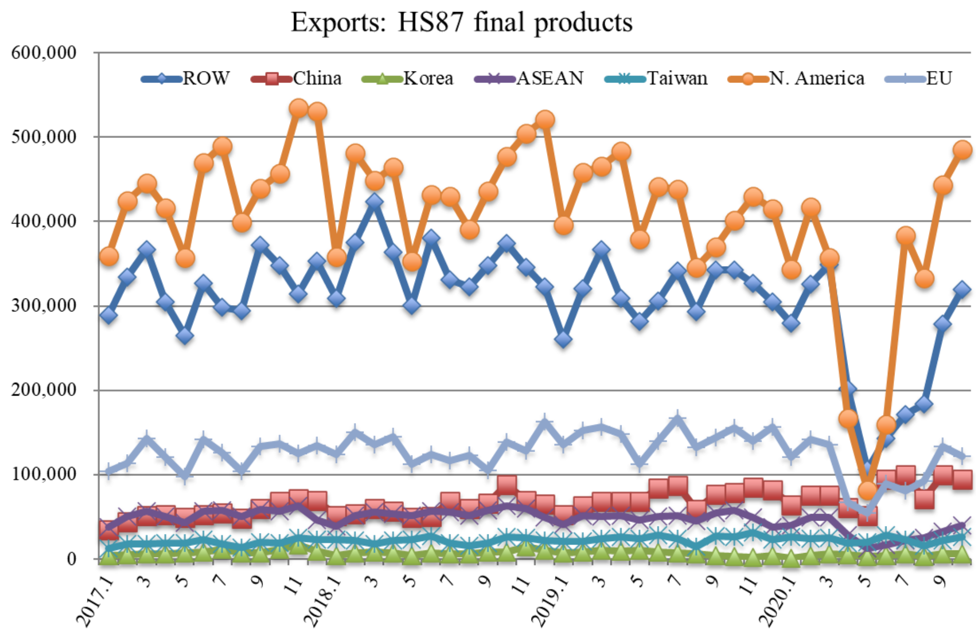
Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Source: Author's calculations.

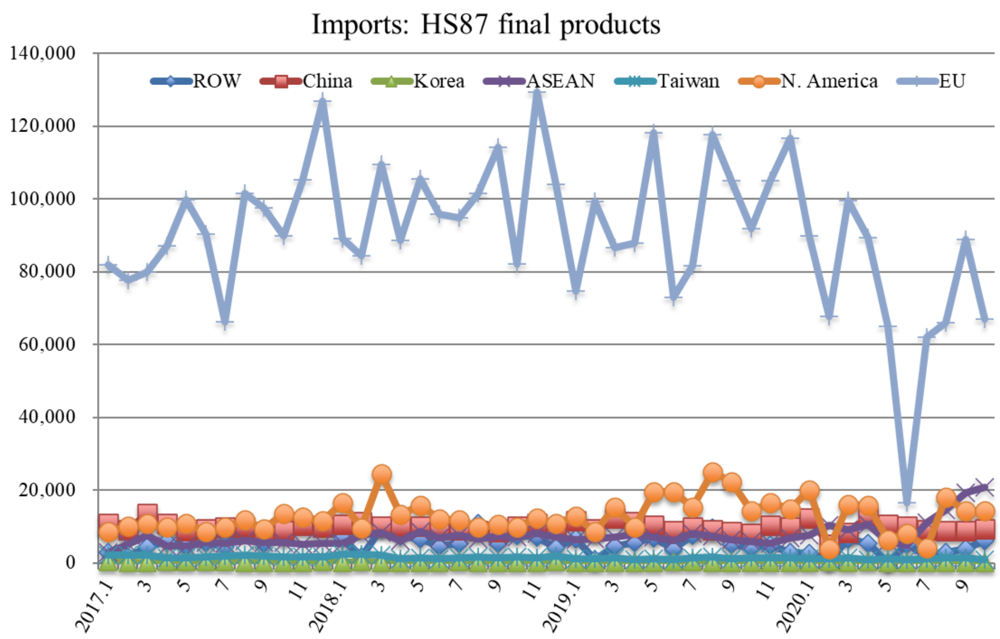
Figure A.5. By-region Machinery Imports (¥ million)



Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Note: HS85 final products exclude HS851712.
Source: Author's calculations.

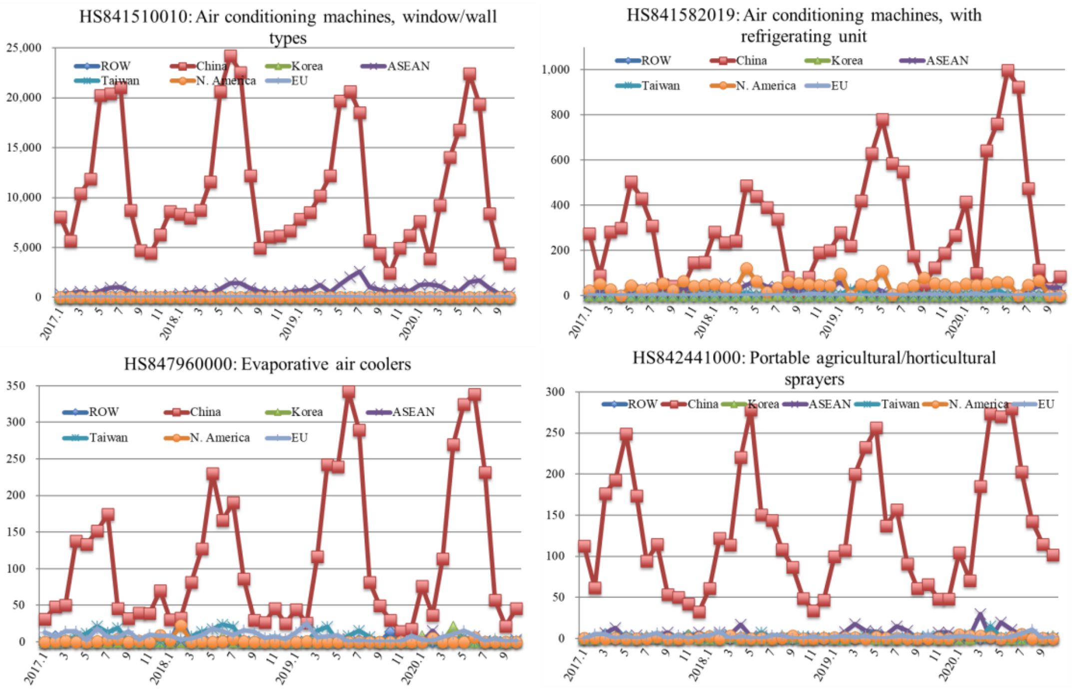
Figure A.6. Exports and Imports in HS87 Final Products (¥ million)





Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Source: Author's calculations.

Figure A.7. Imports in HS84 Final Products with Typical Seasonality (¥ million)



Korea = Republic of Korea, ASEAN = Association of Southeast Asian Nations, N. America = North America, EU = European Union, ROW = rest of the world.
Source: Author's calculations.

Table A.1. Total Exposure of Row Countries to Column Countries' Manufacturing Sectors

		Asia							North America			Europe								Other		
		CHN	JPN	KOR	IND	TWN	AUS	IDN	USA	CAN	MEX	DEU	GBR	FRA	ITA	ESP	TUR	NLD	CHE	BRA	RUS	SAU
Asia	CHN		1.9	3.0		1.9			1.5			0.9										
	JPN	6.3		1.2		0.6			1.4			0.7										
	KOR	16.4	4.4		0.6	1.8			2.9			1.8			0.5						0.6	
	IND	7.2	0.9	1.5		0.5			2.1			0.9	0.5								0.7	0.5
	TWN	13.8	6.4	3.4	0.6			0.8	2.7			1.3									0.6	
	AUS	7.1	2.2	1.5		0.5			1.8			1.0										
	IDN	7.4	2.1	1.9	0.6	0.7			0.9			0.5										
North America	USA	6.5	1.2	1.0						1.6	1.6	1.0										
	CAN	7.2	1.2	1.1		0.5			14.1		1.4	1.2	0.5									
	MEX	14.3	2.3	2.6	0.7	1.1			15.5	1.0		1.7			0.6	0.6				0.6		
Europe	DEU	4.6	0.9	0.6					1.6				1.0	2.0	1.9	1.1	0.6	1.3	1.0		0.8	
	GBR	4.8	0.6	0.6	0.6				2.6	0.5		3.9		1.6	1.2	1.0	0.6	1.0				
	FRA	4.1	0.6						2.4			5.7	1.2		2.3	1.9		0.8	0.6		0.5	
	ITA	4.6		0.7	0.6				1.1			4.9	0.8	2.3		1.6	0.8	0.8	0.6		1.2	
	ESP	4.6	0.6	0.6	0.6				1.2			4.5	1.2	3.3	2.3		0.6	0.8				
	TUR	5.0		1.3	1.0				1.1			2.1	0.6	0.8	0.8	0.8		0.8			2.0	
	NLD	3.7	0.7						1.8			5.0	1.2	1.2	0.7	0.7					0.9	
	CHE	5.2	0.9		0.5				2.4			8.2	1.6	1.9	1.1	1.1	0.6	0.7				
Other	BRA	4.6	0.5	0.6	0.6				2.2			1.0										
	RUS	5.7	0.8	0.8					1.0			1.9		0.6	0.8							
	SAU	3.8	0.6	1.0	1.0				1.3			1.8	0.9	0.5								

Notes: The figures are the value-added share of direct and indirect inputs from the column country in the row coutnry's total manufacturing output. Shares below 0.5% are omitted for clarity's sake. ISO-3 alpha codes are used for country names.
Source: Baldwin and Freeman (2020).

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