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The Impact of COVID-19 on Chinese trade and production: An empirical analysis of processing trade with Japan and the US[☆]

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ABSTRACT

The COVID-19 pandemic severely disrupted international trade, leading countries to grapple with product shortages and firms to experience major supply chain issues. These challenges increased production costs and significantly contributed to lower trade and higher inflation. In this paper, we examine the impact of COVID-19 on Chinese trade through its two main trading partners: Japan and the US. By differentiating products by product type and processing status, we find evidence that products in the middle of the global supply chain were most affected by the pandemic and that the severity of the shock depends on the partner country's role in the global supply chain. Additionally, we find that Chinese exports are more impacted than Chinese imports, regardless of processing status. These findings are largely consistent with economic theory. Understanding that the effects of global shocks vary by product and country will help guide policies that minimize supply chain disruptions.

1. Introduction

In December 2019, doctors diagnosed the first case of COVID-19 in China's Hubei province. The virus spread rapidly across China, leading to factory closures and a nationwide quarantine. Economists initially predicted that COVID-19 would diminish China's economic growth from 6% to 5.4%, and if COVID caused a pandemic, the world GDP would decrease by \$1.1 trillion (Inman, 2020). After two years, however, economists now predict losses of \$18 trillion between 2020 and 2022 (Jackson et al., 2021). The effects of COVID compromised the global economy, and it is imperative to understand the impact of the health crisis on global supply chains. The outbreak not only exposed health and economic weaknesses; it also revealed the critical role of China in global supply chains and the world economy's reliance on Chinese trade and production.

This paper focuses on China's trade with the US and Japan, and analyzes how the COVID-19 outbreak disrupted critical supply chains. More specifically, we examine how the use of foreign inputs in the production of exports (processing trade) makes countries more exposed to global economic crisis. We expect that processing trade, products central to the expansion of global supply chains, will experience greater decreases and slower recoveries than goods produced with short supply chains and based solely in one country. Demand shocks and country shutdowns are likely to affect all products, but processing goods are likely to experience larger supply shocks, making them more susceptible to COVID disruptions (see Section 2.2 for a more thorough discussion). Additionally, processing products in the middle of the supply chain are likely to be affected more. In addition to any COVID outbreaks that these firms may experience in their own establishments, these firms also have to worry about COVID disruptions in firms providing

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inputs and in partners buying their goods. We also expect to observe a difference between imports and exports; all else equal, imports should be affected more as processing imports are more likely to be in the middle of the supply chain than processing exports; the latter are more likely to be final goods. Exports of processing intermediate goods are likely an exception to this. Lastly, we would expect the effect to be stronger early in the pandemic and dissipate as governments reopened business and supply chains adjusted to the shocks.

To test our hypotheses, we focus on China's trade with Japan and the US. In our empirical analysis, we use both annual and monthly trade data between China and its key partners from UN Comtrade. Processing trade involves products that use tariff-free imported inputs in the production of an export. We use Chinese customs data to determine processing classification for each product (HS 6-digit); this classification has been used extensively in past research (see, for example, Dai, Maitra, & Yu, 2016; Dean, Lovely, & Mora, 2009; Koopman, Wang, & Wei, 2008; Thorbecke & Smith, 2010; Xing, 2012). Additionally, we can classify processing trade as an intermediate, a capital, or even a consumption good.¹ In line with our focus on bilateral trade, our processing data is country-product specific. In this paper, *Processing* equals one for a product with processing potential, as determined by whether or not the product contained processing value in 2007.² If a product can be expanded internationally, it can also be expanded domestically, and hence is also more susceptible to supply chain shocks.

We explore the product-level effects of COVID-19 as a disruption to Chinese bilateral trade using monthly trade data from 2019 to mid-2021; note that our monthly data are mirrored using US and Japanese data due to data availability. With a robust econometric analysis, we find a differential effect on processing and non-processing trade, with the effect depending on the partner country. We identify four key findings. First, exports experienced a greater shock than imports, whether the exports are destined for the United States or for Japan, using 2019 trade as the omitted group. This may be an outcome of China's zero-COVID policy, as discussed in a later section. Second, while non-processing exports drop, processing exports drop even more, especially in the first half of 2020. Thus, in line with our hypothesis, we find evidence that extensive reliance on foreign inputs in production makes products more likely to experience large drops in trade activity. Third, we find that the impact on processing goods by product type depends on the partner country: for Japan, intermediate-processing imports experience the sharpest relative drop, but for the United States, it is consumption-processing exports. This is an outcome of Japan's role as a provider of processing-intermediate goods to China, and the US as a destination for processing-final goods. Lastly, we find little difference between trade levels in 2021 and those in 2019, meaning that while Chinese bilateral-trade has recovered from its substantial drop, it has yet to surpass 2019 levels. Our methodological approach is unique in our two-dimensional analysis of China's bilateral trade levels by processing status and product type. This distinction helps estimate the widespread effects of COVID-19 on global supply chains more precisely than in previous research.

Our research adds to existing literature on supply chain disruptions, supply chains, and COVID-19. Global supply chains during COVID exhibited widespread unpredictability along every stage of the supply chain. According to the literature, unpredictability often predicts distorted demand information which then propagates upstream in an amplified form (Chen, Drezner, Ryan, & Simchi-Levi, 2000; Lee, Padmanabhan, & Whang, 1997). While complete access to demand information along the stages of the supply chain can typically reduce distortion (Chen et al., 2000), reduced capacities of firms during COVID-19 led to delayed order fulfillment downstream. As a result, demand information was unreliable, leading to wider variance upstream than is typical in global supply chains. Reduced capacities and factory shutdowns also lengthened cycle times, meaning that goods traveled along supply chains at slower rates. Long cycle times hinder supply chain efficiency (Steckel, Gupta, & Banerji, 2004; Sterman, 1989) and make supply chains more susceptible to changing consumer demand (Steckel et al., 2004). Lastly, the extent of globalization at the time of the shock may also play a role in the magnitude of the COVID-19 economic disruption (Conconi, Magerman, & Plaku, 2020).

Recent literature on COVID indicates that both the type of good and a country's position in the supply chain can have differential effects on trade. Li and Lin (2021) use 2018 data to construct a 26-country general equilibrium model that simulates the effects of COVID on trade. Their model finds that COVID has asymmetric effects by country and that the disruption in China caused a global trade loss of 12.467%. Jomthanachai, Wong, Soh, and Lim (2022) build on these findings, using a risk assessment model to specify that countries with midstream roles in the global supply chain are particularly vulnerable. Empirical research on trade and COVID indicates that the most negative impact on supply chain performance is seen in cases with long-term disruptions to production and demand downstream (Ivanov, 2020), and that Asian exporters are more greatly affected than Asian non-exporters among micro, small, and medium enterprises (Takeda, Truong, & Sonobe, 2022). Despite major disruptions to exports and production, Kiyota (2022), finds no changes to trade centrality within the Association of Southeast Asian Nations. On a broader scale, Eppinger, Felbermayr, Krebs, and Kukharsky (2020) use a quantitative trade model with input-output linkages to gauge the global effects of COVID. Characterizing the disruption as a supply shock in China, they find moderate welfare losses in most countries, with the exception of a few that gain from trade diversion. Furthermore, they theorize that removing the U.S from global supply chains would hardly reduce the U.S exposure to supply shocks in China. We build on previous literature by distinguishing between product type and processing status in determining the effects of COVID on trade.

Because this research focuses largely on China, the effects of COVID on Chinese production and firm performance are also worth noting. Zhao and Chen (2022) study the effects of the pandemic on Chinese firm performance, and find that labor-intensive firms are more negatively affected than capital-intensive firms, and firms necessary for life and production see increases in TFP.

¹ Processing imports, while all inputs to an export, are also classified into these four categories. Thus, an imported t-shirt (a consumption good) can be classified as "processing" if the t-shirt is modified to include a company logo and it is then exported.

² Our findings are robust to alternative definitions of processing trade.

Internationally, [Fang, Collins, and Yao \(2021\)](#) find that new cases, new deaths, and cumulative cases are all correlated with lower foreign direct investment in China. We address the severity of the pandemic in a later section in order to gauge its effects on production.

Our paper, more generally, contributes to literature analyzing how natural disruptions can cause abnormal activity in global supply chains. Existing research often exploits the effects of natural disasters to study supply chain shocks. In a study of supply chains after the Great Japan Earthquake, [Carvalho, Nirei, Saito, and Tahbaz-Salehi \(2021\)](#) conclude that inter-firm linkages serve as shock amplifiers. If this is the case, we would expect larger decreases for processing products. [Besedeš and Murshid \(2019\)](#) study the effects of the eruption of Eyjafjallajökull on air transportation of exports and find that reduced imports from Europe were made up by increased imports from East Asia and the Americas, implying that countries adjust trade patterns in response to shocks. While natural disasters provide ample opportunity for the study of supply chain disruptions, the disruption of COVID-19 differs from those of natural disasters in critical ways. First, the widespread nature of COVID hinders intermediate good substitution from one country with those from another. Second, COVID disrupts an incredibly complex web of global supply chains where distance between connected firms is very high. These factors furthered the effects of COVID-19 on global supply chains.

The effects of disease on trade also help contextualize the disruption of COVID-19. [Fernandes and Tang \(2020\)](#) use Chinese firm data to understand the impact of the SARS epidemic on certain sectors of the global economy. The authors find that the SARS epidemic had substantial impacts on both import and export levels, and that increased interconnectedness in global production implies that supply shocks will have larger effects on connected firms and economies. On a domestic level, [Barro, Ursúa, and Weng \(2020\)](#) analyze the Great Influenza Pandemic, and find that the influenza death rate corresponds to a 6% decline in GDP and an 8% decline in private consumption for a typical country. While public health advances and containment measures distinguish the Great Influenza Pandemic from COVID, these findings imply that widespread disease can have substantial effects on national production. Our work reinforces these findings, both in terms of trade and production.

The most recent supply chain disruption that compares in size to COVID-19 is the 2007–2008 Great Recession. Similar to COVID, the Great Recession impacted both supply and demand globally. This led to supply chain issues compounding at every stage of the global supply chain. Past research has hypothesized that trade elasticity determined the magnitude of trade fragmentation during the Great Recession, though results of this research are ultimately mixed ([Escaith, Lindenberg, & Miroudot, 2010](#)). Additionally, existing literature has concluded that supply chains became smaller in order to rebalance and were important for providing alternative exit scenarios ([Escaith, 2009](#)) during the Great Recession. COVID may cause a shrinkage of supply chains similar to that of the Great Recession. If this is the case, we expect a substantial disruption during COVID-19 and a shift in suppliers as the disruption continues. Thus, our paper sheds light on trade behavior in times of global crisis, and has key implications for economic relationships.

The rest of the paper is organized as follows. Section 2 discusses China's role in global supply chains, and hypothesizes how trade, processing goods, and COVID-19 are linked together. Section 3 describes the data and provides stylized facts using annual and monthly trade data. Section 4 tests our theoretical arguments and provides the empirical relationship between COVID-19, global supply chains, and China. Section 5 concludes.

2. Supply chains, COVID-19, and China's bilateral trade

Global supply chains are worldwide production networks used to source materials involved in the production process. Generally, the stages of production can be divided into the production of raw, intermediate, consumption, and capital goods. By using global supply chains, firms can maximize efficiency with low cost production and specialization. Global supply chains can also increase the vulnerability of production processes through longer shipping times, changing regulations abroad, and challenges in communication and coordination.

Furthering the challenges of global supply chain management, COVID-19 created an economic environment characterized by unpredictability and disjointed production. One of the most glaring examples of production challenges during COVID is the medical equipment shortage, where the worldwide spike in the demand of medical equipment met a reduced supply as factories began closing to protect workers. Computer chips followed a similar pattern which ultimately led to compounding shortages in electronics, factory machinery, and cars. Limited operational capacities at ports further perpetuated product shortages and caused the costs of product transportation to spike. CNN reported in August 2021 that London-based Drewry Shipping – which ships products from China to North America and Europe – was facing shipping container costs 360% higher than those of the previous year ([Ziady, 2021](#)).

The asymmetrical nature of different countries' responses to COVID further complicated global supply chain issues. With different stages of global production exhibiting different levels of capacity, COVID-19 caused a massive disruption to global supply chains. Past research has found that while social distancing may by itself reduce productivity ([Bodenstein, Corsetti, & Guerrieri, 2022](#)), strategically implemented containment measures can mitigate COVID's health and economic effects ([Bodenstein et al., 2022](#); [Li, Ghadami, Drake, Rohani, & Epureanu, 2021](#)). Such mitigation may, however, depend on collaboration between nations. While [Li et al. \(2021\)](#) show that countries can theoretically collaborate to reach an optimal result, [de Lucio, Mínguez, Minondo, and Requena \(2022\)](#) find that strict containment measures actually decreased exports in Spain. This was particularly true for goods consumed outside the home. We may expect the effects of COVID on global supply chains to differ by country as a result of different containment measures.

2.1. COVID in China, Japan, and the US

In December 2019, doctors diagnosed the first case of COVID-19 in Wuhan hospitals. Chinese officials reported the outbreak to the World Health Organization in the first week of January, and later that month, the government locked down China's Hubei province. After the outbreak, China instituted one of the strictest containment strategies in the world, known as the "Zero COVID" approach. The Zero COVID approach involved widespread lockdowns, and Fang, Wang, and Yang (2020) find that the mobility restrictions dramatically reduced inflow to, outflow from, and movement within Wuhan. The goal of Chinese leadership was to achieve zero local transmissions of COVID-19 in China. Driven by this goal, China's response to COVID involved factory and city shutdowns and strict border controls. With production halted in one of the world's most productive countries, shortages abounded. Throughout the next months, the world experienced a domino effect as country leaders responded to the spread of COVID and to its economic effects. COVID-19 shocked the global economy into a state of widespread unpredictability and shortages.

Other countries behaved differently. In the US, the federal government gave individual states agency over COVID regulations and protocols. The fragmented approach meant that some regions of the United States underwent lockdowns while others experienced relatively unchanged lifestyles. About two years after the first case, COVID-19 has infected over 21,000 of every 100,000 people in the United States with approximate 262 of those cases ending patients' lives (NYT, 2022a). Workplace regulations varied by state and sector; many factories closed to prevent the spread of COVID-19, but many others remained open despite the risks. The Japanese government adopted a more cohesive federal response to COVID-19, focusing on containment and mitigation. COVID data show that Japan has approximately 1,808 cases for every 100,000 people, 15 of which led to deaths (NYT, 2022b). While Japan's numbers show that COVID did not devastate the country to the same extent that it devastated others, Japanese citizens criticized the government for restrictive regulations (Dooley, Rich, & Inoue, 2020). Economically, Japan entered a recession as businesses shut down to prevent the spread. A Reuters article (Kihara, 2020) reported in September 2020 that nearly 36,000 Japanese firms had closed operations during COVID-19. Neither Japan nor the United States took as extreme measures as China did in preventing the spread. The effects of the countries' different responses are evident in our trade data as Chinese exports are more affected by the shock than Chinese imports.

The impact of COVID-19 on trade included delays, shortages, and increased transportation costs. These shocks affected both supply and demand. While a few select products benefited from the shocks, most products experienced both a drop of demand and an increase in costs. Government policies offset some of these effects, but the shock nonetheless resulted in a severe and prolonged drop in the trade of most products. What is the mechanism behind these drops in trade?

2.2. How COVID could have disrupted global supply chains

While COVID has had a devastating human toll, here we focus on the economic impact and leave discussion of health outcomes to experts in those fields. We are particularly interested in the evolution of the shock (initial shutdowns, cautious re-opening, and a "new normal"), as well as how this evolution depended on the products' group type and processing classification.

We believe that COVID-19 disrupted processing trade the most. Processing trade consists of both imports that will be used as inputs for exportable products and exports that use foreign inputs. We believe that these exports and imports are likely to experience larger decreases in trade for the following reasons: [1] for these goods, production takes place in various geographical locations, and a disruption in one place can disrupt the whole production process; [2] products with long supply chains see relatively higher transportation costs as they cross multiple borders; and [3] products made by firms that benefit from economies of scale (those with large labor forces) are likely to experience more COVID outbreaks and shutdowns. Note that non-processing trade will also be negatively affected and the extent of the shock will depend both on the severity of the pandemic and on government policy. Thus, the overall effect on trade will vary by country, but the difference between processing and non-processing goods should theoretically persist.

Additionally, processing products in the middle of the supply chain are likely to be affected more. These products are likely to be intermediate goods, rather than raw, capital, or consumption goods. We expect to see these differences because in addition to any COVID outbreaks that these firms may experience in their own establishments, they may have to find a replacement for both foreign input providers and foreign export partners. That is, these establishments also have to worry about COVID disruptions in firms providing inputs or in partners buying the establishment's intermediate goods or even in both trading partners. We also expect to observe a difference between imports and exports. On the import side, there should be less of a difference between product types as all processing goods, by definition, are inputs to an export. For exports, on the other hand, consumption goods are more likely to be downstream products, and, thus, intermediate goods might be more affected by COVID disruptions.

Lastly, we would expect the effect to be stronger early in the pandemic. There were more government shutdowns early in the pandemic which inhibited global production. With the addition of new vaccines and medical treatment, shutdowns became less likely (at least outside of China), easing many restraints on global production. Moreover, the passage of time allows firms to find both new suppliers of inputs and new consumers for their products, even if their former suppliers and consumers are still at limited capacity. Thus, the difference between processing and non-processing goods should dissipate with time.

COVID and Chinese processing trade data

For the empirics, we will test our hypothetical link between COVID-19 and global supply chains using Chinese bilateral trade between China and two of its main trading partners, Japan and the US. We focus on these countries for three key reasons. First, China has played an increasingly crucial role in the global economy. The aggregate value of Chinese exports increased ten-fold in the past twenty years, surpassing 2.5 trillion US Dollars in 2020. Second, we focus on China's bilateral trade with the US and Japan because of their importance to Chinese trade growth and their primary roles in Chinese trade: Japan as a provider of processing inputs, and the US as a primary destination for processing exports (see [Dean et al., 2009](#) for more details). Lastly, China's role is in the middle of global supply chains and its extensive use of processing trade to boost exports, as explained above, makes the country more vulnerable to global shocks.

Our hypothesis implies that the overall impact on exports and imports depends on government policy, the severity of COVID-19 outbreaks, and the country's dependence on processing trade. In the case of China, however, given China's zero-COVID policy, we expect exports to drop more than imports, and this may spill into processing goods too. Per the argument above, we also expect that processing trade (both exports and imports) will have greater decreases in trade than non-processing goods. Additionally, we expect to see little difference between processing good types on the import side, by definition all of these products are inputs to an export. We, however, expect that exported intermediates classified as processing are more likely to experience disruptions than other types of exports; these products types are more likely to be in the middle of the supply chain than the other product types and more susceptible to COVID disruptions. Thus, given the same level of dependence on processing goods, then processing imports should be affected more than processing exports.

Using bilateral trade data between China and its main partners, we find evidence in supports of some, but not all, of our hypotheses.

3. Data and descriptives

The media has provided anecdotal evidence of the prolonged effects of COVID on supply chains over two years after the start of the COVID-19 pandemic. In this paper, we use bilateral trade data to test how long the effects have lasted, whether this effect depends on a product's processing classification, and whether upstream or downstream production is affected more. We first look at both annual and monthly Chinese trade data to analyze trade trends since China's entrance into the WTO and, more importantly, to examine how these trends change due to the supply and demand shocks that resulted from COVID-19. In the next section, we do a more formal empirical analysis.

3.1. Data

We obtain bilateral trade data from the UN Comtrade database by Harmonized System (HS) code at the six-digit level, as reported by China, Japan, and the United States.³ We obtain our product group classification using the World Integrated Trade Solution (WITS) definitions which groups these HS products into different stages of production: intermediate materials, consumption materials, and other (mainly, raw and capital materials). Note that our unit of analysis is bilateral trade at the HS product level, and we separate this data by group classification. We use China-reported annual data from 2000–2018 in US Dollars to explore China's role in global trade prior to COVID-19. Through this data, we analyze China's trajectory in global trade before the disruption. Updated Chinese monthly data are unavailable, so we use mirrored trade data from China's largest trade partners, the United States and Japan. We primarily use monthly data from 2019, 2020, and 2021 to estimate the short-term and prolonged effects of COVID-19 relative to a pre-COVID economy.

We combine bilateral monthly trade data with processing classification to perform our analysis. The processing classification comes from firm-level customs data. For other papers analyzing China's processing trade with this data see [Dai et al. \(2016\)](#), [Dean et al. \(2009\)](#), [Koopman et al. \(2008\)](#), [Thorbecke and Smith \(2010\)](#), [Xing \(2012\)](#). As stated earlier, processing materials are imports to and exports from China that are going to be used for processing (imports) or contain foreign inputs in their production (exports). While it is true that all processing imports are intermediate by definition, some imported goods are not classified as intermediate products: for example, a t-shirt (a consumption good) can be classified as processing if the t-shirt is modified to include a company logo. Likewise, we define non-processing materials as products that are manufactured solely in China, without any fraction of imported material reported by firms in its production. To ensure that the results are not driven by changes in processing values, we use Chinese firm-level data from 2007 to identify whether or not a product is classified as "processing".⁴ The merging process results in a loss of about 8% of export observations and 7% of import observations; this is likely due to products that have been added since 2007. We use a dummy variable to identify processing materials, reasoning that products that can have long global supply chain are products that can also have long country-wide supply chains.⁵ Thus, our measurement of processing does not just capture supply chain issues across countries, but also those within China.

³ We would have liked to include South Korea, but monthly data were not available for this country.

⁴ We cannot test if processing trade is affected during the COVID-19 shock or use a more recent year due to data availability.

⁵ As robustness checks we use three additional definitions: processing value, share of processing, and high processing products (where the share of processing value is greater than 50%).

Table 1
China's annual data: Exports.

Partner	Classification	Process.	Value (mn, USD)		Share of Exp.		2000 vs. 2018	
			2000	2018	2000	2018	Val. (%Δ)	Share (Δ)
Japan	Capital	No	42	325	0.1	0.2	681.1	0.1
		Yes	8696	73,990	18.7	46.6	750.9	27.9
	Consumption	No	292	739	0.6	0.5	153.3	-0.2
		Yes	27,640	60,210	59.4	37.9	117.8	-21.5
	Intermediate	No	1222	3925	2.6	2.5	221.2	-0.2
		Yes	3716	16,140	8.0	10.2	334.3	2.2
	Raw	No	3047	1559	6.5	1.0	-48.8	-5.6
		Yes	1915	2039	4.1	1.3	6.5	-2.8
USA	Capital	No	257	1704	0.3	0.4	563.0	0.1
		Yes	20,820	164,900	26.6	40.6	692.0	14.0
	Consumption	No	276	2652	0.4	0.7	860.2	0.3
		Yes	49,600	197,800	63.4	48.7	298.8	-14.7
	Intermediate	No	1026	4430	1.3	1.1	331.8	-0.2
		Yes	4999	31,790	6.4	7.8	535.9	1.4
	Raw	No	735	1048	0.9	0.3	42.5	-0.7
		Yes	471	1501	0.6	0.4	218.5	-0.2

Note: Authors' calculations using UN Comtrade data. *Process.* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007.

3.2. Descriptives

Annual data. Since joining the WTO in 2001, China has experienced levels of trade growth that are practically unseen in the global economy. To explore these trends and contextualize the disruption, we use annual data from the years 2000 and 2018 to examine China's changing role in the global economy. China's total trade activity in these years ranges from 479 billion US Dollars in 2000 to 4.7 trillion US Dollars in 2018. This activity was driven by both imports and exports, each of which consistently accounts for approximately half of the aforementioned values. Table 1 shows the values and shares of China's exports to the United States and Japan from the years 2000 and 2018. The highest values and shares in both 2000 and 2018 are for processing goods, with the highest being consumption-processing and capital-processing goods, followed by intermediate-processing and raw-processing materials. As our definition of processing indicates whether or not a product has foreign inputs, this implies that Chinese trade is largely dependent on goods with fragmented production processes.

The changes in export values and export shares from 2000 to 2018, as shown in Table 1, are indicative of how Chinese trade and production has changed since China's entrance into the WTO. Our first observation from these calculations is that nearly across all product and processing classifications, the aggregate value of China's exports has grown substantially. For exports to the United States, the largest increase is in consumption non-processing materials which increased by 880.2% from 2000 to 2018. Exports of capital materials and intermediate processing materials also show substantial increases. For exports to Japan, capital processing exports experience the most growth, followed by capital non-processing and intermediate processing exports. Shares of capital processing exports have increased relative to those of other classifications and shares of consumption-processing exports have decreased, meaning that China is shifting much of its production from consumption to capital materials. Though the products experience dramatic increases in export value from 2000 to 2018, shares of the other categories have remained relatively unchanged.

China's imports tell a slightly different story, as shown in Appendix Table A.1. Like exports, China's imports increase dramatically across nearly all classifications, as can be explained by China's increasingly crucial role in global production. Table A.1 shows that the aggregate value of capital processing imports from both Japan and the United States remains high, but that the aggregate value of consumption materials is overshadowed by that of intermediate processing materials. The importance of intermediate processing and capital processing imports support previous characterizations of China's role in the middle of global production. Despite the aggregate value of intermediate processing imports, however, China's trade with Japan indicates that the share of such imports decreased by 14.8 percent from 2000 to 2018. Relative to other imports from Japan, intermediate processing materials experienced the least growth between our years of observation. While still a crucial part of Chinese trade, our data indicates that intermediate processing products are not as important as they once were in China's trade with Japan. This trend does not exist in China's trade with the United States, with the aggregate value of intermediate processing imports experiencing growth similar to other imports and the share remaining relatively unchanged. Consumption non-processing imports from the United States increased by over 5000% between our years of observation, indicating that imported consumption products are becoming more important to the Chinese economy. While less dramatic, this increase also appears in China's trade with Japan.

Monthly data. In order to test our hypotheses in Section 2.2, we use mirrored monthly data from the United States and Japan.⁶ Our primary months of observation are the months of 2020, using 2019 data as an anchor of relativity. Admittedly, 2019 is an imperfect

⁶ Like many other countries, China does not provide updated monthly data and we are forced to use mirrored data from countries that provide updated monthly data.

anchor, particularly in China's trade relationship with the United States, due to the implementation of trade policies that stifled trade activity.⁷ Nonetheless, using 2019 as a base year allows us to account for the updated changes in bilateral relationships in our analysis; if anything, using this base may underestimate the effect as trade was negatively affected by the US-China trade war.

Fig. 1 shows the ratios of China's export values in 2020, separated by month, classification, and processing status. To test if product type is differentially affected, products are divided into consumption, intermediate, and "other" (namely, capital and raw) products. As expected, we see a sharp decrease in trade in the first months of 2020, followed by differential recovery patterns across classifications. Processing materials generally fall further than non-processing materials, with the largest drops occurring in consumption products; although the second point does not match our expectation, the differences are fairly small and these products recover relatively quickly. For exports to Japan, the impact on capital non-processing and raw non-processing materials is most sustained as recovery does not occur by the end of 2020. While consumption non-processing materials exhibit a high level of fluctuation, Fig. 1 shows a relatively smaller drop in exports of such goods to Japan. Notably, exports of intermediate materials to Japan do not reach 2019 levels until December 2020, with non-processing exports again exhibiting high levels of fluctuation; this finding matches our argument that processing intermediates should be affected more than other processing exports (see Section 2). China exported far less capital and raw materials to the United States in January 2020 than in January 2019 which may be indicative of the aforementioned trade policies in 2019. Unlike with exports to Japan, we observe a steady increase in exports of such goods throughout 2020, regardless of processing status. Exports of consumption and intermediate materials to the United States, however, are highly dependent on processing status, as shown by the differential recoveries of non-processing materials in Fig. 1(c), and processing materials in Fig. 1(d).

Appendix Fig. A.1 shows China's imports from the United States and Japan, using all of the same metrics as Fig. 1. In sharp contrast with exports, China generally imported more in 2020 than it did in 2019. We observe high levels of fluctuation across all product classifications and processing statuses which are likely perpetuated by unpredictability in the global economy. Note the differences in scale between processing and non-processing materials in Appendix Fig. A.1. The variance is generally much higher for products that China does not intend to use as processing materials.

While products across classifications and processing statuses follow many of the same patterns, critical differences are apparent. During COVID-19, imports of intermediate materials from Japan largely depended on processing status. Import levels of intermediate non-processing materials were over 100% of 2019 levels in the height of the COVID-19 economic shock. For intermediate materials that China intended to process, however, 2020 import levels were lower (albeit, by approximately 10%) than 2019 import levels. Capital non-processing and raw non-processing materials fell further and exhibited slower recoveries than capital processing and raw processing materials, but the overall swings are relatively small. Imports of consumption products from Japan followed similar trajectories, regardless of processing status. Aside from the larger variance in non-processing imports discussed earlier, most imports from the United States follow similar patterns, characterized by higher and more unstable trade levels than 2019. We still observe a substantial difference between imports of intermediate processing and non-processing materials, but both types show a generally upward trend.

To conclude, we observe significant evidence in support of the arguments found in Section 2.2, even if not all our hypothesis are supported by the data; more details are provided in the next section.

4. How are COVID-19, bilateral trade, and supply chains related?

In this section, we rigorously test the assumptions discussed in Section 2 using the data from 3.

4.1. The econometric specification

To test the evolution of the COVID-19 shock, we use the following baseline specification for partner i , in product p , in month t :

$$\sinh^{-1}(EX/IM)_{ipt} = \beta_0 + \beta_1(Y20_{Q1}) + \beta_2(Y20_{Q2}) + \beta_3(Y20_{Q3,4}) + \beta_4(Y21) + \omega + \theta_{ip} + \epsilon_{ipt} \quad (1)$$

In Eq. (1), $\sinh^{-1}(EX/IM)$ stands for the inverse hyperbolic sine of either exports or imports; we use this transformation to ensure zero values are not dropped from our observations⁸ $Y20_{Q1}$ is the first quarter of 2020 and represents the initial COVID shock; $Y20_{Q2}$ is the second quarter and represents the relative recovery after the initial shock; $(Y20_{Q3,4})$ is the third and fourth quarter of 2020 and represents the short-run impact of the shock; and $Y21$ is all data available for 2021 (Jan–Oct) and represents the mid-run impact of the shock. ω are month fixed effects, θ_{ip} are product-partner fixed effects (or simply product fixed effects when examining bilateral trade), and ϵ_{ipt} is the error term. Given the unexpected nature of COVID-19, we are confident that the shock and its effects are exogenous. The omitted group is the pre-COVID data for all the months of 2019.

Based on the data above and our hypotheses, we expect COVID-19 to have its greatest impact on trade in the first quarter of 2020 because of government imposed shutdowns, and then we expect gradual improvements afterwards as these restrictions are relaxed and firms adjust. The lack of a positive estimate – any $\beta_i > 0$ – implies no improvement over 2019. This analysis will allow us to see if the improvements observed in the data after the initial government shutdowns, are relative improvements, or if the improvements are indeed improvements over the 2019 baseline.

⁷ We use an average of 2016–2018 trade values as a base in our robustness checks in order to circumvent the impact of such policies.

⁸ We also tried a non-linear estimation (PPML) and our estimates remain relatively similar.

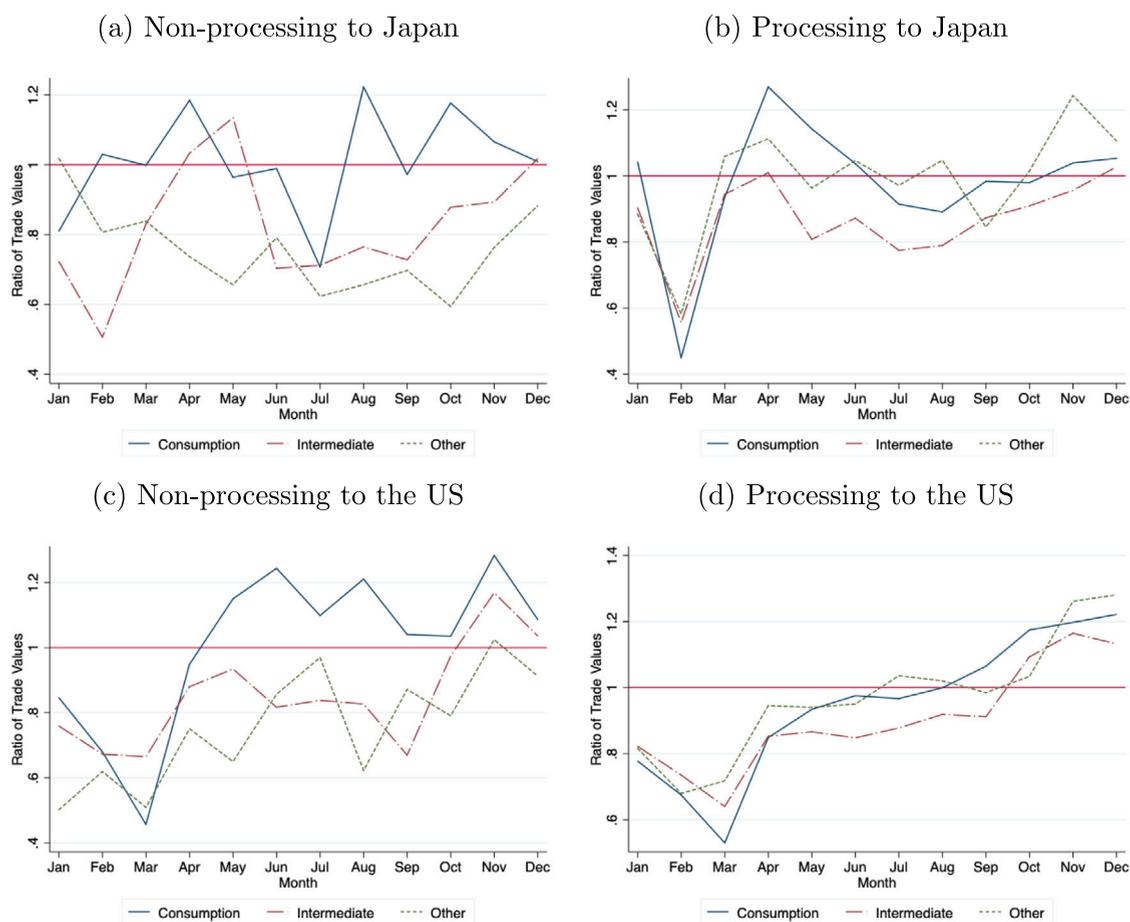


Fig. 1. COVID-19 and China's Exports
(Ratio 2020 : 2019)

Note: These are created using mirrored data from Japan and the US. *Other* includes capital and raw materials. *Processing* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007.

Source: UN Comtrade and Chinese Customs data.

Since we believe COVID had a differential impact on processing and non-processing goods, as discussed in Section 2, we add a "Processing" term to our baseline specification. As explained in that section, these goods are likely to have longer supply chains and more likely to be impacted by COVID. Since this variable is country-product specific, it does not vary with time and is absorbed by the country-product fixed effects. Thus, only the interaction term between processing and our time variables will appear in the estimates.

Lastly, we separate data from the US and Japan as these countries play different roles in the global supply chain, and have had very different government policies to counteract the spread of COVID-19. In terms of these countries' roles in the global supply chain, Japan supplies relatively more intermediate goods to China than the US, and the US imports more consumption goods from China than Japan, as explained in Section 3. As discussed earlier, it is logical to assume that the effect of processing may have a differential impact on intermediate and consumption goods. Likewise, the fact that Japan is a close neighbor and that the US is a top destination for consumption goods might mean that the effects may differ by country. Finally, the actions taken by these two countries early on in the pandemic may result in the COVID economic shock evolving differently. Thus, for most of the analysis, we will provide separate estimates for these two countries.

4.2. Baseline results

As seen in Table 2, exports and imports behaved very differently during the COVID shock. For non-processing goods, on the import side (Column 1), there was an immediate drop due to COVID (−14%), but the effect plateaus after the first quarter. Non-processing goods then sees relative improvements by 2021 (11%). The drop was larger (−22%) and more prolonged for Chinese exports than it was for Chinese imports. For exports, only the values from 2021 are not statistically different from those of 2019

Table 2
Covid shock, trade values, and processing trade: Japan and the United States.

Dep. Var. ⇒	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q1}	-0.14*** (0.03)	-0.11*** (0.04)	-0.01 (0.06)	-0.22*** (0.05)	-0.22*** (0.02)	-0.23*** (0.04)	-0.20*** (0.02)	-0.27*** (0.03)
Y20 _{Q2}	-0.03 (0.03)	-0.03 (0.04)	0.12* (0.07)	-0.11** (0.05)	-0.11*** (0.02)	-0.04 (0.04)	-0.15*** (0.02)	-0.15*** (0.04)
Y20 _{Q3,4}	0.03 (0.03)	0.06 (0.04)	0.08 (0.07)	-0.04 (0.05)	-0.20*** (0.02)	-0.06 (0.04)	-0.23*** (0.02)	-0.16*** (0.03)
Y21	0.11*** (0.03)	0.18*** (0.04)	0.14** (0.06)	0.01 (0.05)	-0.00 (0.02)	0.03 (0.04)	-0.03 (0.02)	0.02 (0.03)
Y20 _{Q1} *Processing	0.01 (0.03)	0.02 (0.04)	-0.12** (0.06)	0.09* (0.05)	-0.11*** (0.02)	-0.14*** (0.04)	-0.09*** (0.03)	-0.02 (0.04)
Y20 _{Q2} *Processing	-0.06* (0.03)	-0.03 (0.05)	-0.23*** (0.07)	0.04 (0.05)	-0.07*** (0.02)	-0.17*** (0.05)	-0.00 (0.03)	0.02 (0.04)
Y20 _{Q3,4} *Processing	-0.04 (0.03)	-0.04 (0.04)	-0.11 (0.07)	0.02 (0.05)	0.06*** (0.02)	-0.06 (0.04)	0.00 (0.03)	0.08** (0.04)
Y21*Processing	-0.03 (0.03)	-0.02 (0.04)	-0.07 (0.07)	0.01 (0.05)	-0.01 (0.02)	-0.08* (0.04)	0.02 (0.03)	0.01 (0.04)
Product-Partner FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	171,289	54,817	70,975	45,497	208,198	77,255	78,025	52,918
Clusters	7158	2341	2989	1828	7222	2475	2932	1,815
Adj. R ²	0.015	0.020	0.014	0.014	0.030	0.057	0.024	0.027

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Othr* are Capital and Raw goods. \sinh^{-1} stands for inverse hyperbolic sine.

(Column 5). Note that this is not necessarily a recovery as the values are still below trend. This implies that Chinese trade has been much slower to recover from COVID than the media has suggested, and that product shortages in 2021 are not exceptions to the “recovery”. These findings match our expected outcomes.

Contrary to our expectations, processing goods behave differently when looking at exports and imports. On the import side, there is very little aggregate difference between processing and non-processing goods; the estimates are mostly negative, but these are not statistically significant. Only when we differentiate goods by product type – consumption goods, intermediate goods, and others – do interesting differences appear.⁹ Processing intermediate goods (Column 3), relative to non-processing ones, experience a substantial drop in the first two quarters of 2020. After this period, while our estimates negative, the differences are no longer statistically significant. We suspect that the difference for intermediates shows up as these products are in need of a more substantial transformation.

Processing exports, as we expected, do much worse than non-processing goods in the first two quarters of 2020, and have a slight improvement in the second half of the year. The pick up in the second half of 2020 is only a relative improvement as these goods still experience an overall drop in that period. This means that the effect to processing goods dissipates as shutdowns end and as firms adjust to supply shocks. A slightly different pattern emerges when separating the results by classification; namely that the negative effect on processing is due to consumption goods (Column 6). Non-processing consumption exports become indistinguishable from the 2019 values after the first quarter of 2020; however, for processing exports, the drops were steeper and continued to be below 2019 values during all the periods observed (only the estimates for second half of 2020 are not statistically significant). While processing intermediate and other goods are not statistically different than non-processing goods; these goods still experience large decreases in trade since non-processing goods also decreased. These findings suggest that, generally, the products that experience the largest drops in trade due to COVID-19 are the same products that have largely driven China’s impressive export growth: consumption goods that use imported intermediate materials.

Since Japan and the US play different roles in the global supply chain, we separate the estimates by country. For trade with Japan (see Table 3), the estimates differ from our earlier combined estimates, especially for the difference between processing and non-processing goods. Relative to 2019, non-processing imports largely remain unchanged early on in the pandemic and even exhibited growth by the second half of 2020 (Column 1). Processing imports, on the other hand, do relatively worse in every period, and the differences are largely statistically significant (only the immediate impact is not). When separating our results by product type, we see that the improvements in non-processing imports come from consumption (Column 2) and intermediate (Column 3) goods; non-processing imports in the *other* category (Column 4) actually saw decreases early on in the pandemic. Even when separating by product type, processing imports as before experience relative decreases. Interestingly, the main driver of the relative drop for

⁹ When splitting the other category into raw and capital goods we get different magnitudes for processing and non-processing goods, but the estimates are stylistically similar.

Table 3
Covid shock, trade values, and processing trade: Japan only.

Dep. Var. ⇒	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q1}	-0.05 (0.04)	-0.00 (0.05)	0.19* (0.11)	-0.21*** (0.07)	-0.14*** (0.02)	-0.14*** (0.05)	-0.12*** (0.03)	-0.18*** (0.05)
Y20 _{Q2}	0.07 (0.05)	0.18*** (0.06)	0.32** (0.16)	-0.14** (0.07)	-0.05** (0.03)	0.01 (0.05)	-0.11*** (0.03)	-0.01 (0.06)
Y20 _{Q3,4}	0.10** (0.04)	0.16*** (0.05)	0.30* (0.16)	-0.03 (0.06)	-0.18*** (0.02)	-0.00 (0.05)	-0.24*** (0.03)	-0.15*** (0.05)
Y21	0.20*** (0.04)	0.35*** (0.05)	0.29** (0.13)	-0.01 (0.06)	0.03 (0.02)	0.03 (0.04)	0.05 (0.03)	-0.01 (0.05)
Y20 _{Q1} *Processing	-0.07 (0.04)	-0.07 (0.05)	-0.31*** (0.11)	0.07 (0.07)	-0.13*** (0.02)	-0.19*** (0.05)	-0.10*** (0.04)	-0.07 (0.05)
Y20 _{Q2} *Processing	-0.13*** (0.05)	-0.15** (0.06)	-0.44*** (0.16)	0.07 (0.07)	-0.03 (0.03)	-0.08 (0.05)	0.03 (0.04)	-0.06 (0.06)
Y20 _{Q3,4} *Processing	-0.10** (0.04)	-0.06 (0.06)	-0.35** (0.16)	0.03 (0.07)	0.03 (0.03)	-0.13** (0.05)	0.01 (0.04)	0.05 (0.05)
Y21*Processing	-0.07* (0.04)	-0.06 (0.06)	-0.20 (0.13)	0.05 (0.07)	-0.04* (0.03)	-0.09* (0.05)	-0.03 (0.04)	0.04 (0.05)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	89,351	28,105	39,514	21,732	101,594	37,540	38,553	25,501
Clusters	3548	1164	1524	860	3576	1229	1448	899
Adj. R ²	0.031	0.052	0.031	0.026	0.040	0.054	0.040	0.037

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Other* are Capital and Raw goods. \sinh^{-1} stands for inverse hyperbolic sine.

processing imports is intermediate goods, but consumption goods also have lower values (though these differences are largely not statistically significant). For the other category, there are no significant differences between processing and non-processing. Since Japan is such an important source of processing imports, this finding provides evidence that products in the middle of the supply chain are affected the most.

For exports to Japan, China experiences a large drop for non-processing goods (Column 5) and, except in the first quarter, there are very little differences when separating the products into processing and non-processing goods. Since non-processing exports do poorly after COVID, this means both processing and non-processing exports continued below the 2019 value for most of the periods observed. Interestingly, the only category with statistically significant differences beyond the first quarter, is consumption exports (Column 7). Thus, we find some evidence that, relatively speaking, processing imports are affected more than processing exports. Unlike, our hypothesis, however, the reason seems to be simply that all exported products do worse.

For trade between China and the US, imports do not recover as quickly as they do for those from Japan (see Table 4, Column 1), perhaps an outcome of the countries' different responses to COVID-19. Another important difference shows up in our estimates for the United States: relative to non-processing goods, there are no decreases for processing imports. This implies that for imports from the US, both processing and non-processing imports experience decrease early on as a result of COVID relative to 2019, and then plateau. The same result holds when we sort the data by product category (Columns 2, 3, and 4); we do find that the difference-in-difference estimates for intermediate goods (Column 3) are negative, but the estimates are not statistically significant. The lack of a statistically significant finding here may be due to the fact that we have less observations for processing intermediate goods coming from the US, relative to those coming from Japan. As stated earlier, for China, the US is a much more important destination for processing exports than for a source of processing imports; the opposite is true for Japan.

While exports to the United States experience a large drop, even more so than those to Japan, the difference between processing and non-processing goods is striking (something that does not show up in the Japanese data). Processing exports do relatively worse in the first half of 2020 than in the second half (Column 5). We identify important differences when separating the data by product classification (Columns 6–8). Intermediate (Column 7) and consumption goods (Column 6) do worse in the immediate impact; there are no significant differences for the other category (Column 8). There is some evidence that consumption goods experienced, as we expect, a more prolonged shock. Note that the difference-in-difference estimate for both intermediate and consumption goods is negative; it is just not statistically significant for intermediate goods. As stated earlier, this finding is probably due to the fact that the US is an important destination of Chinese processing goods.

4.3. Robustness checks

As robustness checks, we vary our definition of processing goods, control for the severity of COVID-19, and use alternative dependent variables. We do not combine our data as we did in Table 2, and instead focus only on bilateral trade. Since we found clear differences between trade with the United States and trade with Japan, we reason that the continued separation of results will yield the most precise findings.

Table 4
Covid shock, trade values, and processing trade: The US Only.

Dep. Var. ⇒	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q1}	-0.21*** (0.04)	-0.20*** (0.05)	-0.14** (0.07)	-0.24*** (0.07)	-0.29*** (0.02)	-0.30*** (0.05)	-0.28*** (0.04)	-0.34*** (0.05)
Y20 _{Q2}	-0.11*** (0.04)	-0.19*** (0.06)	0.02 (0.07)	-0.10 (0.07)	-0.16*** (0.03)	-0.07 (0.07)	-0.18*** (0.03)	-0.25*** (0.05)
Y20 _{Q3,4}	-0.01 (0.04)	0.00 (0.05)	0.00 (0.07)	-0.05 (0.07)	-0.21*** (0.02)	-0.11 (0.06)	-0.23*** (0.03)	-0.16*** (0.04)
Y21	0.04 (0.04)	0.04 (0.06)	0.06 (0.07)	0.03 (0.07)	-0.03 (0.02)	0.03 (0.06)	-0.09*** (0.03)	0.05 (0.04)
Y20 _{Q1} *Processing	0.08** (0.04)	0.10 (0.06)	-0.01 (0.07)	0.11 (0.07)	-0.09*** (0.03)	-0.11** (0.05)	-0.08** (0.04)	0.02 (0.05)
Y20 _{Q2} *Processing	-0.00 (0.04)	0.03 (0.07)	-0.11 (0.08)	0.01 (0.07)	-0.12*** (0.03)	-0.27*** (0.07)	-0.05 (0.04)	0.05 (0.05)
Y20 _{Q3,4} *Processing	-0.04 (0.04)	-0.09 (0.06)	-0.02 (0.08)	0.01 (0.07)	0.08*** (0.03)	-0.01 (0.07)	-0.00 (0.04)	0.11** (0.05)
Y21*Processing	-0.02 (0.04)	-0.05 (0.06)	-0.00 (0.08)	-0.02 (0.08)	0.01 (0.03)	-0.06 (0.06)	0.05 (0.04)	-0.01 (0.05)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	81,938	26,712	31,461	23,765	106,604	39,715	39,472	27,417
Clusters	3610	1177	1465	968	3646	1246	1484	916
Adj. R ²	0.008	0.010	0.007	0.010	0.038	0.089	0.024	0.032

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Othr* are Capital and Raw goods. \sinh^{-1} stands for inverse hyperbolic sine.

Changing the definition of processing

For our first robustness check, we only classify goods as Processing if their share of processing goods is greater than 50% for both Japan and the US. We reclassify goods in this way as products with high processing shares may experience larger drops in trade, and goods with small processing shares may be more similar to non-processing goods. As with the baseline estimates, non-processing imports from Japan recover fairly quickly with no statistically significant difference by the second quarter of 2020. Unlike in the baseline estimates, however, processing goods do relatively worse in every post-COVID period (Appendix Table A.2, Column 1). We would expect this to be true with these robustness checks as the threshold for a product to be considered Processing is higher. Products with higher processing shares may need to be processed at multiple different facilities, perhaps even in different countries, leading to more prolonged effects for processing goods.

Another key difference between these estimates and the baseline estimates is the magnitude of the differences between processing and non-processing imports in the first two quarters of 2020. The differences are more drastic in our baseline estimates than with the higher threshold for processing. This implies that imports with higher processing shares were less impacted than imports with lower processing shares. This difference may be due to the delayed spread of COVID, with China being able to import and process products with foreign inputs before COVID drastically changed production in those countries. Similar to our earlier results, the impact of COVID on processing goods are primarily driven by processing consumption goods (Column 2) and processing intermediate goods (Column 3). Given these results, this reclassification makes our argument about COVID and its impact on global supply chains stronger. For exports to Japan (Column 5), non-processing exports do poorly in almost all periods observed, and there is very little difference with processing goods. Separating these by category type (Columns 6, 7, and 8) does not alter this finding.

We also focus on high processing products for trade with the US (see Appendix Table A.3). Imports from the US drop in the first half of 2020 and only reach 2019 values in 2021 (Column 1). Processing imports fare worse, but many of these differences are not statistically significant. The conclusion largely holds when separating the data into our three categories: consumption goods (Column 1), intermediates (Column 2), and other (Column 3). Non-processing exports to the US do poorly (Column 5), just like those to Japan. Likewise, separating these goods by category type (Columns 6, 7, and 8) does not alter the results; only intermediate processing exports experience a drop relative to non-processing goods. Contrary to our expectations, raising the threshold for a good to classify as Processing does not show clear evidence of a prolonged effect, as it did with our estimates for Japan. One key difference from our baseline estimates is that, for the US, there is very little difference between processing and non-processing goods. This implies that much of the difference we observe from consumption goods in Column 6 of Table 4 comes from goods that have low shares of processing value. As discussed earlier with reference to Japan, this means that exports with high processing value were less impacted than exports with low processing value.

A second way to define processing is to use a direct measurement instead of using a 1 or 0 value. For this, we use the actual processing value in 2007, and convert it using inverse hyperbolic sine. This process allows us to keep zero values for non-processing goods and we can still interpret the estimates like those of log transformations (i.e., elasticities). For China's trade with Japan

(Appendix Table A.4), we again get very similar results as those of the baseline estimates. The main difference is that the interaction term estimates are smaller. This implies that products with the highest share of processing value were impacted more. Combining this with the previous robustness check implies that the relationship is nonlinear, hence our preference to separate all processing goods, regardless of their share of processing value. For China's trade with the US (Appendix Table A.5), both exports and imports exhibit large drops (with imports recovering faster). For processing goods, only exports have a relative drop, and these drops are mainly coming from consumption and intermediates. The effect on consumption goods, as in the baseline estimates, is more prolonged.

For our last alternate measurement of processing, we use the 2007 share of processing value in a traded product. Unlike using value, the share allows us to test if products which may not be large in dollar terms but are highly dependent on processing trade are affected more than products with smaller shares. In this case, we leave the value as a share rather than a percent to avoid small estimates; but we must be careful about how we interpret these results. Even with this definition, our results are stylistically similar, and again, reinforce the findings in the baseline estimates. For trade with Japan (Appendix Table A.6), non-processing imports recover quickly, but non-processing exports do not improve upon values of 2019. On the other hand, processing imports do much worse, especially consumption and intermediate imports, and there are almost no differences between processing and non-processing exports. For trade with the US (Appendix Table A.7), the drop for non-processing goods is again worse for exports, and there is still no recovery for imports (unlike those from Japan). Processing goods, whether imported or exported, do worse; however, most differences between processing and non-processing are not statistically significant when separating the data by categories. Interestingly, the drop is mostly led by intermediate goods (Columns 3 and 7) and the difference we observed with consumption goods disappears (as it did when using a higher threshold for processing goods in Table A.3). This again reinforces the point that there is no linear relationship when examining the effect of COVID-19 on processing goods, and that the relationship is dependent on product classification.

That our findings are robust to multiple measurements of processing, including ones that require high shares of foreign inputs and direct measurements of shares, reaffirms our argument that reliance on processing trade made products more vulnerable to the shock. Additionally, because processing status substantially affected the severity of the shock, we find evidence that products in the middle of the global supply chains are likely to be affected more.

Controlling for the severity of COVID-19

To examine whether or not the decline in imports and exports came directly from the severity of COVID, we control for the number of cases in our baseline results (see Appendix Tables A.8 for Japan, and Appendix Table A.9 for the USA). We combine our trade and processing data with data from the World Health Organization to perform these estimates. The results, especially the difference-in-difference estimates, are largely unchanged.

When adding COVID cases as controls to our estimates, we find the largest effect is for non-processing exports. When adding both own COVID cases and China's COVID cases, exports largely decrease with cases (own cases in Japan do not seem to have much of an impact). As for the baseline estimates, we observe exports largely growing compared to 2019. This implies that the severity of the pandemic was a large reason behind the drop in exports. This is not surprising as there were zero cases in 2019 and the trade disruptions have been widely documented. What is interesting is that our difference-in-difference results, the main focus of this paper, remain largely unchanged. Processing exports, relative to non-processing exports, decrease more early on in the pandemic (more prolonged for the US than for Japan) and the differences largely disappear by 2021.

On the import side, we find that adding COVID cases plays a limited role in trade. This is inline with our results as imports are impacted less than exports by COVID-19. Interestingly, the association between imports and COVID cases in China is positive; that is, imports increase with higher COVID cases in China. The imports recovery observed in Japan in 2021 disappears, meaning that the recovery observed in the baseline estimates might be due to changes in the severity of the cases. As with our baseline estimates, the difference-in-difference estimates for US imports are largely not statistically significant, and for Japan imports difference-in-difference estimates continue to be negative and statistically significant (particularly for intermediate goods).

Changing the dependent variable

We can also use a different measurement of our dependent variable to test if our estimates are robust to changes in this measurement. Trade values are affected by price levels, and we use one that is not: net weight in kilograms, transformed using inverse hyperbolic sine. If the net weight estimates follow trade value estimates, we can safely exclude price changes as the driver behind our results.¹⁰ The estimates for net weight as the dependent variable are similar to those of trade values. For trade with Japan (Appendix Table A.10), the net weight of non-processing imports recover fairly quickly after COVID, but non-processing exports experience no recovery. Processing goods do worse, especially on the import side, where the effects are prolonged. For exports, there are almost no differences between processing and non-processing goods after the initial shock in which processing goods do worse. For trade with the US (Appendix Table A.11), the estimates for non-processing goods are largely the same, but not for processing goods. The key difference for processing goods is that the drop for imports only shows up in the second half of 2020 and in 2021. On the export side, there is actually a relative improvement for processing goods, led mainly by consumption goods.

¹⁰ We put net weight in the robustness checks, and not in the baseline estimates, because this variable is more prone to measurement error. For example, 65 thousand product-country pairs, or a bit under 20% of our observations, have zero net weight during the observed periods. This is not possible and thus indicative of measurement error.

Another measurement of the trade impact is to use a ratio rather than the trade value. As discussed in Section 3, 2019 may not have had normal trade activity due to the China-US Trade war, and thus the month fixed effects do not control for regular month business cycles. We normalize the trade value using the ratio of the trade value to the average trade value between 2016–2018; this would control for additional monthly trends in “normal” time. This robustness check also reinforces our findings. For trade with Japan (Appendix Table A.12), non-processing exports are again negatively affected, but not imports. Imported processing products, as in the baseline estimates, drop in all periods, but these are now mainly due to intermediate goods. While exports are negatively affected (especially intermediate goods), whether or not the products are processing goods has no bearing on the outcome after the first quarter. For trade with the US (Appendix Table A.13), non-processing exports are affected, but not non-processing imports. While there is no drop for imports from the US, there is also no improvement over the 2019 import values; and, as before, the effects do not depend on the processing category of the product. Exports experienced a large decrease in value and the drop was even larger for processing goods. For these, the drop appears to come from consumption goods; these estimates are negative, and most are statistically significant.

5. Conclusion

Countries continue to grapple with economic disruptions more than two years after COVID-19 was first detected. While COVID has affected daily life and has led to millions of deaths, it has also disrupted commerce on a global level. The disruption has had widespread effects on global supply chains, ultimately leading to high levels of price fluctuation, product shortages, and transportation issues.

In this paper, we examine how the COVID outbreak affected Chinese bilateral trade with the US and Japan. Our analysis focuses on processing trade, which includes both imported inputs and the exports that use those inputs. As explained in Section 2.2, we expect that processing trade will experience greater decreases and slower recoveries than goods produced with short supply chains. Additionally, processing products in the middle of the supply chain are likely to decrease more. We also expect that imports should be affected more as processing imports are more likely to be in the middle of the supply chain than processing exports. Lastly, we expect the effect to be stronger early in the pandemic and dissipate as governments reopened business and supply chains adjust to the shocks.

Our main contribution is our documentation of the trajectory of the global shock on China’s bilateral trade, and our examination of whether the use of processing trade has made China’s economy more susceptible to global crises. Our key finding is that while COVID-19 has disrupted trade on many levels, processing goods were particularly susceptible to the shock. We conclude with strong empirical evidence that COVID has severely disrupted global supply chains and has affected the very products that drove China’s tremendous trade growth since joining the WTO. While global supply chains may help hedge against country-specific shocks, we provide empirical evidence to show that they are also more affected by global shocks. Thus, in addition to changing our daily lives, COVID may lead to a change in the trends of greater fragmentation of the production process and ever expanding global supply chains that have developed in recent history.

A second key finding is that non-processing exports, whether the exports are destined for the United States or for Japan, experienced a greater shock than non-processing imports. This may partially be a result of China’s strict zero-COVID policy. At the bilateral trade level, we find that processing imports from Japan, especially intermediate goods, were most affected by the shock. This demonstrates that China is still heavily reliant on Japanese inputs for its processing exports. As processing exports for China dropped, so did the need for the imported inputs needed for these products. Lastly, we find that while Chinese bilateral-trade recovered from its substantial drop in early 2020, it has, for the most part, yet to surpass 2019 levels. Ultimately, this means that the full recovery from COVID is really yet to take place.

Our findings point to implications beyond China’s trade and production. First, the shock is likely to result in a shortening of supply chains to hedge against global shocks. Second, given China’s zero-COVID policy, firms are likely to second guess relying on China as an integral part of production. These will not only change firm decisions, but will also affect government policies that influence global supply chains. Additionally, these shocks will open up opportunities for other countries to attract foreign direct investment, and to increase value-added within a shortening supply chain. Countries that prepare for that eventuality are likely to benefit the most from these changes.

Our work can be expanded in several ways. The first is to expand the number of countries in our dataset. A limitation of our work is that we only have access to bilateral Chinese trade data from the US and Japan. Once more countries provide monthly data, we may get a clearer picture of how supply chains are, more generally, affected. A second way to expand this work is to explore how firms behaved during the pandemic; this would help us understand the precise mechanism behind our findings. Thus, a firm-level study using customs data from China during the pandemic, something that is currently unavailable, would be an ideal extension of this work.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

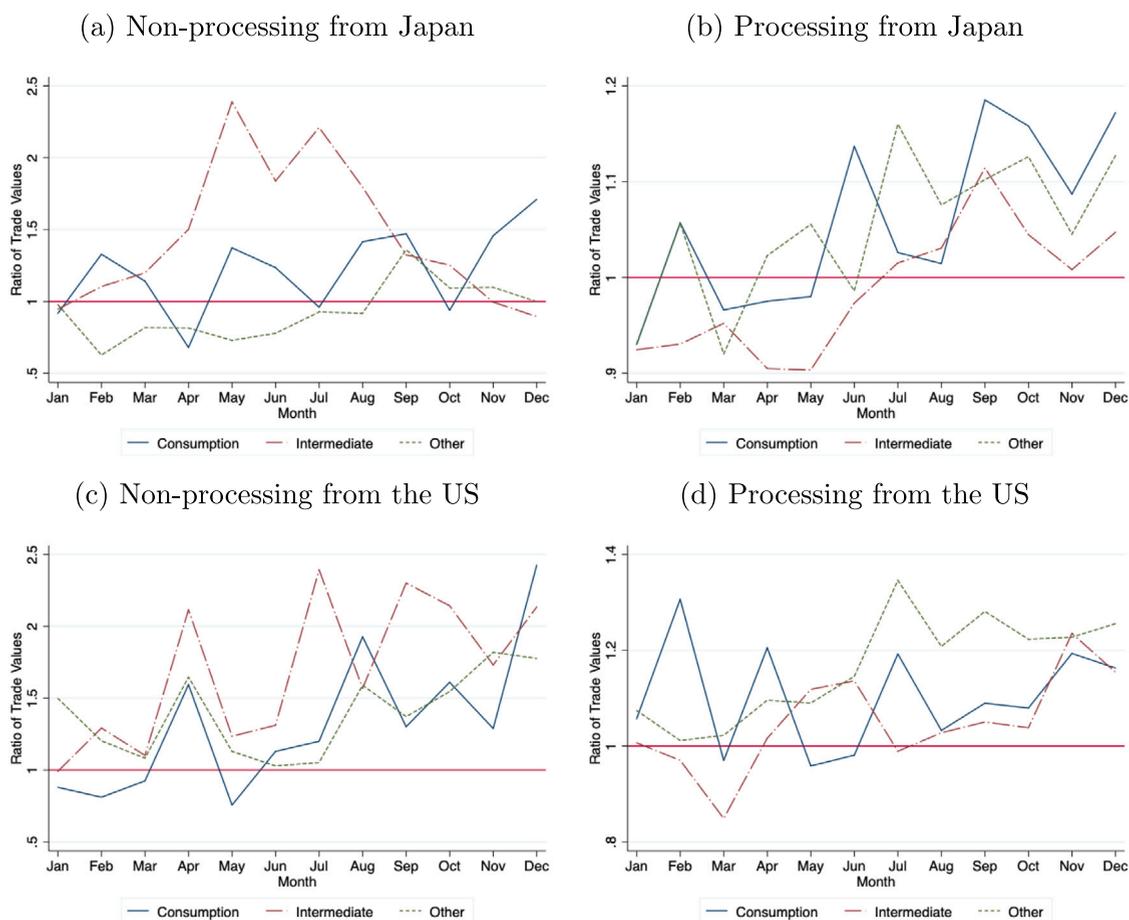


Fig. A.1. COVID-19 and China's Imports (Ratio 2020 : 2019)

Note: These are created using mirrored data from Japan and the US. *Other* includes capital and raw materials. *Processing* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007.

Source: UN Comtrade and Chinese Customs data.

Appendix. Figures and tables

See Fig. A.1 and Tables A.1–A.13.

Table A.1
China's annual data: Imports.

Partner	Classification	Process.	Value (mn, USD)		Share of Imp.		2000 vs. 2018	
			2000	2018	2000	2018	Val. (%Δ)	Share (Δ)
Japan	Capital	No	1425	9934	5.7	7.8	597.1	2.1
		Yes	10,580	64,070	42.6	50.5	505.6	7.9
	Consumption	No	111	1510	0.4	1.2	1,262.8	0.7
		Yes	2569	17,740	10.3	14.0	590.5	3.6
	Intermediate	No	240	1011	1.0	0.8	321.4	-0.2
		Yes	9705	30,780	39.1	24.3	217.2	-14.8
	Raw	No	52	173	0.2	0.1	231.9	-0.1
		Yes	145	1583	0.6	1.2	990.2	0.7

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Table A.1 (continued).

Partner	Classification	Process.	Value (mn, USD)		Share of Imp.		2000 vs. 2018	
			2000	2018	2000	2018	Val. (%Δ)	Share (Δ)
USA	Capital	No	2039	1943	16.4	2.5	-4.7	-13.8
		Yes	4438	22,800	35.6	29.9	413.7	-5.8
	Consumption	No	171	9434	1.4	12.4	5,404.1	11.0
		Yes	854	9814	6.9	12.9	1,048.8	6.0
	Intermediate	No	183	3057	1.5	4.0	1,566.8	2.5
		Yes	2843	17,430	22.8	22.9	513.1	0.0
	Raw	No	114	2163	0.9	2.8	1,804.0	1.9
		Yes	1808	9632	14.5	12.6	432.7	-1.9

Note: Authors' calculations using UN Comtrade data. *Process.* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007.

Table A.2

Processing = 1 if share >50%:Trade with Japan.

Dep. Var. ⇒	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q1}	-0.09*** (0.02)	-0.05* (0.03)	-0.05 (0.03)	-0.18*** (0.03)	-0.23*** (0.01)	-0.29*** (0.02)	-0.17*** (0.02)	-0.25*** (0.03)
Y20 _{Q2}	0.00 (0.02)	0.09*** (0.03)	-0.01 (0.03)	-0.09*** (0.03)	-0.07*** (0.01)	-0.06*** (0.02)	-0.08*** (0.02)	-0.07*** (0.03)
Y20 _{Q3,4}	0.05*** (0.02)	0.14*** (0.03)	0.04 (0.03)	-0.03 (0.03)	-0.17*** (0.01)	-0.14*** (0.02)	-0.22*** (0.02)	-0.15*** (0.03)
Y21	0.19*** (0.02)	0.34*** (0.03)	0.20*** (0.03)	0.01 (0.03)	-0.00 (0.01)	-0.05*** (0.02)	0.03* (0.02)	-0.00 (0.03)
Y20 _{Q1} *Processing	-0.05* (0.02)	-0.04 (0.05)	-0.11*** (0.04)	0.14*** (0.05)	-0.04* (0.02)	-0.04 (0.03)	-0.07* (0.04)	0.02 (0.04)
Y20 _{Q2} *Processing	-0.12*** (0.03)	-0.10** (0.05)	-0.16*** (0.04)	0.00 (0.05)	-0.01 (0.02)	-0.02 (0.04)	-0.04 (0.04)	0.04 (0.04)
Y20 _{Q3,4} *Processing	-0.09*** (0.03)	-0.10** (0.05)	-0.14*** (0.04)	0.12** (0.05)	0.04** (0.02)	0.05* (0.03)	-0.05 (0.04)	0.07* (0.04)
Y21*Processing	-0.13*** (0.03)	-0.13** (0.05)	-0.21*** (0.04)	0.10* (0.06)	0.01 (0.02)	0.01 (0.03)	-0.02 (0.04)	0.06 (0.04)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	89,351	28,105	39,514	21,732	101,594	37,540	38,553	25,501
Clusters	3548	1164	1524	860	3576	1229	1448	899
Adj. R ²	0.032	0.053	0.032	0.027	0.040	0.054	0.040	0.037

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals one if (processing trade value in 2007)/(total trade value in 2007) > .5. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Othr* are Capital and Raw goods. \sinh^{-1} stands for inverse hyperbolic sine.

Table A.3

Processing = 1 if share >50%: Trade with The US.

Dep. Var. ⇒	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q1}	-0.16*** (0.02)	-0.15*** (0.03)	-0.16*** (0.03)	-0.18*** (0.03)	-0.35*** (0.01)	-0.40*** (0.02)	-0.31*** (0.02)	-0.33*** (0.03)
Y20 _{Q2}	-0.10*** (0.02)	-0.18*** (0.04)	-0.01 (0.04)	-0.09*** (0.03)	-0.24*** (0.02)	-0.32*** (0.02)	-0.18*** (0.03)	-0.23*** (0.03)
Y20 _{Q3,4}	-0.02 (0.02)	-0.04 (0.03)	0.01 (0.03)	-0.04 (0.03)	-0.16*** (0.01)	-0.11*** (0.02)	-0.23*** (0.02)	-0.10*** (0.03)
Y21	0.03 (0.02)	0.01 (0.03)	0.06* (0.03)	0.01 (0.03)	-0.02* (0.01)	-0.03* (0.02)	-0.06*** (0.02)	0.06** (0.03)

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Table A.3 (continued).

Dep. Var. \Rightarrow	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Y20_{Q1}$ *Processing	0.07** (0.03)	0.09 (0.07)	0.02 (0.05)	0.14* (0.07)	-0.03 (0.02)	0.02 (0.04)	-0.11* (0.06)	-0.01 (0.04)
$Y20_{Q2}$ *Processing	-0.06 (0.04)	0.06 (0.07)	-0.19*** (0.06)	0.04 (0.08)	-0.01 (0.03)	0.07 (0.05)	-0.15** (0.06)	0.05 (0.05)
$Y20_{Q3,4}$ *Processing	-0.06* (0.03)	-0.07 (0.05)	-0.09* (0.05)	0.02 (0.07)	0.04 (0.03)	0.01 (0.04)	-0.02 (0.06)	0.06 (0.05)
$Y21$ *Processing	-0.00 (0.03)	-0.02 (0.06)	-0.03 (0.06)	0.04 (0.07)	-0.00 (0.03)	0.02 (0.04)	0.01 (0.06)	-0.07* (0.04)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	81,938	26,712	31,461	23,765	106,604	39,715	39,472	27,417
Clusters	3610	1177	1465	968	3646	1246	1484	916
Adj. R^2	0.008	0.010	0.008	0.010	0.037	0.088	0.024	0.032

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals one if (processing trade value in 2007)/(total trade value in 2007) > .5. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Other* are Capital and Raw goods. \sinh^{-1} stands for inverse hyperbolic sine.

Table A.4

Processing = \sinh^{-1} (processing): Trade with Japan.

Dep. Var. \Rightarrow	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Y20_{Q1}$	-0.06* (0.03)	-0.00 (0.05)	0.11 (0.08)	-0.23*** (0.06)	-0.14*** (0.02)	-0.16*** (0.05)	-0.11*** (0.03)	-0.21*** (0.04)
$Y20_{Q2}$	0.10*** (0.04)	0.20*** (0.05)	0.29*** (0.11)	-0.14** (0.06)	-0.04 (0.02)	0.04 (0.05)	-0.09*** (0.03)	-0.02 (0.05)
$Y20_{Q3,4}$	0.10*** (0.04)	0.20*** (0.05)	0.15 (0.11)	-0.07 (0.05)	-0.19*** (0.02)	-0.08* (0.04)	-0.23*** (0.03)	-0.15*** (0.05)
$Y21$	0.23*** (0.03)	0.43*** (0.04)	0.22** (0.09)	-0.05 (0.06)	0.03 (0.02)	0.02 (0.04)	0.05 (0.03)	-0.02 (0.05)
$Y20_{Q1}$ *Processing	-0.00 (0.00)	-0.01* (0.00)	-0.02*** (0.01)	0.01* (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.00 (0.00)
$Y20_{Q2}$ *Processing	-0.01*** (0.00)	-0.01*** (0.00)	-0.03*** (0.01)	0.00 (0.00)	-0.00* (0.00)	-0.01** (0.00)	0.00 (0.00)	-0.00 (0.00)
$Y20_{Q3,4}$ *Processing	-0.01*** (0.00)	-0.01** (0.00)	-0.01* (0.01)	0.01 (0.00)	0.00** (0.00)	-0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)
$Y21$ *Processing	-0.01*** (0.00)	-0.01*** (0.00)	-0.01 (0.01)	0.01* (0.00)	-0.00* (0.00)	-0.00* (0.00)	-0.00 (0.00)	0.00 (0.00)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	89,351	28,105	39,514	21,732	101,594	37,540	38,553	25,501
Clusters	3548	1164	1524	860	3576	1229	1448	899
Adj. R^2	0.032	0.054	0.031	0.027	0.040	0.054	0.040	0.037

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals \sinh^{-1} (processing value in 2007) and is at the partner country-product level. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Other* are Capital and Raw goods. \sinh^{-1} stands for inverse hyperbolic sine.

Table A.5

Processing = \sinh^{-1} (processing): Trade with The US.

Dep. Var. \Rightarrow	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Y20_{Q1}$	-0.22*** (0.03)	-0.21*** (0.05)	-0.18*** (0.06)	-0.26*** (0.06)	-0.29*** (0.02)	-0.31*** (0.05)	-0.27*** (0.03)	-0.34*** (0.04)
$Y20_{Q2}$	-0.13*** (0.04)	-0.21*** (0.06)	-0.01 (0.07)	-0.12* (0.06)	-0.16*** (0.02)	-0.09 (0.06)	-0.18*** (0.03)	-0.27*** (0.05)
$Y20_{Q3,4}$	-0.03 (0.03)	-0.01 (0.05)	-0.02 (0.07)	-0.08 (0.06)	-0.20*** (0.02)	-0.07 (0.06)	-0.22*** (0.03)	-0.16*** (0.04)

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Table A.5 (continued).

Dep. Var. ⇒	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y21	0.03 (0.03)	0.03 (0.05)	0.05 (0.07)	0.02 (0.07)	-0.02 (0.02)	0.06 (0.05)	-0.09*** (0.03)	0.05 (0.04)
Y20 _{Q1} *Processing	0.01*** (0.00)	0.01** (0.00)	0.00 (0.00)	0.01** (0.00)	-0.01*** (0.00)	-0.01** (0.00)	-0.01** (0.00)	0.00 (0.00)
Y20 _{Q2} *Processing	0.00 (0.00)	0.00 (0.00)	-0.01 (0.01)	0.00 (0.00)	-0.01*** (0.00)	-0.02*** (0.00)	-0.00 (0.00)	0.00 (0.00)
Y20 _{Q3,4} *Processing	-0.00 (0.00)	-0.01 (0.00)	0.00 (0.01)	0.00 (0.00)	0.00*** (0.00)	-0.00 (0.00)	-0.00 (0.00)	0.01** (0.00)
Y21*Processing	-0.00 (0.00)	-0.00 (0.00)	0.00 (0.01)	-0.00 (0.01)	-0.00 (0.00)	-0.01* (0.00)	0.00 (0.00)	-0.00 (0.00)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	81,938	26,712	31,461	23,765	106,604	39,715	39,472	27,417
Clusters	3610	1177	1465	968	3646	1246	1484	916
Adj. R ²	0.008	0.010	0.007	0.010	0.038	0.090	0.024	0.032

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals \sinh^{-1} (processing value in 2007) and is at the partner country-product level. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Other* are Capital and Raw goods. \sinh^{-1} stands for inverse hyperbolic sine.

Table A.6

Processing = Share of processing value: Trade with Japan.

Dep. Var. ⇒	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q1}	-0.07*** (0.02)	-0.04 (0.03)	-0.01 (0.04)	-0.20*** (0.04)	-0.22*** (0.01)	-0.28*** (0.02)	-0.16*** (0.02)	-0.25*** (0.03)
Y20 _{Q2}	0.03 (0.02)	0.12*** (0.04)	0.06 (0.04)	-0.10** (0.04)	-0.06*** (0.02)	-0.06** (0.03)	-0.08*** (0.03)	-0.06 (0.03)
Y20 _{Q3,4}	0.08*** (0.02)	0.18*** (0.03)	0.09** (0.04)	-0.05 (0.03)	-0.19*** (0.01)	-0.16*** (0.02)	-0.22*** (0.02)	-0.15*** (0.03)
Y21	0.23*** (0.02)	0.38*** (0.03)	0.29*** (0.04)	-0.01 (0.03)	-0.01 (0.01)	-0.07*** (0.02)	0.03 (0.02)	-0.01 (0.03)
Y20 _{Q1} *Processing	-0.08** (0.04)	-0.07 (0.06)	-0.19*** (0.06)	0.21*** (0.07)	-0.07** (0.03)	-0.07 (0.05)	-0.10* (0.05)	0.02 (0.05)
Y20 _{Q2} *Processing	-0.20*** (0.04)	-0.20*** (0.07)	-0.29*** (0.06)	0.04 (0.08)	-0.02 (0.03)	-0.03 (0.05)	-0.03 (0.06)	0.01 (0.06)
Y20 _{Q3,4} *Processing	-0.16*** (0.04)	-0.22*** (0.07)	-0.24*** (0.06)	0.19** (0.08)	0.08*** (0.03)	0.12*** (0.05)	-0.04 (0.05)	0.08 (0.05)
Y21*Processing	-0.22*** (0.04)	-0.26*** (0.07)	-0.37*** (0.06)	0.18** (0.08)	0.02 (0.03)	0.06 (0.05)	-0.01 (0.06)	0.07 (0.06)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	89,351	28,105	39,514	21,732	101,594	37,540	38,553	25,501
Clusters	3548	1164	1524	860	3576	1229	1448	899
Adj. R ²	0.033	0.054	0.033	0.027	0.040	0.054	0.040	0.037

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals (processing trade value in 2007)/(total trade value in 2007) and is at the partner country-product level. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Other* are Capital and Raw goods. \sinh^{-1} stands for inverse hyperbolic sine.

Table A.7

Processing = Share of processing value: Trade with the US.

Dep. Var. ⇒	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q1}	-0.18*** (0.02)	-0.19*** (0.04)	-0.14*** (0.04)	-0.20*** (0.04)	-0.33*** (0.02)	-0.39*** (0.02)	-0.30*** (0.03)	-0.32*** (0.03)
Y20 _{Q2}	-0.08*** (0.02)	-0.20*** (0.04)	0.04 (0.04)	-0.09** (0.04)	-0.22*** (0.02)	-0.30*** (0.03)	-0.17*** (0.03)	-0.25*** (0.03)

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Table A.7 (continued).

Dep. Var. ⇒	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q3,4}	-0.01 (0.02)	-0.04 (0.03)	0.03 (0.04)	-0.04 (0.04)	-0.17*** (0.02)	-0.11*** (0.03)	-0.23*** (0.03)	-0.13*** (0.03)
Y21	0.03 (0.02)	0.00 (0.04)	0.08* (0.04)	0.01 (0.04)	-0.02 (0.02)	-0.02 (0.03)	-0.07*** (0.03)	0.07** (0.03)
Y20 _{Q1} *Processing	0.12** (0.05)	0.23** (0.09)	-0.02 (0.07)	0.20** (0.10)	-0.09** (0.04)	-0.02 (0.06)	-0.16** (0.08)	-0.03 (0.06)
Y20 _{Q2} *Processing	-0.10* (0.05)	0.11 (0.09)	-0.33*** (0.09)	-0.00 (0.11)	-0.09** (0.04)	-0.03 (0.08)	-0.20** (0.08)	0.09 (0.07)
Y20 _{Q3,4} *Processing	-0.09* (0.05)	-0.08 (0.08)	-0.15* (0.08)	-0.00 (0.10)	0.09** (0.04)	-0.01 (0.07)	-0.03 (0.09)	0.13* (0.07)
Y21*Processing	0.00 (0.05)	0.03 (0.08)	-0.06 (0.08)	0.02 (0.10)	-0.00 (0.04)	-0.03 (0.07)	0.06 (0.09)	-0.09 (0.06)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	81,938	26,712	31,461	23,765	106,604	39,715	39,472	27,417
Clusters	3610	1177	1465	968	3646	1246	1484	916
Adj. R ²	0.008	0.010	0.008	0.010	0.037	0.088	0.024	0.033

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals (processing trade value in 2007)/(total trade value in 2007) and is at the partner country-product level. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Othr* are Capital and Raw goods. \sinh^{-1} stands for inverse hyperbolic sine.

Table A.8

Controlling for COVID Cases: Japan only.

Dep. Var. ⇒	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q1}	-0.34*** (0.06)	-0.48*** (0.09)	-0.03 (0.13)	-0.42*** (0.12)	0.70*** (0.04)	0.94*** (0.07)	0.52*** (0.07)	0.58*** (0.09)
Y20 _{Q2}	-0.21*** (0.06)	-0.27*** (0.09)	0.08 (0.17)	-0.30*** (0.10)	0.48*** (0.04)	0.76*** (0.07)	0.22*** (0.06)	0.50*** (0.09)
Y20 _{Q3,4}	-0.24*** (0.06)	-0.37*** (0.10)	0.01 (0.17)	-0.21* (0.12)	0.44*** (0.04)	0.88*** (0.07)	0.15** (0.07)	0.45*** (0.10)
Y21	-0.16** (0.06)	-0.22** (0.10)	-0.03 (0.15)	-0.21 (0.13)	0.67*** (0.05)	0.96*** (0.07)	0.42*** (0.08)	0.62*** (0.10)
Y20 _{Q1} *Processing	-0.06 (0.04)	-0.07 (0.05)	-0.31*** (0.11)	0.07 (0.07)	-0.13*** (0.02)	-0.18*** (0.05)	-0.10*** (0.04)	-0.06 (0.05)
Y20 _{Q2} *Processing	-0.13*** (0.05)	-0.15** (0.06)	-0.44*** (0.16)	0.07 (0.07)	-0.03 (0.03)	-0.08 (0.05)	0.03 (0.04)	-0.06 (0.06)
Y20 _{Q3,4} *Processing	-0.10** (0.04)	-0.06 (0.06)	-0.36** (0.16)	0.03 (0.07)	0.03 (0.03)	-0.13** (0.05)	0.01 (0.04)	0.05 (0.05)
Y21*Processing	-0.07* (0.04)	-0.06 (0.06)	-0.20 (0.13)	0.05 (0.07)	-0.04* (0.03)	-0.09** (0.05)	-0.03 (0.04)	0.04 (0.05)
\sinh^{-1} (Own Cases)	0.02*** (0.00)	0.03*** (0.01)	0.02*** (0.01)	0.00 (0.01)	0.01** (0.00)	-0.01 (0.00)	0.02*** (0.00)	0.00 (0.01)
\sinh^{-1} (China Cases)	0.02*** (0.00)	0.03*** (0.01)	0.01 (0.01)	0.02* (0.01)	-0.09*** (0.00)	-0.10*** (0.00)	-0.08*** (0.01)	-0.08*** (0.01)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	89,351	28,105	39,514	21,732	101,594	37,540	38,553	25,501
Clusters	3548	1164	1524	860	3576	1229	1448	899
Adj. R ²	0.032	0.054	0.031	0.026	0.044	0.062	0.043	0.040

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Othr* are Capital and Raw goods. \sinh^{-1} stands for inverse hyperbolic sine.

Table A.9
Controlling for COVID Cases: The US Only.

Dep. Var. ⇒	\sinh^{-1} (Imports)				\sinh^{-1} (Exports)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Y20_{Q1}$	-0.37*** (0.07)	-0.27** (0.12)	-0.28** (0.13)	-0.55*** (0.13)	0.17*** (0.05)	0.37*** (0.07)	0.04 (0.09)	0.01 (0.09)
$Y20_{Q2}$	-0.16** (0.08)	-0.17 (0.13)	0.03 (0.13)	-0.33** (0.13)	0.64*** (0.05)	0.93*** (0.09)	0.47*** (0.09)	0.46*** (0.10)
$Y20_{Q3,4}$	-0.09 (0.08)	0.01 (0.13)	0.00 (0.14)	-0.32** (0.15)	0.63*** (0.05)	0.96*** (0.09)	0.44*** (0.10)	0.58*** (0.10)
$Y21$	-0.04 (0.08)	0.05 (0.13)	0.05 (0.14)	-0.25* (0.15)	0.81*** (0.05)	1.11*** (0.08)	0.59*** (0.10)	0.79*** (0.10)
$Y20_{Q1}$ *Processing	0.08* (0.04)	0.09 (0.06)	-0.01 (0.07)	0.11 (0.07)	-0.09*** (0.03)	-0.11** (0.05)	-0.08** (0.04)	0.02 (0.05)
$Y20_{Q2}$ *Processing	-0.00 (0.04)	0.03 (0.07)	-0.11 (0.08)	0.01 (0.07)	-0.12*** (0.03)	-0.27*** (0.07)	-0.05 (0.04)	0.05 (0.05)
$Y20_{Q3,4}$ *Processing	-0.04 (0.04)	-0.09 (0.06)	-0.02 (0.08)	0.01 (0.07)	0.08*** (0.03)	-0.01 (0.07)	-0.00 (0.04)	0.11** (0.05)
$Y21$ *Processing	-0.02 (0.04)	-0.05 (0.06)	-0.00 (0.08)	-0.02 (0.08)	0.01 (0.03)	-0.06 (0.06)	0.05 (0.04)	-0.01 (0.05)
\sinh^{-1} (Own Cases)	-0.01* (0.00)	-0.01 (0.00)	-0.01** (0.00)	0.00 (0.01)	-0.05*** (0.00)	-0.05*** (0.00)	-0.04*** (0.00)	-0.05*** (0.00)
\sinh^{-1} (China Cases)	0.02*** (0.01)	0.01 (0.01)	0.02** (0.01)	0.03*** (0.01)	-0.01*** (0.00)	-0.03*** (0.00)	-0.00 (0.01)	-0.00 (0.01)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	81,938	26,712	31,461	23,765	106,604	39,715	39,472	27,417
Clusters	3610	1177	1465	968	3646	1246	1484	916
Adj. R^2	0.009	0.010	0.008	0.010	0.042	0.097	0.027	0.037

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Other* are Capital and Raw goods. \sinh^{-1} stands for inverse hyperbolic sine.

Table A.10
Net Weight: Trade with Japan.

Dep. Var. ⇒	Net Weight: Imports				Net Weight: Exports			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Y20_{Q1}$	-0.08 (0.05)	-0.05 (0.07)	0.30* (0.16)	-0.27*** (0.07)	-0.13*** (0.03)	-0.16** (0.07)	-0.12*** (0.04)	-0.14** (0.06)
$Y20_{Q2}$	0.04 (0.05)	0.14** (0.07)	0.40** (0.20)	-0.21*** (0.08)	-0.00 (0.03)	0.04 (0.06)	-0.07* (0.04)	0.06 (0.06)
$Y20_{Q3,4}$	0.09* (0.05)	0.15** (0.06)	0.45** (0.19)	-0.10 (0.07)	-0.17*** (0.03)	0.02 (0.06)	-0.21*** (0.03)	-0.17*** (0.05)
$Y21$	0.16*** (0.05)	0.29*** (0.06)	0.38** (0.15)	-0.08 (0.07)	-0.02 (0.03)	-0.01 (0.05)	-0.02 (0.04)	-0.04 (0.05)
$Y20_{Q1}$ *Processing	-0.07 (0.05)	-0.04 (0.07)	-0.46*** (0.16)	0.10 (0.08)	-0.17*** (0.03)	-0.19*** (0.07)	-0.12*** (0.04)	-0.16*** (0.06)
$Y20_{Q2}$ *Processing	-0.12** (0.06)	-0.14* (0.08)	-0.52** (0.20)	0.11 (0.08)	-0.05 (0.03)	-0.10 (0.06)	0.03 (0.05)	-0.11* (0.07)
$Y20_{Q3,4}$ *Processing	-0.12** (0.05)	-0.10 (0.07)	-0.51*** (0.19)	0.03 (0.08)	0.03 (0.03)	-0.14** (0.06)	0.00 (0.04)	0.07 (0.06)
$Y21$ *Processing	-0.09* (0.05)	-0.08 (0.07)	-0.35** (0.16)	0.05 (0.08)	-0.02 (0.03)	-0.06 (0.06)	-0.02 (0.04)	0.04 (0.06)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	88,186	27,591	39,334	21,261	100,398	37,024	38,323	25,051
Clusters	3507	1145	1516	846	3551	1219	1443	889
Adj. R^2	0.021	0.029	0.022	0.020	0.031	0.047	0.026	0.030

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Other* are Capital and Raw goods. Net Weight is in kilos and is logged (meaning, zero values are dropped).

Table A.11
Net Weight: Trade with The US.

Dep. Var. ⇒	Net Weight: Imports				Net Weight: Exports			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q1}	-0.30*** (0.08)	-0.38*** (0.12)	-0.28** (0.12)	-0.26 (0.20)	-0.32*** (0.04)	-0.39*** (0.08)	-0.35*** (0.05)	-0.26*** (0.09)
Y20 _{Q2}	-0.21*** (0.07)	-0.24** (0.11)	-0.20* (0.11)	-0.13 (0.13)	-0.13*** (0.04)	-0.11 (0.08)	-0.15*** (0.05)	-0.21** (0.09)
Y20 _{Q3,4}	-0.04 (0.06)	0.10 (0.09)	-0.20* (0.11)	-0.07 (0.11)	-0.17*** (0.03)	-0.04 (0.08)	-0.19*** (0.04)	-0.15** (0.06)
Y21	-0.07 (0.06)	0.07 (0.09)	-0.18* (0.10)	-0.11 (0.11)	-0.08*** (0.03)	0.01 (0.07)	-0.16*** (0.04)	0.02 (0.06)
Y20 _{Q1} *Processing	0.05 (0.09)	0.15 (0.13)	-0.02 (0.13)	0.14 (0.22)	0.00 (0.04)	0.10 (0.08)	-0.07 (0.06)	0.14 (0.10)
Y20 _{Q2} *Processing	-0.01 (0.07)	-0.00 (0.12)	0.00 (0.12)	-0.12 (0.15)	-0.01 (0.04)	-0.02 (0.09)	-0.00 (0.06)	0.13 (0.10)
Y20 _{Q3,4} *Processing	-0.12* (0.07)	-0.27*** (0.10)	0.04 (0.12)	-0.08 (0.13)	0.20*** (0.04)	0.19** (0.08)	0.01 (0.06)	0.17** (0.07)
Y21*Processing	-0.09 (0.07)	-0.21** (0.10)	0.02 (0.11)	-0.07 (0.13)	0.16*** (0.04)	0.15* (0.08)	0.09* (0.05)	0.09 (0.07)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	53,714	17,296	26,047	10,371	91,116	34,188	37,269	19,659
Clusters	3184	1058	1402	724	3438	1186	1453	799
Adj. R ²	0.006	0.008	0.006	0.005	0.017	0.058	0.015	0.009

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Othr* are Capital and Raw goods. Net Weight is in kilos and is logged (meaning, zero values are dropped).

Table A.12
Ratio with Base 16–18: Trade with Japan.

Dep. Var. ⇒	Imports/(Base 16–18)				Exports/(Base 16–18)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q1}	-0.00 (0.03)	0.04 (0.05)	0.11 (0.11)	-0.10** (0.04)	-0.07*** (0.02)	-0.06 (0.04)	-0.07*** (0.02)	-0.10*** (0.03)
Y20 _{Q2}	0.14*** (0.04)	0.24*** (0.05)	0.40*** (0.15)	-0.08** (0.04)	-0.04* (0.02)	-0.01 (0.05)	-0.06** (0.02)	-0.00 (0.04)
Y20 _{Q3,4}	0.13*** (0.03)	0.13*** (0.04)	0.36** (0.15)	0.05 (0.04)	-0.09*** (0.02)	0.01 (0.04)	-0.13*** (0.02)	-0.05 (0.03)
Y21	0.24*** (0.03)	0.35*** (0.05)	0.33*** (0.12)	0.08** (0.04)	0.06*** (0.02)	0.04 (0.03)	0.06*** (0.02)	0.04 (0.03)
Y20 _{Q1} *Processing	-0.05 (0.03)	-0.07 (0.05)	-0.17 (0.11)	0.04 (0.05)	-0.06*** (0.02)	-0.09** (0.04)	-0.03 (0.03)	-0.01 (0.03)
Y20 _{Q2} *Processing	-0.14*** (0.04)	-0.18*** (0.06)	-0.44*** (0.15)	0.07* (0.04)	0.01 (0.02)	-0.02 (0.05)	0.03 (0.03)	-0.02 (0.04)
Y20 _{Q3,4} *Processing	-0.09** (0.04)	-0.02 (0.05)	-0.37** (0.15)	-0.01 (0.04)	0.02 (0.02)	-0.06 (0.04)	0.02 (0.03)	0.01 (0.04)
Y21*Processing	-0.10*** (0.03)	-0.08 (0.05)	-0.23** (0.12)	-0.01 (0.04)	-0.03* (0.02)	-0.05 (0.03)	-0.01 (0.03)	0.00 (0.04)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	85,931	26,542	38,257	21,132	99,267	37,042	37,358	24,867
Clusters	3277	1069	1427	781	3418	1197	1355	866
Adj. R ²	0.013	0.034	0.011	0.005	0.015	0.021	0.017	0.013

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Othr* are Capital and Raw goods. *Base 16–18* is the average of monthly values from 2016–2018.

Table A.13

Ratio with Base 16–18: Trade with The US.

Dep. Var. ⇒	Imports/(Base 16–18)				Exports/(Base 16–18)			
	All	Cons	Inter	Othr	All	Cons	Inter	Othr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Y20 _{Q1}	−0.05*	−0.03	−0.03	−0.09**	−0.14***	−0.18***	−0.11***	−0.17***
	(−0.03)	(−0.05)	(−0.06)	(−0.04)	(0.01)	(0.03)	(0.02)	(0.03)
Y20 _{Q2}	−0.01	−0.04	0.10*	−0.05	−0.07***	−0.03	−0.07***	−0.09***
	(−0.03)	(−0.05)	(−0.06)	(−0.04)	(0.02)	(0.04)	(0.02)	(0.03)
Y20 _{Q3,4}	0.02	0.05	−0.01	−0.01	−0.07***	−0.00	−0.09***	−0.06**
	(−0.03)	(−0.04)	(−0.06)	(−0.05)	(0.01)	(0.04)	(0.02)	(0.03)
Y21	0.08***	0.09**	0.09*	0.04	0.03*	0.07*	−0.01	0.07**
	(−0.03)	(−0.04)	(−0.05)	(−0.04)	(0.01)	(0.04)	(0.02)	(0.03)
Y20 _{Q1} *Processing	0.00	0.00	−0.04	0.04	−0.05***	−0.03	−0.05**	−0.00
	(−0.03)	(−0.05)	(−0.06)	(−0.04)	(0.02)	(0.03)	(0.02)	(0.03)
Y20 _{Q2} *Processing	−0.03	−0.04	−0.13**	0.03	−0.04**	−0.12***	−0.01	0.01
	(−0.03)	(−0.05)	(−0.06)	(−0.05)	(0.02)	(0.04)	(0.03)	(0.03)
Y20 _{Q3,4} *Processing	−0.02	−0.06	0.01	0.01	0.03**	−0.03	0.03	0.06*
	(−0.03)	(−0.04)	(−0.06)	(−0.05)	(0.02)	(0.04)	(0.02)	(0.03)
Y21*Processing	−0.02	−0.06	−0.02	0.00	0.01	−0.05	0.05**	−0.01
	(−0.03)	(−0.05)	(−0.05)	(−0.05)	(0.02)	(0.04)	(0.02)	(0.03)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	78,324	25,449	29,838	23,037	105,089	39,412	38,636	27,041
Clusters	3359	1103	1335	921	3554	1226	1436	892
Adj. R ²	0.004	0.004	0.005	0.003	0.016	0.029	0.012	0.016

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust standard errors, clustered at the country-product level, are shown in parenthesis. *Processing* equals one if the product has processing potential since the product, at the partner country-product level, contained processing value in 2007. *Q* is for quarter of the year, *Con* are consumption goods, *Inter* are intermediate goods, and *Othr* are Capital and Raw goods. *Base 16–18* is the average of monthly values from 2016–2018.

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