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The Impact Of COVID-19 On the Global Value Chain in Indonesia Using a Granular Analysis Approach

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Abstract

The COVID-19 pandemic, which started in China, the center of the global supply chain, has affected the Performance of the Global Value Chain (GVC). Corporations in Indonesia depend on raw materials from China, while their multi-sourcing capabilities are still limited. This study aims to analyze the effect of the COVID-19 pandemic on the contribution of Indonesia to GVC as assessed from supply and demand in other countries. This study uses a granular analysis approach, in which the data are cut into pieces as much as possible to make them clear and more detailed. The simulation results of granular data from 46,938 corporations indicate that if China can only meet approximately 80% of the initial capacity due to COVGlobalID-19, other countries must supply the average value if they want to maintain the existing supply chain according to conditions before COVID-19. The simulation results also indicate that China's substitute countries in fulfilling domestic raw materials mostly come from ASEAN and East Asian countries because of price factors and regional proximity. Some goods whose supply chains are dominated by China have a significant decline resulting in a longer supply chain, such as woven fabrics that have to be exported to Africa and Latin America.

Keywords: COVID-19, Global Value Chain, export, import, supply shock

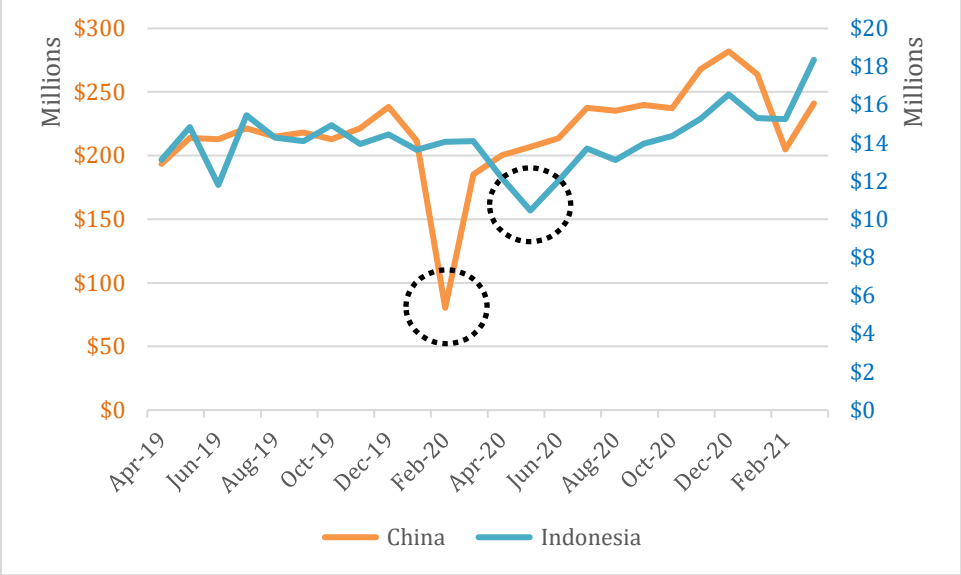
Introduction

Not a single country in the world can meet all its needs. Export and import activities will help countries meet their needs and make a country dependent on other countries for it. The value chain concept is used to analyze international trade in Global Value Chains (GVC) which includes activities to bring products from its conception, through design, sourced raw materials and intermediate inputs, marketing, distribution, and support to end consumers (Frederick, 2016). There are many indicators to assess the country's involvement in GVCare many indicators to assess a country's involvement in the GVC, including Foreign Direct Investment (FDI) which is an investment support and a decrease in exports/imports is also a proxy indicator in the Global Value Chain shock.

Currently, many countries depend on China to meet their needs. The COVID-19 pandemic is affecting various aspects of life and creating supply shocks in China that impact the supply chains of other countries. It happens because China has an essential role as a major importer of raw materials for other countries.

Chart 1 shows that the covid 19 pandemics in February 2020 has significantly decreased China's exports. Indonesia only felt the impact of the decline three months later, which is in May 2020. After that, China and Indonesia's exports generally moved hand in hand.

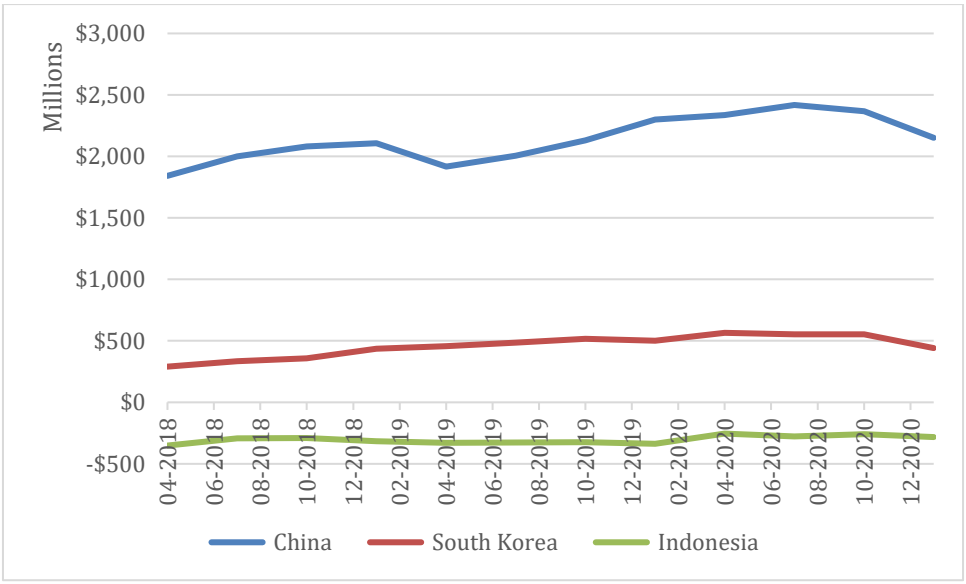
Chart 1. Comparison of Export of China and Indonesia April 2019-March 2021



Source: CEIC Database, 2021

With this pandemic, Indonesia should take advantage of its increased level of participation in GVC due to hampered economic activity, which causes some business actors to relocate their factories from affected countries, such as from China to South Korea (Hayakawa & Mukunoki, 2020). Despite this opportunity, Indonesia's FDI had negative growth in 2020.

Chart 2. Net International Investment Position of China, South Korea, and Indonesia from Mar 2011 to Dec 2020



Source: CEIC Database, 2021

Under normal conditions, the ability of a company or country to participate in GVC is strongly influenced by the quality of infrastructures, such as roads, ports, and airports. Infrastructure and the efficiency of procedures there are also important (Cusolito et al., 2016). It is instrumental in the process of shipping goods from one place to another.

Unfortunately, during the COVID-19 pandemic, this process was hampered. Each country, especially ports, should follow health protocols for safety reasons. A lengthy clearance process results in the additional operational costs of the ship. Not only onboard, but the agency's performance on the ground is also affected. The delivery process is also

affected by restrictions on working hours due to physical distancing policies and working from home (Arifin, 2020).

Disruption in the transportation sector is one of the causes of reduced demand in the import market (Dekker, 2020). The shipping industry experienced a decline in cargo volume by not only export-import cargoes but also domestic cargoes. Cargo with the destination country as China has decreased by 14%–18%. It also affects other destination countries, such as Singapore and South Korea. Meanwhile, domestic cargoes, especially cargoes that support export-import and national distribution, also declined 5%–10% (Arifin, 2020). The volume of cargo in the shipping industry and cargo volume in the aviation industry have decreased. For example, the volume of cargo at Minangkabau International Airport (BIM) decreased by 10%–20% (Hendra, 2020).

According to data released by (BPS, 2020), Indonesia's exports from March to May 2020 experienced a decline; after that, they gradually recover. Even so, cumulatively, Indonesia's export value from January to September 2020 only reached US$ 117.19 billion or decreased by 5.81% compared to that in the same period in 2019. Meanwhile, Indonesia's import value in September 2020 reached US$ 11.57 billion, or an increase of 7.71% compared to that in August 2020, but compared to September 2019, and it decreased by 18.88%.

At the beginning of the COVID-19 pandemic, there was a decline in demand for palm oil in the international market, one of Indonesia's export commodities (OECD, 2020). It was due to the decreasing demand from the hotel and food processing industries due to lockdowns. However, the demand for palm oil has gradually recovered with increasing demand from the sanitizer industry (Dekker, 2020). Meanwhile, as of September 2020, the number of Indonesian imports still had negative growth of 18.88% compared to that in the same period in 2019.

Although it has been stated that Indonesia is still very dependent on China and other countries to meet its import needs, Indonesia also needs to strengthen its contribution to the activities of GVC. This study aims to analyze the effect of the COVID-19 pandemic on the contribution of Indonesia to GVC as assessed from supply and demand to other countries.

Literature Study

1.1 GVC Definition

GVC is a phenomenon in which each country plays its respective roles as a provider of raw materials, intermediate products, and finished goods (Putri Nurdiati & Oktaviani, 2015). Some of the main characteristics of GVC are its production systems that are spread out and divided into various countries, thus creating the highest efficiency and greater profits in every part of the production system. A country's ability to join GVC is an essential aspect of development, especially for low-income countries (Gereffi & Fernandez-Stark, 2016).

Participation in the GVC is expected to increase added value in a country's goods and services industry sector. It proves that GVC has an essential role as a trading option for developing countries. Participation in GVC can create growth opportunities, positively impacting the economic development and development of a region (Sudhana, 2017). A study by the Ministry of National Development Planning / National Development Planning Agency, in cooperation with the EU–Indonesia Trade Corporation Facility (TCF), identified strategic steps that Indonesia should take to participate in GVC, namely 1) exploiting comparative advantages, 2) focusing on industries that have networks overseas, and 3) focusing on foreign markets that have potential for demand growth (Bapenas, 2016).

GVC is very close to increasing state income from the share of international trade, increasing GDP, and increasing employment (Gereffi & Fernandez-Stark, 2016). The involvement of a country in GVC is determined by three things: communication technology, logistics, and economic openness. And Indonesia is still lagging behind in these 3 things. Indonesia has limited fast internet access, making communication between countries impractical and efficient. Poor logistics performance and complicated licensing also hamper export activities (Bapenas, 2016).

1.2 Global Supply Shock

COVID-19 has not only caused a global catastrophe in terms of human deaths, but has also impacted the financial industry and activities such as manufacturing and supply chain logistics. The COVID-19 pandemic has resulted in the closure of commercial and economic activities, disruption of personal, work and home routines (for example, closing schools, working from home, social distancing, response to the retail and foodservice sectors).

Quarantines and pandemics have been shown to impact human activities and economic growth. COVID-19 affects the whole cycle from the field to the client, as seen in the food inventory network, which may be one of the economy's primary regions. Demand has declined for a few particular products, indicating a short excess supply.

Governments worldwide have implemented various steps to halt the spread of the COVID-19 pandemic, ranging from racial segregation laws to extreme lockdowns and the blocking of excessive financial movement. These actions have a variety of ramifications. Globally, because of the pandemic, GDP is expected to fall by 3% in 2020. The effect will seep into the framework, causing further misfortunes in the coming years.

1.3 Impact on Developing Countries

Due to their lower resilience to shocks, developing countries are more affected by the COVID-19 pandemic than developed countries. The COVID-19 pandemic has devastating effects on developing countries, such as poverty, hunger and malnutrition. Because of the blockade, many developing countries have registered slower economic growth.

According to a report by the International Monetary Fund (IMF), developing countries need $2.5 trillion to meet immediate COVID-19 financing requirements. Unfortunately, developing countries cannot fulfill their financial needs due to a lack of foreign investment, economic activity, and labor mobility, resulting in low GDP. Lower mobility rates are due to various factors, including national lockdown requirements and random activity and local factors, including poverty. In conclusion, people in developing countries face a double whammy due to the COVID-19 pandemic and lockdown: they either die of starvation or poverty.

In terms of economy and food security, the COVID-19 pandemic impacted almost all Asian countries. Domestic consumption in outbreak-affected Asian countries fell sharply but only temporarily. The weakening demand for other industries and economies is accelerated by a drop in tourism and business travel. There has been significant supply chain disruption. It forced business closures and employees' inability to get to work due to border closures, travel bans, and other restrictions (Joshi et al., 2021).

1.4 Price Factors

The effect of exchange rate adjustments on trade is influenced by the fact that countries trade many intermediate inputs. An appreciation not only raises the relative price of domestic goods, lowering the country's price competitiveness, but it also lowers the cost of foreign inputs used in manufacturing, improving competitiveness. While GVC weights and gross trade weights are highly correlated, their absolute differences are essential. Value-added and input-output-based trade weights deviate from standard trade weights by about 50% on average, and in some situations, the average absolute percentage deviation is also greater than 100%.

REERs (real effective exchange rates) indicate a country's international price and cost competitiveness. REERs are calculated by taking a trade-weighted average of a country's bilateral exchange rates with its most relevant trading partners and adjusting for price levels.

The GVC REERs show more significant shifts in market competition for the euro area countries that were most affected by the crisis, implying that they may have helped detect pre-crisis country vulnerabilities. GVC REERs, which could provide valuable complementary insights into competition trends, would be helpful in macroeconomic analysis.

Input-output data can be used to collect information on countries' value-added systems, and trade price data can be used to investigate the price and non-price variables that drive market share evolution.

Shifts in supply chains, price factor variation, and residual non-price factors, which can be thought of as being linked to product quality and customer preferences, can all be decomposed into changes in global value-added market shares. The decomposition is carried out at a very detailed product level, allowing for market conditions to be regulated. Also, a new concept is added into the decomposition to account for changes in global supply chains; it is measured as the weighted growth in a country's share of the output of all products produced by all countries. Finally, non-price competition is calculated as a residual term unaccounted for by the previously listed variables (European Central Bank, 2017).

1.5 Regional Proximity

Taking Asia as an example, with nearly 30% of global FDI inflows directed to developing Asia in 2013, the region is the world leader in attracting FDI. Multinational companies (MNE) as the main facilitators of globalization, their investment location decisions have a significant impact on FDI and trade flows. MNEs are increasingly being forced to choose FDI locations based on their transnational value chain configuration. Increased geographic fragmentation and the distribution of output and consumption locations are a direct result of subtle global cuts in supply chains. The physical transportation of input and output goods becomes more important as geographic distribution expands. In today's global business network, the efficiency and predictability of this transportation network can be considered as an important driver of a country's attractiveness. Especially for developing countries, where transportation infrastructure is an important factor in determining attractiveness and competitiveness (Halaszovich & Kinra, 2020).

Methodology

1.6 The aim, design, and setting of the study

This research is trying to find out, what is the relationship and pattern of trade that occurs between Indonesia and China. We will map Indonesia's supply capacity based on import-export data from many companies in Indonesia based on supplier country origin.

Based on the descriptive model, we expect to find trading patterns from the simulation results. This study also wants to determine the factors that affect the pattern of relationships and dependence between countries. Based on the literature study, two main factors can influence price factors and distance factors. This study tries to prove and whether both factors can simulate trade patterns and dependence between countries well.

The update of this study is the number of observations included in the simulation that reaches tens of thousands of companies in Indonesia and each company; we do a breakdown for several categories of goods so that more detailed simulation results are obtained. Based on the literature search results, we can tell the readers that not many researchers research trade patterns and dependence between countries, especially during the COVID-19 pandemic.

1.7 Data

Measurements were made by collecting granular data from 46,938 corporations or importers focused on the 15 largest commodities from China.

1.8 Granular Analysis

The overall level of specificity of the data at hand is referred to as granularity. When compared to sand, think of granularity as a big rock. Although the sand is much more granular (smaller), the giant rock is made entirely. The most granular data (smallest grain of sand) cannot be broken down any further, and in the above case, a single product in a single store. When it comes to data and flexibility, The researcher usually wants it to be as granular as possible before rolling it up to the interested stage.

1.9 Modeling

The demand for raw materials (D_{INA}) in Indonesia is met by domestic supplies (S_{INA}) and foreign supplies (S_{FOR}). Foreign supplies consist of several countries, so this data is a cross-section. $S_{FORi} = \{S_{FOR\text{-}1st\ country}, S_{FOR\text{-}2nd\ country}, \dots, S_{FOR\text{-}Nth\ country}\}$. Fulfillment of raw materials from abroad is the sum of importing raw materials, mainly composed of those goods comes from China. Other countries will meet

the shortage of supply from China following the priority order in the supply chain for specific commodities or goods. Countries that historically have supplied these commodities or goods in more significant quantities have a higher priority in meeting shortages caused by China.

$$\boldsymbol{D_{INA} = \sum_{i}^{N} S_{FOR\,i} + S_{INA}}$$

Trade Surplus (TS) can be interpreted as the number of goods provided (D) is greater than the number of goods requested (S). At the same time, Trade Deficit (TD) occurs when the number of goods provided (D) is greater than the number of goods requested (S).

$$\boldsymbol{TS = S > D}$$

$$\boldsymbol{TD = D > S}$$

In the context of the global value chain, if China is unable to meet market demand, then china can be said to have a deficit (TD_{CHN}) in supplying the needs of the world's goods. From a different point of view, the supply deficit will be met by some countries. Countries that supply the difference in the needs of such goods can be said to have a trade surplus (TS_{FORi}).

$$\boldsymbol{TD_{CHN} = \sum_{i}^{N} TS_{FORi}}$$

The state surplus in covering China's deficit, which experienced supply shock or was affected by COVID-19, is measured based on the supply capacity of these countries. The capacity measurement can be based on historical behavior. If a country has a trade surplus, then the country can be said to have the capacity to supply goods of a surplus-value referred to (CAP_{FORi}). The value of supply capacity for a country that has a trade surplus will be of positive value. If a country has a trade deficit, then the value of supply capacity for that country will be negative.

$$\boldsymbol{CAP_{FORi} = \begin{Bmatrix} x^{+}, if\ S > D \\ x^{-}, if\ S < D \end{Bmatrix}}$$

From the above explanation, a country's supply capacity is time-series data. It is because the supply capacity data will certainly vary every year. However, a country's supply capacity (CAP_{FORit}) is panel data that has characteristics of both cross-section(i) and time series (t). In implementing the granular analysis method, each country will have two capacities: maximum capacity (MAXCAPFORit) and average capacity (AVGCAPFORit). Of course, both types of capacity will vary over time and will differ between countries.

$$\boldsymbol{i = \{1, 2, \dots, N\}}$$

$$\boldsymbol{t = \{1, 2, \dots, T\}}$$

$$\boldsymbol{\overline{CAP_{FORi}} = \frac{\sum_{i}^{N}\sum_{t}^{T} CAP_{FORi}}{n}}$$

$$\boldsymbol{CAP_{FORit} = \begin{Bmatrix} MAXCAP_{FORit}, if\ CAP_{FORit}\ \ is\ maximum \\ AVGCAP_{FORit}, = \overline{CAP_{FORit}} \end{Bmatrix}}$$

This study uses data on exports and imports of commodities from many countries from January 2016 to December 2019. We group it into several regions for these countries: the European region, Australia, Asia, and Africa. This research commodity data can be detailed in more detail according to the type of commodities; for instance, steel, woven fabric, artificial resin plastic material, other textiles, organic chemicals, audiovisual, other base metals, aluminum, non-organic chemicals, engine spare parts, ceramic products, paper and paper articles, rubber goods, bells, watches and parts, and copper.

Based on historical data, we perform descriptive statistical calculations on commodity needs for each country. The statistics include the maximum number of needs and the average number of needs during 2016-2019. If a country has a surplus of commodity supply, then the country's rank can rise to a higher rank in simulation.

At first, the commodity supply chain between countries will form a specific pattern; let us call it the initial pattern. Under normal conditions, trade patterns and supply chains between countries will not change much and are still steady. However, in the event of economic

shocks caused by the covid 19 pandemics, the supply chain will change; final pattern.

Since China is one of the largest commodity providers globally, then if there is a shock in the production cycle, this will affect other countries. We simulated china by delivering shocks of 50% lower production than the initial conditions with maximum assumption.

We sorted commodity suppliers from the largest suppliers to the smallest suppliers. This order is essential because it will determine the chain of commodity suppliers. If the most significant supplier cannot meet the commodity needs for one thing or another, then the supplier in the second order will meet those needs. The same analogy can be applied to the third, fourth, and so on. By comparing the initial and final simulation results, this study seeks to find out which countries might fill the gap in commodity supply left by the Chinese state.

Result

The results indicate that Indonesian corporations have a very high dependence on raw materials from China, including 19.5% with dependence > 95%. Companies with a multi-sourcing strategy (ASEAN, East Asia, India, Europe, and the US) are still minimal. Due to the price factor and the relatively close distance to the quality, that continues to improve. When COVID-19 occurred, causing a shock to China, it seemed that corporations would rely on ASEAN and East Asian countries because they historically had had the largest share of imports.

Table 1. Indonesia's dependence to meet imports of raw materials

Corporate	Raw Material Dependence		
	>50% (Moderate dependence)	>95% (Close Dependence)	Multi-Sourcing **
China	28.3	19.5	
ASEAN	13.1	7.2	15.6
East Asian	9.8	5.2	11.6
India	1.4	0.7	1.8
Europe	6.7	3.4	8.3
US	2.9	1.4	3.8
* There are 46,983 importers of raw materials			
** The multi-sourcing strategy is used if supply from China is <50% and the rest is met by ASEAN / East Asia / India / EU / US with at least 30%			

Furthermore, the capacity of other countries to reduce supply shock from China due to COVID-19 is minimal. In this case, we use components imported raw materials from China during the highest pressure period, namely in the 1st Quarter of 2021. The results indicate that if Indonesian raw materials obtained from China experience a supply shock so that they can only meet 90%–95% of the initial capacity, the country's capacity to meet the domestic supply of raw materials is still relatively safe. This result has taken into account that countries in East Asia and ASEAN countries experience a shock only to meet 80% of their capacity.

Table 2. Fulfillment capacity of raw material imports

Supply Shock	Decreased capacity due to COVID-19		
	Mild	Moderate	Severe
CHINA	95%–90%	80%	70%
Fulfillment Simulation	The capacity that other countries have had to provide historically		
ASEAN	80%	Average	Max
ASIA TIMUR	80%	Average	Max
LAIN	Average	Average	Max

To see the pattern of the fulfillment of domestic materials if there is a disruption from China, we used 15 components of the most significant raw material imports from China during the highest pressure period in Q1 2020. The country with the most significant imports is assumed to cover the shortage of supply from China. If the country is still lacking, then the country with the second-largest import value will fulfill the demand, and so on.

This study indicates that the substitute countries for China in meeting domestic raw materials mostly come from ASEAN countries, Japan, Korea, and Taiwan. The countries are followed by Europe, the US, Africa, and South America (Latin America). In this case, there are several items such as paper goods, audiovisuals, ceramic products, and machine parts, and watches where Europe has a close distribution chain compared to ASEAN countries.

The simulation further indicates that the shock that occurs in some textile goods and woven fabrics will have a very long supply chain, especially if alternative supply countries such as Japan and Korea also experience a decline in supply. It happens because China dominates GVC for textile products in the world.

Discussion

China is the largest importer country for Indonesia in terms of meeting domestic needs and re-export. The present study's findings indicate that China has three levels of fulfilling imports for Indonesia during the global pandemic. China can still meet Indonesia's import needs at a light level by reaching 90%–95% of its initial capacity. It means that the remaining 5%–10% must be met by other countries that have a position after China fulfilling import needs. Based on the granular data obtained, the results indicate that the second place after China is occupied by ASEAN countries, then East Asian countries, India, Europe, and, finally, the United States. Product capacity is not the only reason for placing a country in the second position after China, but the distance of the country and the prices and costs are also considered.

However, if China can only meet approximately 80% of its initial capacity, the capacity of other countries must be able to supply at least as much as its historical average. Even if China can only supply approximately 70% of its capacity, other countries must provide maximum capacity based on historical patterns. If other countries fail, the domestic supply chain is disrupted.

Because of the pandemic, ports must comply with health protocols imposed by the government. Protocols that must be adhered to include spraying ship disinfectants, checking the health of the ship's crew, and checking the history of the ship's journey, which result in additional operational costs of the ship and a lengthy clearance process. Also, agencies' performance on the ground affects the delivery process, caused by restrictions on working hours, due to physical distancing and work-from-home policies (Arifin, 2020). According to (Dekker, 2020), disruption in the transportation sector is one of the causes of reduced demand in the import market. Even though more and more countries import goods and services from Indonesia, Indonesian participation in GVC will be even higher. The decline in imports from various countries was also exacerbated by the conflict between China and the United States, which impacted the economies of China's partner countries such as Hong Kong, Japan, South Korea, and Malaysia.

The shipping industry experienced a decline in cargo volume by export considering import cargoes and domestic cargoes. Cargo with the destination country as China has decreased by 14%–18%. It also affects other destination countries, such as Singapore and South Korea. Meanwhile, domestic cargoes, especially cargoes that support export-import and national distribution, also declined 5%–10% (Arifin, 2020). The volume of cargo in the shipping industry and the volume of cargo in the aviation industry have decreased. For example, at Minangkabau International Airport (BIM), the volume of cargo decreased by 10%–20% (Hendra, 2020).

Indonesia's exports from March to May 2020 experienced a decline; after that, they gradually recover (BPS, 2020). Even so, cumulatively, Indonesia's export value from January to September 2020 only reached US$ 117.19 billion or decreased by 5.81% compared to that in the same period in 2019. Meanwhile, Indonesia's import value in September 2020 reached US$ 11.57 billion, or an increase of

7.71% compared to August 2020, but compared to September 2019, and it decreased by 18.88%. The import value of all categories of goods used during January to September 2020 decreased compared to that during the same period in 2019. The decrease occurred in the category of consumer goods (9.36%), raw/auxiliary materials (18.86%), and capital goods (19.83%).

Based on the findings, it is conveyed that commodities such as paper, audiovisuals, ceramic products, machine parts, and watches are filled by Europeans, who have close distribution chains compared to ASEAN countries. The substitute countries for China in meeting domestic raw materials come from ASEAN countries, Japan, Korea, and Taiwan, and Europe and the United States meet the rest.

Conclusion

The COVID-19 pandemic, which started in China as the global supply chain center, has affected GVC. Corporations in Indonesia have a high dependence on raw materials originating from China. The simulation results of granular data from 46,938 corporations indicate that if China is only able to meet approximately 80% of its initial capacity due to COVID-19, then the capacity of other countries must be able to supply at least as much as its historical average if it wants to maintain the existing supply chain according to conditions before Covid-19. Even if China can only supply 70% of its capacity, other countries must provide maximum capacity based on the historical pattern of 2017–2019, but these conditions are challenging to meet because of the many restrictions due to COVID-19. The simulation results also indicate that the substitute countries for China in fulfilling domestic raw materials mostly come from ASEAN and East Asian countries, mainly because of price factors and regional proximity. However, certain commodities such as ceramics and paper goods come from European countries; this seems to be related to the quality and characteristics of FDI. Furthermore, some goods whose supply chains are very much dominated by China show that the shock that occurs can result in a longer supply chain, such as woven fabrics that need to be exported to Africa and Latin America.

Acknowledgment

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Attachment

Table 3. Supply Chain Simulation with 50% Production Shock in China with Maximum Assumption

Commodity	Supply Chain Simulation																							
Steel Woven fabric	CN	CN (SHOCK)	Insuf	JPN	Insuf	SNG	Insuf	S. KOREA	Insuf	TAIWAN	Insuf	EUR	Insuf	LATAM	Insuf	AFRICA	Insuf	OAUS	Insuf	CANADA	Insuf	PHI	Insuf	BRUNEI	Insuf
	318,0	159,0	159,0	360,7	####	247,1		91,8		71,5		62,7		5,2		2,6		2,0		1,0		0,2		0,2	
Artificial resin plastic material Other textiles	CN	CN (SHOCK)	CN (Insuf)	S. KOREA	Insuf	TAIWAN	Insuf	VIET	Insuf	JPN	Insuf	THA	Insuf	AUS	Insuf	LATAM	Insuf	OAUS	Insuf	CANADA	Insuf	S. ARABIA	Insuf	PHI	Insuf
	2021,1	101,1	101,1	89,8	####	43,4	####	19,6	####	17,8	####	8,6	8,1	0,6	7,9	1,9	6,2	0,7	5,7	0,4	5,4	0,3	5,2	0,2	5,1
Organic chemicals	CN	CN (SHOCK)	CN (Insuf)	SNG	Insuf	MALAYSIA	Insuf	THA	Insuf	S. KOREA	Insuf	JPN	Insuf	S. ARABIA	Insuf	AUS	Insuf	OAUS	Insuf	AFRICA	Insuf	CANADA	Insuf	LATAM	Insuf

Commodity	Supply Chain Simulation																							
Audio visual	137,9	69,0	69,0	252,3	####	76,1		65,0		56,5		50,8		3,0		2,5		1,1		0,8		0,5		0,5	
Other base metals Aluminum	CN	CN (SHOCK)	CN (Insuf)	S. KOREA	Insuf	SNG	Insuf	JPN	Insuf	TAIWAN	Insuf	THA	Insuf	S. ARABIA	Insuf	OAUS	Insuf	LATAM	Insuf	AFRICA	Insuf	CANADA	Insuf	MYR	Insuf
	97,3	48,6	48,6	64,7	####	28,3	####	23,5	5,7	19,2	2,9	18,6		0,6		0,4		0,3		0,1		0,1		0,0	
Non organic chemicals Engine spar eparts	CN	CN (SHOCK)	CN (Insuf)	SNG	Insuf	JPN	Insuf	MALAYSIA	Insuf	EUR	Insuf	IND	Insuf	VIET	Insuf	S. ARABIA	Insuf	AFRICA	Insuf	PHI	Insuf	CANADA	Insuf	BRUNEI	Insuf
	123,5	61,7	61,7	212,8		72,2		44,8		36,2		21,3		0,5		0,4		0,3		0,3		0,1		0,0	
Ceramic products Paper and	CN	CN (SHOCK)	CN (Insuf)	TAIWAN	Insuf	SNG	Insuf	EUR	Insuf	JPN	Insuf	S. KOREA	Insuf	CANADA	Insuf	AUS	Insuf	IND	Insuf	OAUS	Insuf	LATAM	Insuf	BRUNEI	Insuf
	16	80,5	80,5	181,6	7,0	97,2		20,6		11,4		10,9		0,3		0,2		0,1		0,0		0,0		0,0	

Commodity	Supply Chain Simulation																							
paper articles	0,9																							
Rubber goods Bells, watches and parts	CN	CN (SHOCK)	CN (Insuf)	JPN	Insuf	SNG	Insuf	S. KOREA	Insuf	EUR	Insuf	THA	Insuf	PHI	Insuf	LATAM	Insuf	CANADA	Insuf	AFRICA	Insuf	S. ARABIA	Insuf	OAUS	Insuf
	53,8	26,9	26,9	33,1	####	22,8	4,6	10,8	2,1	10,3		7,6		0,3		0,3		0,2		0,1		0,1		0,0	
Copper Steel	CN	CN (SHOCK)	CN (Insuf)	SNG	Insuf	JPN	Insuf	AUS	Insuf	US	Insuf	EUR	Insuf	CANADA	Insuf	S. ARABIA	Insuf	PHI	Insuf	OAUS	Insuf	LATAM	Insuf	MYR	Insuf
	54,0	27,0	27,0	48,1	2,8	19,0		13,1		10,2		8,0		0,2		0,2		0,1		0,1		0,1		0,0	
Woven fabric Artificial resin plastic	CN	CN (SHOCK)	CN (Insuf)	SNG	Insuf	JPN	Insuf	AUS	Insuf	EUR	Insuf	US	Insuf	VIET	Insuf	LATAM	Insuf	CANADA	Insuf	PHI	Insuf	OAUS	Insuf	S. ARABIA	Insuf
	41,3	20,6	20,6	44,8	9,6	16,8	6,6	19,3		12,3		12,0		0,6		0,4		0,2		0,1		0,0		0,0	

Commodity	Supply Chain Simulation																							
material																								
Other textiles Organic chemicals	**CN**	**CN (SHOCK)**	**CN (Insuf)**	**SNG**	**Insuf**	**JPN**	**Insuf**	**EUR**	**Insuf**	**TAIWAN**	**Insuf**	**S. KOREA**	**Insuf**	**IND**	**Insuf**	**LATAM**	**Insuf**	**PHI**	**Insuf**	**OAUS**	**Insuf**	**AFRICA**	**Insuf**	**S. ARABIA**	**Insuf**
	38,9	19,5	19,5	90,0		17,7		10,7		10,2		8,1		0,6		0,2		0,1		0,1		0,1		0,1	
Audio visual Other base metals	**CN**	**CN (SHOCK)**	**CN (Insuf)**	**IND**	**Insuf**	**EUR**	**Insuf**	**MALAYSIA**	**Insuf**	**JPN**	**Insuf**	**S. KOREA**	**Insuf**	**LATAM**	**Insuf**	**O. ASIA**	**Insuf**	**PHI**	**Insuf**	**CANADA**	**Insuf**	**OAUS**	**Insuf**	**BRUNEI**	**Insuf**
	25,8	12,9	12,9	8,3	9,9	5,0	6,9	3,2	5,7	7,3		1,4		0,1		0,0		0,0		0,0		0,0		0,0	
Aluminum Non organic chemicals	**CN**	**CN (SHOCK)**	**CN (Insuf)**	**EUR**	**Insuf**	**SNG**	**Insuf**	**US**	**Insuf**	**S. KOREA**	**Insuf**	**THA**	**Insuf**	**OAUS**	**Insuf**	**CANADA**	**Insuf**	**IND**	**Insuf**	**LATAM**	**Insuf**	**AFRICA**	**Insuf**	**CAMBODIA**	**Insuf**
	35,6	17,8	17,8	58,3	0,7	21,3		15,0		14,2		11,7		0,9		0,5		0,4		0,2		0,2		0,1	

Commodity	Supply Chain Simulation																							
Engine spare parts Ceramic products	CN	CN (SHOCK)	CN (Insuf)	JPN	Insuf	SNG	Insuf	THA	Insuf	EUR	Insuf	IND	Insuf	OAUS	Insuf	LATAM	Insuf	PHI	Insuf	CANADA	Insuf	AFRICA	Insuf	MYR	Insuf
	23, 5	11,8	11,8	40,7		22,0		7,1		6,6		4,6		0,2		0,1		0,1		0,1		0,1		0,0	
Paper and paper articles Rubber goods	CN	CN (SHOCK)	CN (Insuf)	SNG	Insuf	JPN	Insuf	EUR	Insuf	US	Insuf	THA	Insuf	PHI	Insuf	LATAM	Insuf	VIET	Insuf	OAUS	Insuf	AFRICA	Insuf	BRUNEI	Insuf
	24, 6	12,3	12,3	43,2		24,2		15,0		8,3		4,7		0,4		0,2		0,1		0,1		0,0		0,0	
Bells, watches and parts	CN	CN (SHOCK)	CN (Insuf)	SNG	Insuf	JPN	Insuf	THA	Insuf	S. KOREA	Insuf	MALAYSIA	Insuf	VIET	Insuf	AFRICA	Insuf	OAUS	Insuf	CANADA	Insuf	PHI	Insuf	S. ARABIA	Insuf
	18, 5	9,3	9,3	48,0		20,8		8,0		5,6		4,0		0,3		0,2		0,1		0,0		0,0		0,0	

Table 4. Supply Chain Simulation with 80% Production Shock in China with Average Assumption

Commodity	Supply Chain Simulation																																						
Steel Woven fabric	CN	CN (SHOCK)	Insuf	JPN	Insuf	SNG	Insuf	S.KOREA	Insuf	TAIWAN	Insuf	EUR	Insuf	O.ASIA	Insuf	MALAYSIA	Insuf	VIET	Insuf	AUS	Insuf	THA	Insuf	IND	Insuf	US	Insuf	LATAM	Insuf	AFRICA	Insuf	OAUS	Insuf	CANADA	Insuf	PHI	Insuf	BRUNEI	Insuf
	318,0	254,4	63,6	2433,8	73,8	1811,6	86,9	88,2	90,5	53,6	108,4	69,5	101,6	27,2	113,9	28,9	121,9	27,5	118,8	15,4	118,1	14,8	118,0	13,4	117,1	11,4	117,6	3,3	119,5	2,8	119,3	1,3	120,0	0,9	120,1	0,4	120,0	0,8	119,4
Artificial resin plastic material	CN	CN (SHOCK)	Insuf	S.KOREA	Insuf	TAIWAN	Insuf	VIET	Insuf	JPN	Insuf	THA	Insuf	EUR	Insuf	IND	Insuf	O.ASIA	Insuf	SNG	Insuf	MALAYSIA	Insuf	US	Insuf	AFRICA	Insuf	AUS	Insuf	LATAM	Insuf	OAUS	Insuf	CANADA	Insuf	S.ARABIA	Insuf	PHI	Insuf
	2021,7	1611,7	40,4	68,7	34,2	35,1	32,0	11,7	35,0	11,6	35,0	6,3	34,3	4,3	34,3	3,3	34,8	3,3	34,5	3,8	32,6	2,8	31,3	1,4	31,2	1,1	30,8	0,3	30,8	0,5	30,6	0,2	30,5	0,1	30,5	0,1	30,5	0,1	30,5
Other textiles	CN	CN (SHO	Insuf	SNG	Insuf	MALAYS	Insuf	THA	Insuf	S.KOR	Insuf	JPN	Insuf	EUR	Insuf	TAIWAN	Insuf	US	Insuf	VIET	Insuf	O.ASIA	Insuf	IND	Insuf	PHI	Insuf	S.ARAB	Insuf	AUS	Insuf	OAUS	Insuf	AFRICA	Insuf	CANADA	Insuf	LATAM	Insuf

Commodity	Supply Chain Simulation																																				
		CK)				IA				EA																													
	137,9	110,3	27,6	195,2	26,5	63,4	28,4	65,8	27,6	53,5	30,7	55,7	25,7	27,7	29,7	22,2	28,5	15,4	30,6	11,8	31,9	8,7	31,2	5,6	31,0	5,5	30,6	3,1	30,5	2,1	30,9	2,4	29,6	0,7	29,7	0,4	29,8	0,4	29,9
Organic chemicals Audio visual	CN	CN (SHOCK)	Insuf	S.KOREA	Insuf	SNG	Insuf	JPN	Insuf	TAIWAN	Insuf	THA	Insuf	VIET	Insuf	EUR	Insuf	IND	Insuf	O.ASIA	Insuf	MALAYSIA	Insuf	US	Insuf	AUS	Insuf	S.ARABIA	Insuf	OAUS	Insuf	LATAM	Insuf	AFRICA	Insuf	CANADA	Insuf	MYR	Insuf
	97,3	77,8	19,5	34,8	21,0	18,5	21,7	19,4	20,4	14,6	22,3	17,2	20,7	12,8	22,1	12,4	22,6	6,3	23,3	5,0	23,4	5,1	23,4	1,9	23,6	1,1	23,5	0,8	23,4	0,5	23,3	0,5	23,1	0,1	23,1	0,1	23,1	0,0	23,1
Other base metals	CN	CN (SHOCK)	Insuf	SNG	Insuf	JPN	Insuf	MALAYSIA	Insuf	EUR	Insuf	IND	Insuf	S.KOREA	Insuf	THA	Insuf	TAIWAN	Insuf	US	Insuf	LATAM	Insuf	O.ASIA	Insuf	AUS	Insuf	VIET	Insuf	S.ARABIA	Insuf	AFRICA	Insuf	PHI	Insuf	CANADA	Insuf	BRUNEI	Insuf
	123	98,8	24,7	172	3,4	73,5	2,1	46,9		36,2		21,3		14,8		13,5		5,4		4,0		1,3		0,7		0,6		0,5		0,4		0,3		0,3		0,1		0,0	

Commodity	Supply Chain Simulation																																						
	,5			,4																																					
Aluminum	CN	CN (SHOCK)	Insuf	TAIWAN	Insuf	SNG	Insuf	EUR	Insuf	JPN	Insuf	S.KOREA	Insuf	THA	Insuf	US	Insuf	VIET	Insuf	MALAYSIA	Insuf	AFRICA	Insuf	PHI	Insuf	O.ASIA	Insuf	CANADA	Insuf	AUS	Insuf	IND	Insuf	OAUS	Insuf	LATAM	Insuf	BRUNEI	Insuf
	160,9	128,7	32,2	91,3	49,0	82,8	56,4	24,9	52,1	11,3	52,2	9,0	54,1	8,5	54,4	5,7	53,5	2,8	52,6	1,8	52,2	0,2	52,6	1,7	51,3	0,3	51,4	0,2	51,5	0,5	51,2	1,5	49,8	0,0	49,8	0,1	49,8	0,0	49,8
Non organic chemicals Engine spareparts	CN	CN (SHOCK)	Insuf	JPN	Insuf	SNG	Insuf	S.KOREA	Insuf	EUR	Insuf	THA	Insuf	TAIWAN	Insuf	MALAYSIA	Insuf	US	Insuf	IND	Insuf	O.ASIA	Insuf	VIET	Insuf	AUS	Insuf	PHI	Insuf	LATAM	Insuf	CANADA	Insuf	AFRICA	Insuf	S.ARABIA	Insuf	OAUS	Insuf
	53,8	43,0	10,8	21,5	8,0	16,4	6,5	8,4	6,4	8,2	6,3	8,0	6,0	4,1	6,3	4,0	6,5	3,5	6,9	2,0	6,9	1,8	6,9	1,2	7,3	1,3	6,9	0,2	7,0	0,2	7,0	0,1	7,0	0,1	7,0	0,4	6,7	0,1	6,6
Ceramic products	CN	CN (SH	Insuf	SNG	Insuf	JPN	Insuf	AUS	Insuf	US	Insuf	EUR	Insuf	MALAY	Insuf	O.AS	Insuf	S.KOR	Insuf	TAIW	Insuf	THA	Insuf	VIET	Insuf	IND	Insuf	CANA	Insuf	S.ARA	Insuf	PHI	Insuf	OAUS	Insuf	LATAM	Insuf	MYR	Insuf

Commodity	Supply Chain Simulation																																						
		OCK)												SIA		IA		EA		AN								DA		BIA									
	54,0	43,2	10,8	31,2	3,6	14,9	4,8	4,8	13,1	8,8	14,5	10,0	12,4	8,1	12,0	7,6	10,8	5,1	10,5	3,3	10,7	4,0	10,1	1,6	10,1	2,2	9,0	0,4	8,8	0,2	8,8	0,2	8,8	0,1	8,8	0,1	8,8	0,0	8,8
Paper and paper articles	CN	CN (SHOCK)	Insuf	SNG	Insuf	JPN	Insuf	AUS	Insuf	EUR	Insuf	US	Insuf	S.KOREA	Insuf	THA	Insuf	TAIWAN	Insuf	IND	Insuf	O.ASIA	Insuf	MALAYSIA	Insuf	AFRICA	Insuf	VIET	Insuf	LATAM	Insuf	CANADA	Insuf	PHI	Insuf	OAUS	Insuf	S.ARABIA	Insuf
	41,3	33,0	8,3	30,9	11,0	11,9	12,9	9,8	15,8	13,9	14,1	10,5	15,7	11,2	15,8	5,6	15,1	4,8	14,8	4,0	15,0	2,6	15,7	2,6	15,2	0,8	15,1	0,4	15,3	0,7	15,0	0,3	14,9	0,0	14,9	0,0	14,9	0,1	14,9
Rubber goods Bells, watches and parts	CN	CN (SHOCK)	Insuf	SNG	Insuf	JPN	Insuf	EUR	Insuf	TAIWAN	Insuf	S.KOREA	Insuf	US	Insuf	MALAYSIA	Insuf	AUS	Insuf	O.ASIA	Insuf	CANADA	Insuf	THA	Insuf	VIET	Insuf	IND	Insuf	LATAM	Insuf	PHI	Insuf	OAUS	Insuf	AFRICA	Insuf	S.ARABIA	Insuf
	38,9	31,1	7,8	62,5	15,8	19,8	13,7	13,3	11,1	8,5	12,8	8,2	12,8	6,2	13,1	6,5	11,3	2,9	11,8	1,2	12,0	1,0	12,3	1,6	12,0	0,5	12,3	0,6	12,3	0,2	12,2	0,1	12,2	0,2	12,2	0,2	12,1	0,1	12,0

Commodity	Supply Chain Simulation																																						
Copper	CN	CN (SHOCK)	Insuf	IND	Insuf	EUR	Insuf	MALAYSIA	Insuf	JPN	Insuf	S.KOREA	Insuf	TAIWAN	Insuf	THA	Insuf	SNG	Insuf	US	Insuf	VIET	Insuf	AUS	Insuf	AFRICA	Insuf	LATAM	Insuf	O.ASIA	Insuf	PHI	Insuf	CANADA	Insuf	OAUS	Insuf	BRUNEI	Insuf
	25,8	20,6	5,2	2,1	8,4	1,9	8,4	1,3	9,1	2,9	7,7	1,3	7,9	1,0	8,2	1,4	7,8	0,8	7,8	0,5	7,8	0,2	7,8	0,1	7,8	0,1	7,8	0,1	7,8	0,0	7,8	0,0	7,7	0,0	7,7	0,0	7,8	7,8	
Steel	CN	CN (SHOCK)	Insuf	EUR	Insuf	SNG	Insuf	US	Insuf	S.KOREA	Insuf	THA	Insuf	JPN	Insuf	MALAYSIA	Insuf	VIET	Insuf	AUS	Insuf	TAIWAN	Insuf	O.ASIA	Insuf	PHI	Insuf	OAUS	Insuf	CANADA	Insuf	IND	Insuf	LATAM	Insuf	AFRICA	Insuf	CAMBODIA	Insuf
	35,6	28,5	7,1	39,4	9,0	21,1	8,4	13,3	10,1	13,8	10,5	11,2	11,0	10,2	11,0	7,0	11,1	4,9	11,5	6,3	9,3	4,0	9,2	3,2	8,0	1,3	8,1	1,0	7,9	0,6	7,9	0,3	8,0	0,1	8,0	0,1	8,1	0,0	8,1
Woven fabric Artificial resin plastic material	CN	CN (SHOC	Insuf	JPN	Insuf	SNG	Insuf	THA	Insuf	EUR	Insuf	IND	Insuf	MALAYSIA	Insuf	AUS	Insuf	S.KOREA	Insuf	VIET	Insuf	US	Insuf	TAIWAN	Insuf	O.ASIA	Insuf	OAUS	Insuf	LATAM	Insuf	PHI	Insuf	CANADA	Insuf	AFRICA	Insuf	MYR	Insuf

Commodity	Supply Chain Simulation																																		
		K)																																		
	23,5	18,8	4,7	29,9	3,8	24,3	1,6	7,6	1,1	5,7	2,0	5,0	1,6	4,2	1,5	3,6	1,3	2,8	0,8	1,6	0,8	1,5	0,8	1,0	0,6	0,5	0,8	0,2	0,8	0,7	0,2	0,1	0,2	0,1	0,2	0,1	0,2	0,0	0,2
Other textiles	CN	CN (SHOCK)	Insuf	SNG	Insuf	JPN	Insuf	EUR	Insuf	US	Insuf	THA	Insuf	S.KOREA	Insuf	MALAYSIA	Insuf	TAIWAN	Insuf	IND	Insuf	O.ASIA	Insuf	AUS	Insuf	CANADA	Insuf	PHI	Insuf	LATAM	Insuf	VIET	Insuf	OAUS	Insuf	AFRICA	Insuf	BRUNEI	Insuf
	24,6	19,7	4,9	31,9	4,0	21,9	6,3	15,4	6,0	7,4	6,9	4,7	6,9	3,8	6,6	3,4	6,2	1,5	6,8	1,4	6,8	0,7	7,2	0,9	7,4	0,7	7,4	0,3	7,5	0,1	7,5	0,1	7,5	0,1	7,5	0,0	7,5	0,0	7,6
Organic chemicals	CN	CN (SHOCK)	Insuf	SNG	Insuf	JPN	Insuf	THA	Insuf	S.KOREA	Insuf	MALAYSIA	Insuf	TAIWAN	Insuf	EUR	Insuf	LATAM	Insuf	IND	Insuf	AUS	Insuf	O.ASIA	Insuf	US	Insuf	VIET	Insuf	AFRICA	Insuf	OAUS	Insuf	CANADA	Insuf	PHI	Insuf	S.ARABIA	Insuf
	18,5	14,8	3,7	41,4	1,1	21,9		8,0		5,6		4,0		3,9		2,9		2,7		1,4		0,8		0,4		0,4		0,3		0,2		0,1		0,0		0,0		0,0	

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