Section 2 Increasing global supply constraints

The spread of COVID-19, which has continued since 2020, has significantly affected upstream and downstream supply chains, and its effects continue to this day. In addition to the effects of labor shortages and economic stagnation caused by measures such as lockdowns and other behavioral restrictions to prevent the spread of infection such as movement and travel restrictions, the rapid rise in demand due to large-scale fiscal measures has led to logistic delays and soaring prices. The disruptions in logistics have led to a chain reaction of negative events where soaring resource and energy prices have led to soaring logistics prices.

Food prices have also risen due to a resource and food shortage and failed crops caused by extreme weather events such as torrential rains, hurricanes, cold waves, and droughts around the world. In particular, some semiconductors and automobile parts were mainly manufactured in certain countries and regions, and the damage caused by extreme weather events and other factors became a bottleneck, causing stagnation in the supply chain of entire products such as semiconductors and automobiles which in turn led to significant delays in supply and production cuts.

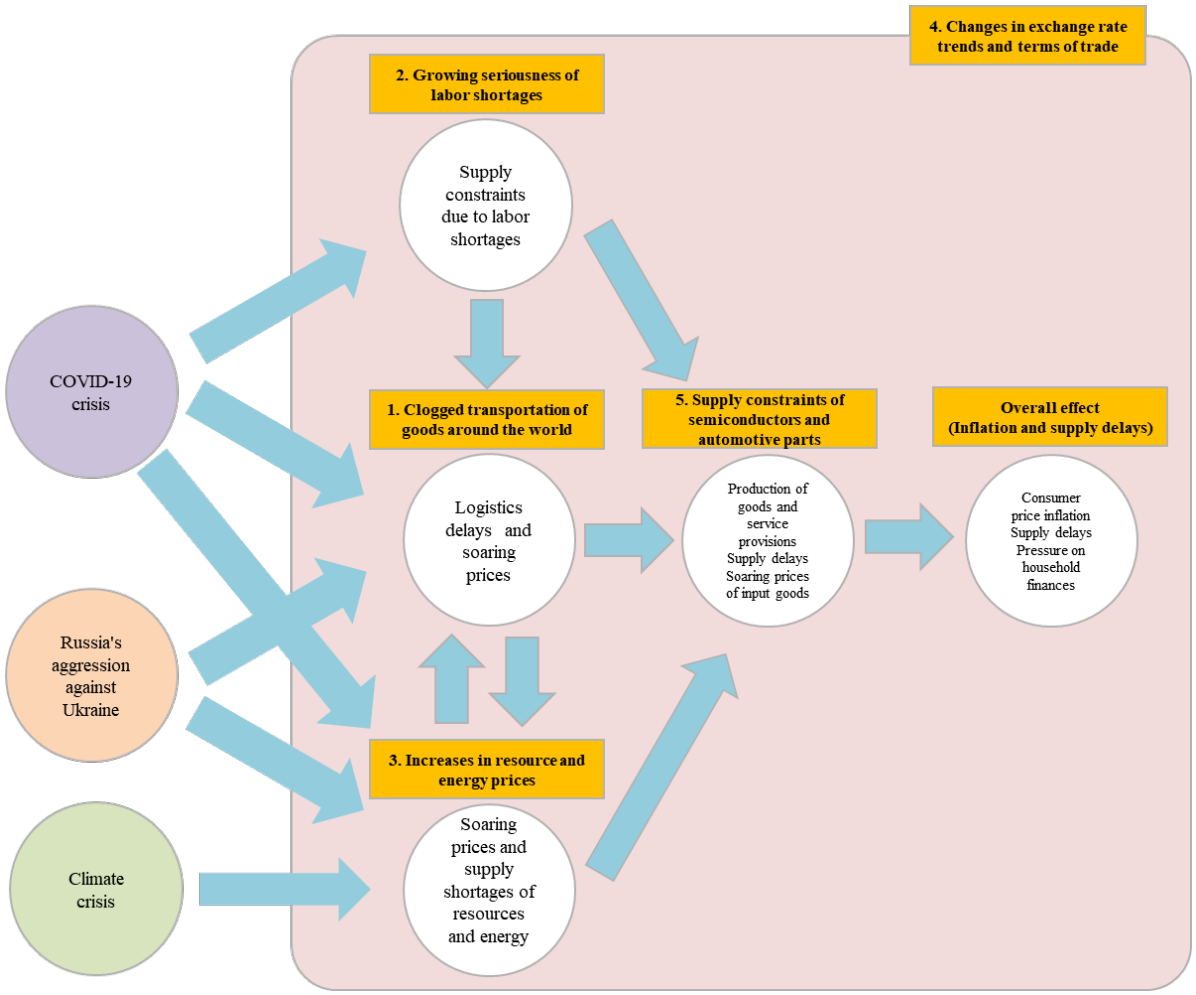
Moreover, in February 2022, Russia's aggression against Ukraine began and worsened supply chain disruptions, in turn causing the prices of the goods that Russia and Ukraine have produced in abundance and exported; such as oil, natural gas and other energy sources, grains, such as wheat and corn, and raw materials, such as rare gases and mineral resources, etc., to soar due to concerns over supply and global supply and demand imbalances.

Together with worsening terms of trade of countries that heavily rely on foreign countries for resources and energy, the effects of supply constraints caused by various factors is causing a wide range of goods and services to be in tight supply and demand and inflation to surge.

The supply constraints present throughout supply chains and their relationships with each other are summarized in the figure below (Figure I-1-2-1).

In this section we will look at the actual state of the various, multi-layered supply constraints that are present in supply chains, labor markets, and resource and energy supplies due to increasing global uncertainty from the spread of COVID-19, extreme weather events caused by climate change, and Russia's aggression against Ukraine, as shown in the figure mentioned above.

Figure I-1-2-1. Relationship diagram of the supply constraints in supply chains



Source: Based on various materials.

1. Clogged transportation of goods around the world

Measures such as behavioral restrictions, movement and travel restrictions from the global spread of COVID-19, and the rise in demand due to quick fiscal measures has caused the transportation of goods to be in tight supply and demand, and has led to soaring international logistics costs. According to a survey[3] conducted from November 4,2021 to December 7 by JETRO, among reasons such as "increased demand," "domestic and overseas movement restrictions, and operational restrictions," and "a shortage of raw materials and parts," the main reason why Japanese companies are reviewing their supply chains is because of "disruption in international transportation and soaring transportation costs." This is a major issue for Japanese companies.

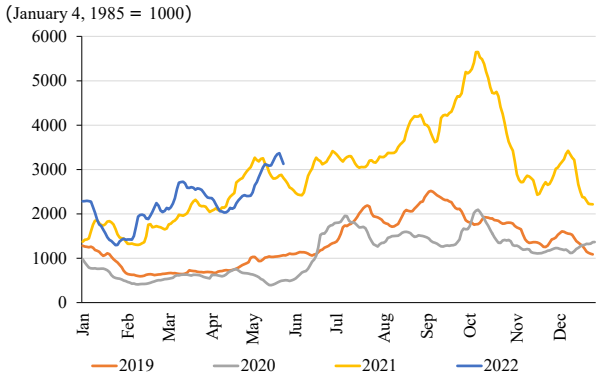
[3] *Questionnaire Survey on Overseas Business Operations by Japanese Companies, Supply Constraints, Transport Disruptions and Corporate Responses*. (JETRO, 2022)

(1) Marine transportation

In Japan, marine transportation is responsible for 99.6% of cargo transportation in terms of weight for goods transported between foreign countries[4]. Even in terms of value, marine transportation is the main means of transportation with it accounting for about 70% of transportation while air transportation accounting for 30%. Approximately two-thirds of the value of marine transportation comes from transportation using marine containers[5].

Looking at sea freight rates, the Baltic Dry Index, an international indicator of sea freight rates, has risen since the end of 2020, more than quadrupled on October 6, 2021 compared to the beginning of 2021, and fell sharply in November (Figure I-1-2-1). Since then, 2022 has been at the same level as 2021.

Figure I-1-2-2. Baltic Dry Index



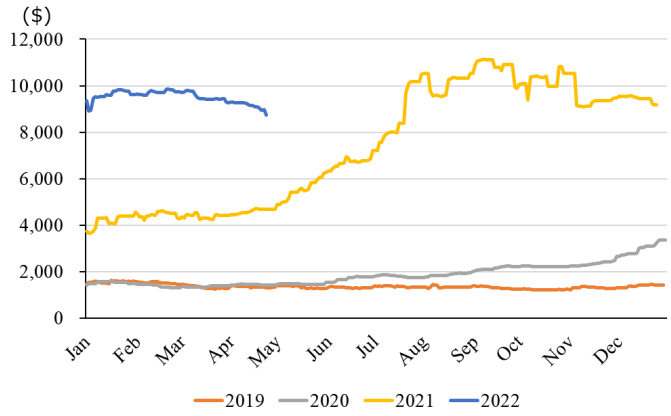
Note: Freight rate index for bulk carriers (ships carrying iron ore, coal, grain, etc.) published by the London-based Baltic Exchange. The indices with 1000 set as the value for January 4, 1985.
Source: Refinitiv.

Meanwhile, looking at the Freightos Baltic Index (FBX), an international freight rate index for container ships, it was relatively stable at a level of less than 2,000 dollars throughout the year in 2019, but in 2021, it rose to a level five times higher than the level in 2019, and it continues to be at a high level of less than $10,000 in 2022 (Figure I-1-2-3). This disruption in logistics shows that the effects of soaring freight rates and logistics delays due to tight supply and demand for containers continue.

[4] *Shipping Now 2021-2022* (The Japanese Shipowners' Association, 2021) (https://www.jsanet.or.jp/data/shipping.html).

[5] *Trends in Trading Amounts by Transportation* (Ministry of Land, Infrastructure, Transport and Tourism, 2021) (https://www.mlit.go.jp/common/001358400.pdf).

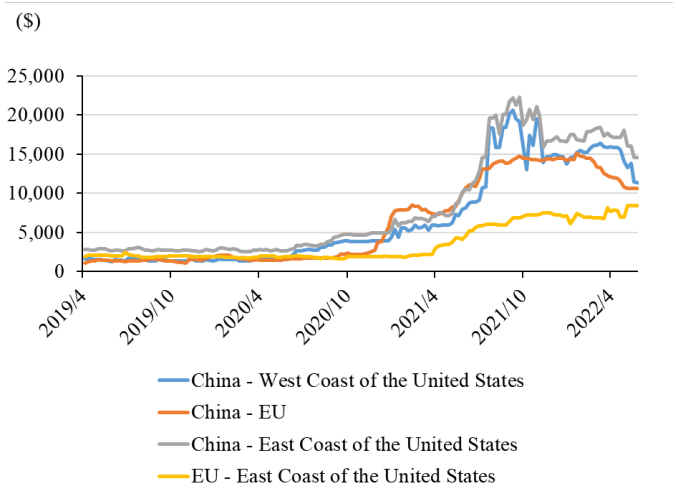
Figure I-1-2-3. Freightos Baltic Index (Global)



Note 1: Weighted average of 12 major container ship freight rates of maritime routes.
Note 2: Rate per 40 ft. container.
Source: Freightos, Refinitiv.

Looking at freight rates of major maritime routes for container ships, all routes departing from China have been at a high level since the second half of 2021. (Figure I-1-2-4).

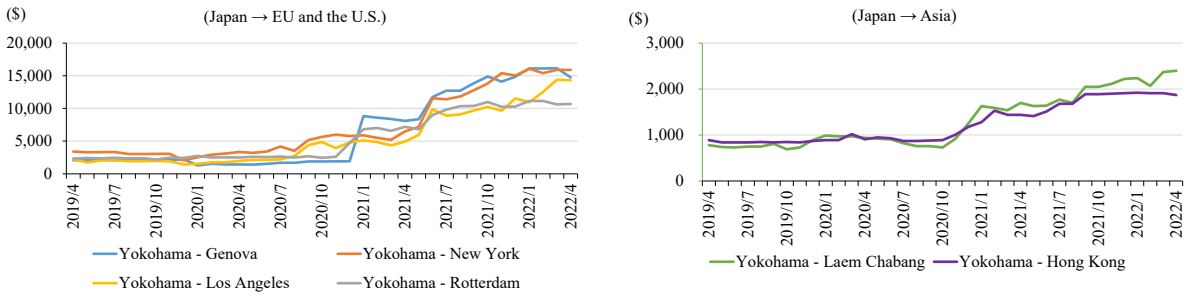
Figure I-1-2-4. Freight rates of major maritime routes for container ships between Europe, the United States and China by maritime route



Source: Freightos, Refinitiv.

In addition, looking at freight rates by maritime routes from Japan, prices for both Europe and the United States and Asia have risen significantly. In particular, the freight rates for Europe and the United States have been more than five times higher compared to 2019 (Figure I-1-2-5).

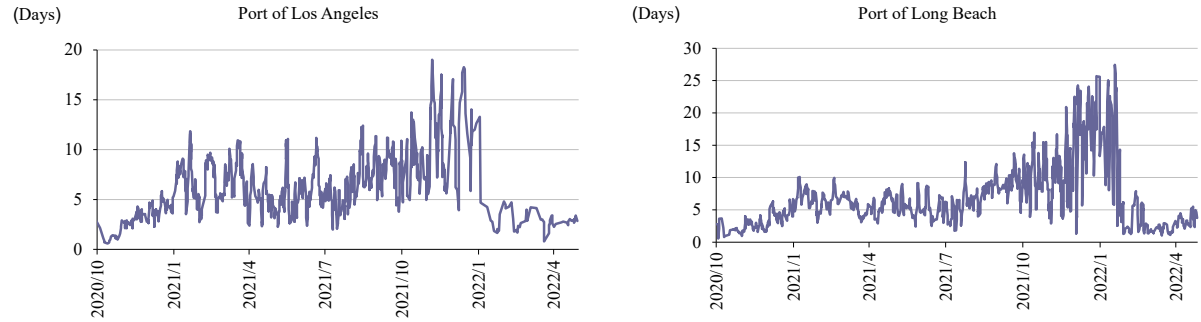
Figure I-1-2-5. Freight rates for container ships departing from Japan by maritime route



Note: Rate per 40 ft. container.
Source: Japan Maritime Center

The ports of Los Angeles and Long Beach in the United States, which are major ports there that handle the largest volume of maritime cargo after China, increased the number of waiting days at the ports due to labor shortages at the ports, warehouses, and in land transportation (Figure I-1-2-6).

Figure I-1-2-6. Average waiting time for container ships at major ports on the west coast of the United States



Note: The average wait time is the moving average of the last six port visits.
Source: Refinitiv.

Waiting times for container ships at ports were prolonged especially in the second half of 2021, worsening to less than three weeks at the Port of Los Angeles and, temporarily, to less than four weeks at the Port of Long Beach. Since then, the waiting times at both ports improved to a level of less than a week at the beginning 2022, which can be attributed to changes in the waiting process of container ships and additional charges being imposed[6] on lingering empty containers at ports. Until now, the waiting process for entering the ports at the ports of Los Angeles and Long Beach started when container ships entered the ports within 20 nautical miles. It was changed, however, on November 15,

[6] *Port of Los Angeles Announces Additional Charges on Lingering Empty Containers* (JETRO, 2022) (https://www.jetro.go.jp/biznews/2022/01/64184e850189c59a.html).

2021[7] to start when container ships leave the port immediately before the port of Los Angeles or Long Beach. Additionally, container ships that do not have berthing reservations within 72 hours must wait at a certain offshore area near the port. As a result of the change in the waiting process, the number of container ships that berthed longer than they were intended to have been announced using a new method, with 109 actual vessels that berthed longer than they were intended to on January 9, 2022, and remaining at around 100 vessels since then. Although the waiting time at the ports has decreased, it cannot be said that the congestion in sea transportation, including those in ports and areas around ports, has been eliminated.

In addition, due to the effects of the lockdown in Shanghai following the resurgence of COVID-19 in March 2022, land transportation in China has stagnated, and its effects on marine and air transportation to the United States has become apparent[8].

In the United States, demand for imports of goods increased sharply, partly due to the effects of the measures to increase demand. However, while the number of container ships entering ports increased, there are still lingering empty containers at ports which is accelerating a global container shortage. With a rapid increase in imports of goods, it is becoming difficult to export filled up containers.

The CAx (Container Availability Index) can be used to check the utilization rate of containers used in importing and exporting with container ships[9]. Looking at the CAx for the Port of Los Angeles, the largest port in the United States, and the Port of Shanghai, the largest port in China, the Port of Los Angeles remained high at above 0.9 in the 13th week of 2021, confirming that there are relatively large amounts of full containers at the time of import (Figure I-1-2-7). In contrast, the Port of Shanghai Port is in a well-balanced state with regard to container exports and imports, as it is hovering around 0.5 to 0.6 (same figure). Representative examples for interpreting CAx are summarized in Table I-1-2-8.

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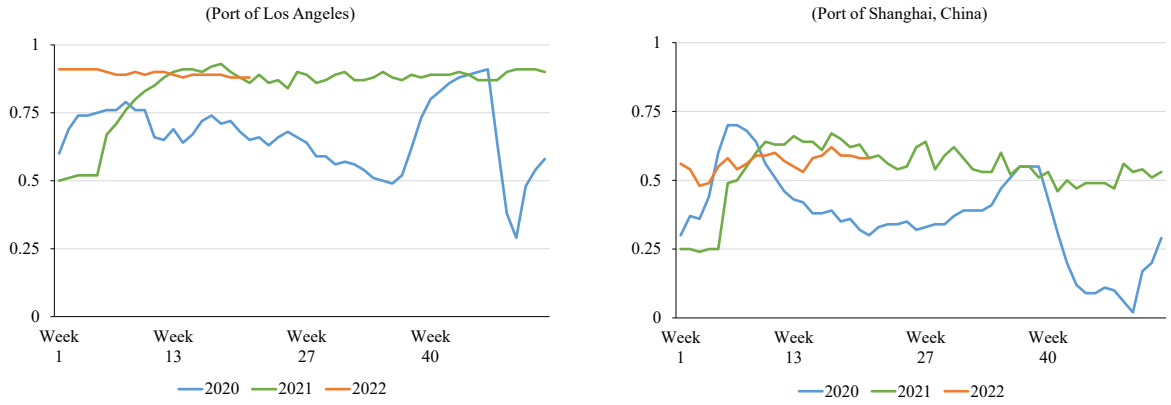
7 *The Fourth Overseas Port Status Report (as of around January 27 2022)* (Ministry of Land, Infrastructure, Transport and Tourism, 2022).

8 *Potential of Another Disruption in U.S. Ports Due to Prolonged Lockdown in Shanghai, Outlook From the National Retail Federation* (JETRO, 2022) (https://www.jetro.go.jp/biznews/2022/04/73680d31784f6488.html).

9 CAx is an index that shows the balance of full containers used in exports and imports, and is expressed from 0 to 1 with 0.5 as the standard. if the CAx is 0.5, the same amount of full containers are exchanged between exports and imports, indicating a balanced state. On the other hand, when it exceeds 0.5, it indicates that there are more full containers at the time of import than exports. Conversely, if it is below 0.5, it indicates that there are more full containers at the time of export than imports.

Figure I-1-2-7. Container Availability Index (CAx)



Note 1: This is weekly data.
Note 2: Value for a 40 ft. container.
Source: Container Exchange [10].

Figure I-1-2-8. Examples for interpreting CAx

CAx value	General examples for interpretation	Examples for interpretation for longer periods of time
0 to 0.45	· Demand for export containers is higher than the demand for import containers. · There is a high probability that container rental fees will increase. · There is a high probability that the acceptance of cargo will be delayed. · If the CAx is lower than the long-term average, there is a possibility of an increase in cargo production.	· It is possible that there aren't enough containers imported to fully handle exports. · There is a high probability of a container shortage · There is a high probability of receiving empty containers to eliminate the container shortage.
0.45 to 0.55	· Demand for export containers and full import containers is balanced.	· There is a high probability that exports and imports using empty containers will decrease. · The volume of cargo is stable.
0.55 to 1	· Demand for export containers is lower than the demand for imported containers. · There is a high probability that the container rental fees will decrease.	(If during/after the container shortage) · High probability of it being a sign that the container shortage at ports will be alleviated. (If there is no apparent container shortage)

[10] Container Exchange, (https://www.container-xchange.com/features/cax/)

	· If the CAx is higher than the long-term average, there is a possibility of a decrease in cargo production.	· High probability that full exports are not enough to reduce the surplus · Surpluses may be the result of empty containers that were shipped from the port the previous week returning as current imports.

Note: It should be noted that CAx is an index used to understand container imbalances in exports and imports at a particular location during a particular week, and interpretations differ depending on the port.
Source: Container Exchange.

With regard to the imbalances of container transportation in ports we have looked at until now, transport capacity not being fully utilized in round trip transportation is known as "backhaul problems."[11]

An example where backhaul problems occur is in the discussions of trade policies such as tariffs and import quotas. In order to avoid backhaul problems when import restrictions such as tariffs and import quotas reduce domestic imports, transport companies need to reduce their exports. Therefore, decreasing imports can benefit companies that produce for their own countries. On the other hand, the decline in exports could also cause losses for companies that produce for foreign countries. Anderson J. E. and E. van Wincoop (2004) shows that while the cost of tariffs and non-tariff barriers is 7.7% for the cost of marine transportation, the impact of the cost of transportation is greater at 10.7%.[12] Based on these factors, it can be said that the impact of transportation costs is particularly large compared to tariffs and non-tariff barriers even in ordinary circumstances.

In light of the surge in transportation costs, the imbalance in container transportation leads to restricted warehouse capacity and congestion in the Port of Los Angeles and other ports. In addition, restricted land transportation together with other factors has led to a surge in maritime freight rates. In contrast, in order to have delivery without backhauls, it is necessary to significantly limit the import of favorable goods in accordance with the processing capabilities and export volume of the port. This could lead to tight supply and demand and inflationary pressures.

Thus, the impact of freight rates are greater than trade policy issues, and it is important to return them to normal from the perspective of backhaul issues as well. In order to achieve this, it is necessary to eliminate bottlenecks such port congestion in its early stages, warehousing capacity, and supply capacity of land transportation.

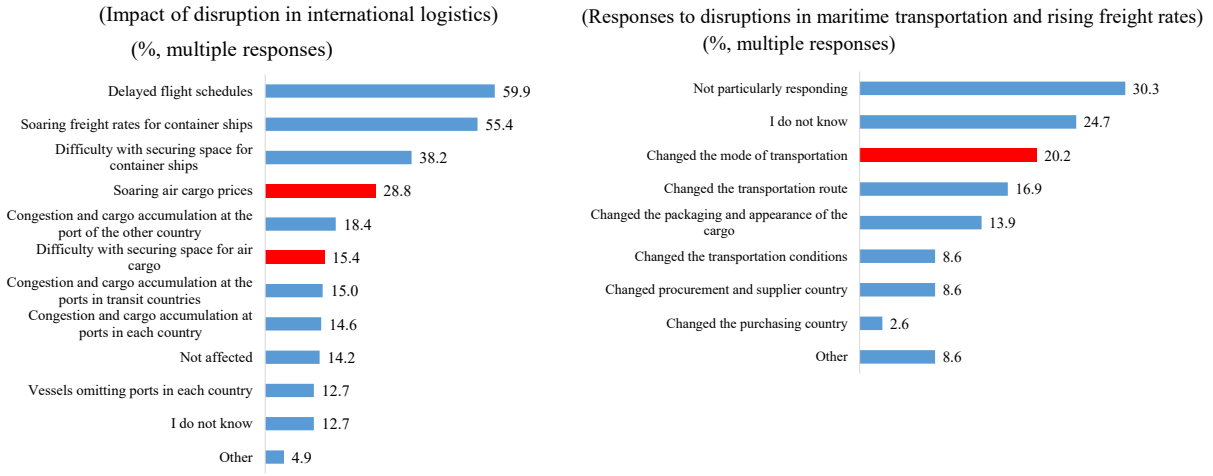
(2) Air transportation

In response to the tight supply and demand for marine transportation that we have looked at so far, there is a movement to replace marine transportation with air transportation along with increasing international cargo volume and rising air cargo rates. According to a survey released by JETRO in

[11] Ishikawa, J. and Tarui, N., (2016),"Backfiring with Backhaul Problems: Trade and industrial policies with endogenous transport costs" RIETI Discussion Paper Series 16-E-006.
[12] Anderson, J. E. and E. van Wincoop (2004), "Trade costs," Journal of Economic Literature, 42, p.691-751.

February 2022, in addition to the aforementioned responses to container ships, there are also concerns about air transportation, such as "soaring air cargo prices" and having "difficulty with securing air cargo space." Responses to disruptions in marine transportation and rising freight rates included "not particularly responding," "I do not know," and "changed the mode of transportation (from sea to air transportation or air to small scale sea transportation)" (Figure I-1-2-7).

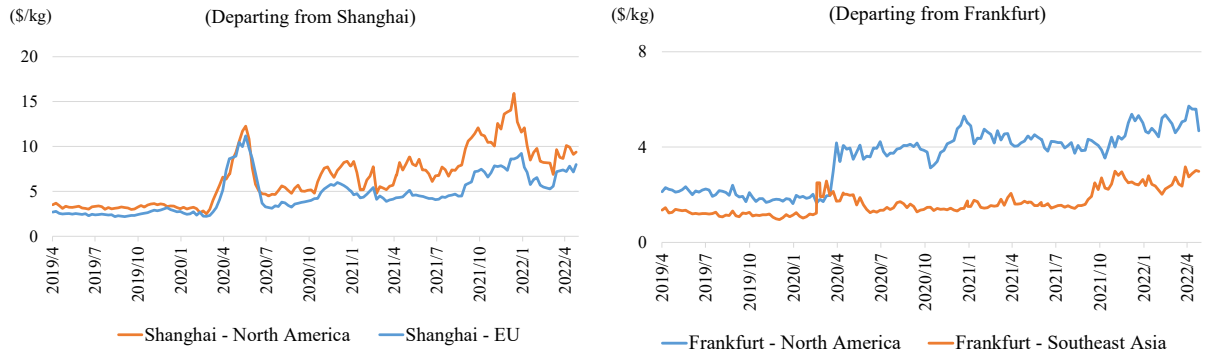
Figure I-1-2-9. The impact of disruption in international logistics and responses to it



Source: *Supply Constraints, Transport Disruptions and Corporate Responses (February 17, 2022)* (JETRO).

Looking at the condition of airfares with the increase in demand for air transportation, it can be confirmed that airfares from Shanghai rose sharply, peaking in May, 2020, due to tight supply and demand after rapid economic recovery after Shanghai being the first to contain COVID-19. Although temporary freight rates subsequently declined afterward, in the United States, demand for goods remained strong even amid the spread of COVID-19, and demand for change in the mode of transportation increased due to tight supply and demand for marine transportation. During the year-end sales season, freight rates to North America rose again at the end of 2021, exceeding its peak in May 2020. In addition, airfares from Frankfurt to North America have been high since the sharp rise in 2020, and prices have accelerated further toward the year-end sales season. In 2022, airfares have been rising due to the effects of Russia's aggression against the Ukraine tightening supply and demand due to flights being reduced and increasing fuel costs due to flight routes being changed to detour routes that avoid Russia's airspace and soaring the fuel prices (Figure I-1-2-10).

Figure I-1-2-10. Trends in air freight rates



Source: TAC Air Cargo Freight Index, Refinitiv.

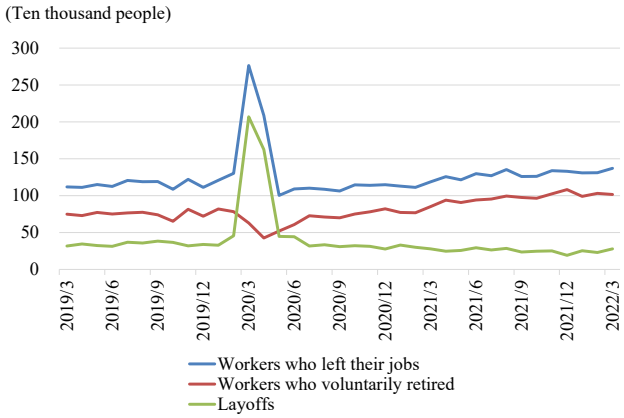
(3) Land transportation

In addition to marine and air transportation, trade between foreign countries requires domestic transport from airports and ports, as well as long-haul, cross-country trucks. In the United States, there is a shortage of port workers, warehousing and inland truck drivers. In some cases, cargo of container ships arriving at ports is not transported due to clogged domestic logistics, coupled with soaring prices for used trucks. According to the ATA (American Truck Associations), there is a shortage of approximately 80,000 truck drivers as of 2021, and it is estimated that there will be a shortage of 160,000 truck drivers by 2030[13]. In addition to increased demand for cargo, early retirement, and the closure of license schools during the COVID-19 pandemic, particularly in Canada, restricted supply of logistics is worsening due to demonstrations of truck drivers spreading against the mandatory vaccination for COVID-19. Looking at the number of workers who left their jobs in the transportation sector in the United States, while the number of layoffs has been on a downward trend after it rose sharply during the COVID-19 crisis, the number of workers who voluntarily retired has reached 1.02 million in March 2022, a level approximately 1.5 times higher than 2019's average of about 700,000 workers (Figure I-1-2-11)[14].

[13] *Driver Shortage Update 2021 (*ATA, 2021) (https://www.trucking.org/sites/default/files/2021-10/ATA%20Driver%20Shortage%20Report%202021%20Executive%20Summary.FINAL_.pdf).

[14] The number of workers who voluntarily retired is not only growing in the transportation sector, but also in the U.S. labor market. See Part I, Chapter 2, Section 2, “the U.S.” for developments in the U.S. labor market.

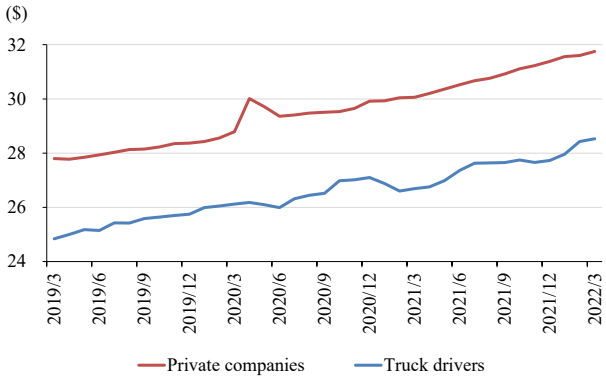
Figure I-1-2-11. Number of workers who left their jobs in the transportation sector in the United States



Note: Seasonally-adjusted values.
Source: U.S. Department of Labor, CEIC.

Although efforts in increasing wages to eliminate the shortage of truck drivers can be seen, tight supply demand conditions continues as there is still a labor shortage due to wage levels still being lower than those of private companies, the mental and physical burden that the job comes with, as well as due to prejudices about the job, and an increase in the number of young people who want to go on to university (Figure I-1-2-12).

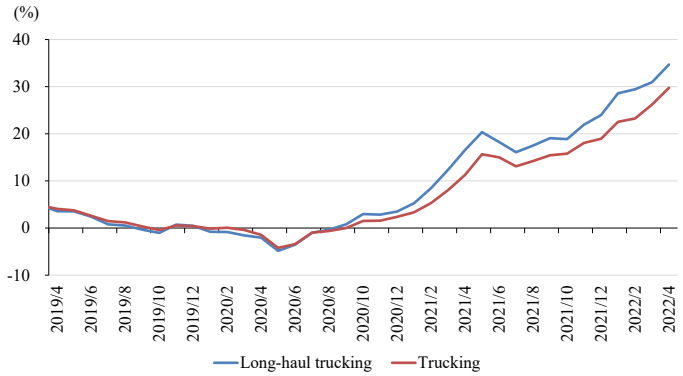
Figure I-1-2-12. Average hourly wage of truck drivers in the United States



Note: Seasonally-adjusted values.
Source: U.S. Department of Labor, CEIC.

However, this increase in wages has contributed to raising transportation costs, and together with the substantial rise in energy prices, the Producer Price Index for trucking has pushed up logistics costs by 29.8% and long-haul trucking has pushed it up by 34.7% year-on-year as of April 2022(Figure I-1-2-13).

Figure I-1-2-13. Producer Price Index for trucking in the United States (Year-on-year changes)



Note: Unadjusted values.
Source: U.S. Department of Labor.

Under these circumstances, many national governments are taking measures to eliminate logistics disruption. In Japan for example, the Ministry of Land, Infrastructure, Transport and Tourism has issued a request for cooperation to related organizations such as shippers, container ship companies, and logistics companies regarding the efficient use of containers and securing transportation space on February 5, 2021, to improve the supply and demand situation for international maritime container transport from and to Japan in response to the global shortage of international maritime container transport capacity and empty containers. Since April 2021, multiple container ship companies have been using container terminals at the Port of Yokohama, making operations more flexible. Furthermore, in April 2021 and January 2022, the Ministry of Economy, Trade and Industry, the Ministry of Land, Infrastructure, Transport and Tourism, and the Ministry of Agriculture, Forestry and Fisheries jointly held "information sharing meetings to promote cooperation with regard to the problem of container shortages for related persons." The meetings focused mainly on logistics disruption of container ships and analyzed the main factors behind the container shortage which were "(1) decreased production volume of new containers before the spread of COVID-19," "(2) rapid increase in shipments from Asia to North America," "(3) reduced container processing capacity due to a shortage of port workers[15]," and "(4) containers not being forwarded to Asia due to lingering empty containers in Europe and the United States[16]."

In the United States, efforts, especially for marine transportation, are being made to eliminate congestion through measures such as changing operation hours of ports to 24 hours a day, 7 days a week, alleviating restrictions on stockpiling containers at ports, imposing penalties for berthing

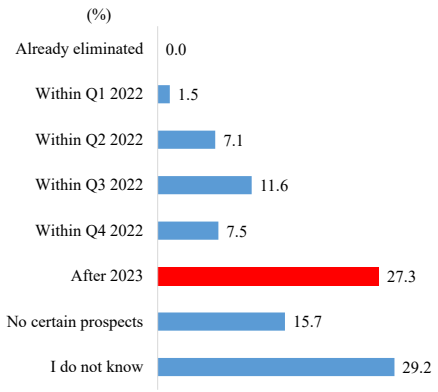
[15] Container production in China has recovered since the second half of 2020, and has doubled in 2021. China has been making progress in collecting empty containers from overseas, and has collected 4.9 million TEU as of October 2021.

[16] *Information Sharing Meetings with Regard to Container Shortages* (Ministry of Economy, Trade and Industry , Ministry of Land, Infrastructure, Transport and Tourism, Ministry of Agriculture, Forestry and Fisheries, 2021, 2022) （https://www.mlit.go.jp/report/press/tokatsu01_hh_000586.html）

container ships and storing containers in ports, and receiving piers and container storage locations used by the Navy in ports[17].

Although there are some signs of improvement in logistics as a whole so far, eliminating congesting has been slower than expected by the market[18]. According to a February survey conducted by JETRO, 27.7% of respondents forecasted that congestion and high transportation costs will be eliminated during 2022, while 27.3% forecasted "after 2023," and 15.7% said that they have "no certain prospects," which suggests that logistics disruption is expected to be prolonged (Figure I-1-2-14).

Figure I-1-2-14. Forecasts of when congestion and soaring transportation costs will be eliminated



Note: As of February 9, 2022.
Source: *Supply Constraints, Transport Disruptions and Corporate Responses (February 17, 2022)* (JETRO).

2. Growing seriousness of labor shortages

The spread of COVID-19 has significantly affected the labor market, and many jobs have been lost. Just as labor shortage in land transportation has led to supply constraints in the supply chain, the loss of jobs, labor shortages, and wage increases that come with them have had a large effect on price increases and supply delay in production of goods and services. Here we will look at the situation of employment and job loss in the labor market, and its effects.

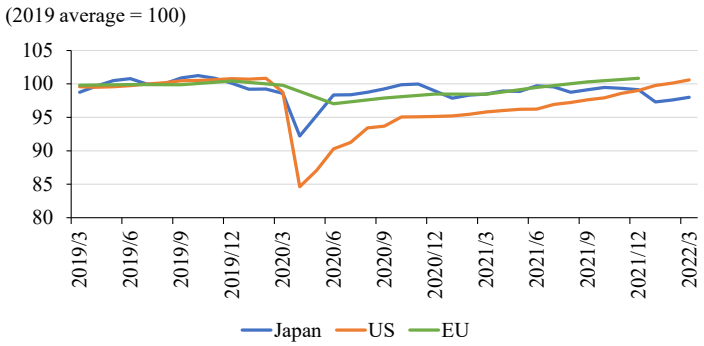
Looking at the indexed number of workers in Japan, the United States and the EU to make an international comparison of how job loss during COVID-19 affected the labor market and supply

[17] USNI News (2021) "Navy Opens Up Military Deep-water Pier to Merchant Ships to Ease California Cargo Crisis."

[18] A.P. Moller - Maersk, a global marine transportation giant in Denmark, said that eliminating the delay would take longer than the company had previously expected. They said that West Coast region of the United States had the largest number of waiting days for unloading and loading container ships at the beginning of 2022. And for Northern Europe, they expect that the number of waiting days at the Port of Antwerp in Belgium will decrease from ten days at the beginning of 2022 to about two days. *Ocean Transport at Maersk: Elimination of Shipping Delays Taking Longer than Expected* (Reuters, 2022) (https://jp.reuters.com/article/maersk-supply-chain-idJPKBN2JM02E).

chain, it can be confirmed that the number of workers in the EU and the United States has returned to pre-COVID-19 levels but not in Japan (Figure I-1-2-15).

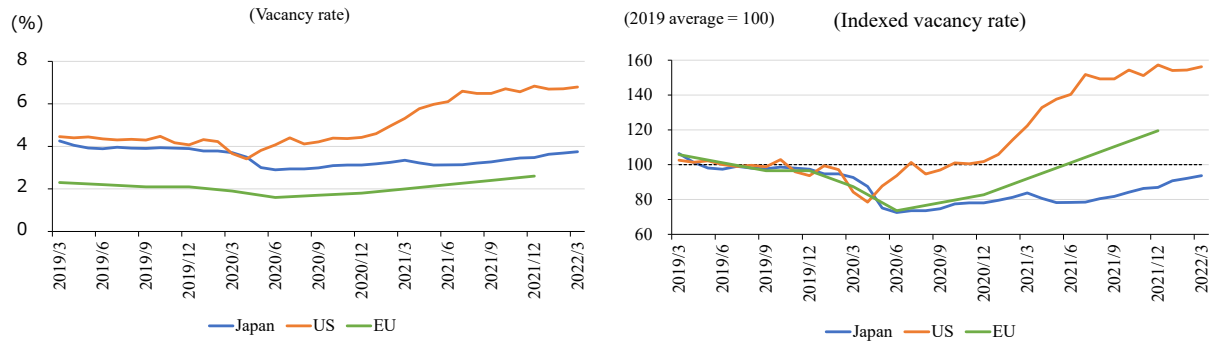
Figure I-1-2-15. Trends in number of workers



Note: The indices with 100 set as the value for 2019 average. Quarterly value for EU (released up until Q4 2021).
Source: *Labor Force Survey* (Ministry of Internal Affairs and Communications), U.S. Department of Labor, eurostat.

Next, we will look at the vacancy rate after the COVID-19 crisis, calculated based on the number of workers and the number of job offers (Fig. I-1-2-16) as it can show whether labor demand is recovering. The vacancy rate in United States has been higher compared to Japan and the EU before COVID-19, but it has risen along with the economic recovery after COVID-19. Moreover, looking at the indexed vacancy rates, the vacancy rate in the United States has increased significantly since January 2021 after reaching pre-COVID-19 levels in July 2020. In addition, it can be confirmed that the EU has reached pre-COVID-19 levels since the second quarter of 2021, while Japan still has not (Fig. I-1-2-16).

Figure I-1-2-16. Trends in vacancy rates

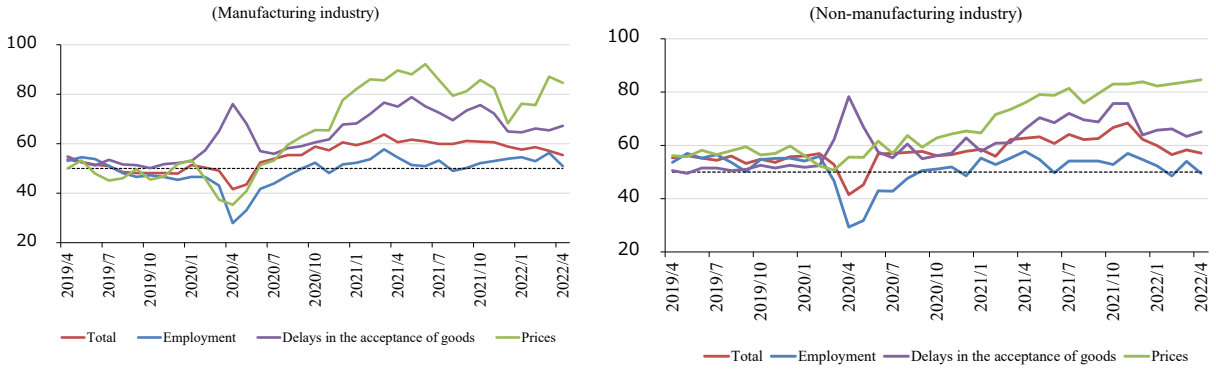


Note 1: Vacancy rate is calculated as number of job openings / (number of workers + number of job openings) * 100.
Note: The indices with 100 set as the value for 2019 average. Quarterly value for EU (released up until Q4 2021).
Source: *Labor Force Survey* (Ministry of Internal Affairs and Communications), *Statistics of Employment Security Services* (Ministry of Health, Labor and Welfare), U.S. Department of Labor, eurostat.

In the United States and the EU, labor demand has increased due to economic recovery but labor supply has not caught up and there have been labor shortages. Meanwhile, in Japan, economic recovery after COVID-19 has been delayed and there continues to be a shortage in labor demand.

Now let's look at the how labor shortages in the labor markets of the United States and the EU affected their economic activities. In the United States, the ISM Manufacturing and Non-Manufacturing Business Index, which is an index that represents the economy based on the results of surveys given to purchasing officers in manufacturing and non-manufacturing industries, shows that both manufacturing and non-manufacturing industries have shown strong recovery after the COVID-19 crisis. The employment index, on the other hand, is at a turning point for determining economic conditions at around 50, and is at a low level compared to the general index. This suggests that labor shortages are one of the factors limiting supply in the economy as a whole (Figure I-1-2-17).

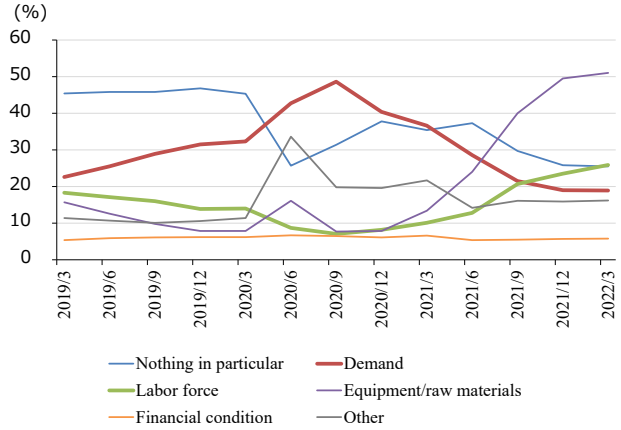
Figure I-1-2-17. ISM Manufacturing and Non-manufacturing Business Index in the United States



Note: 50.0 is a level that is considered the turning point for economic expansion and contraction.
Source: Institute for Supply Management (ISM), CEIC.

Looking at the factors limiting production in the manufacturing industry in Europe, when the spread of COVID-19 began, a decrease in demand was the main limiting factor, but as of March 2022, about a half of all companies said that equipment and raw materials have been limiting factors. It can be confirmed that labor shortage is a limiting factor for about one in four companies (Figure I-1-2-18).

Figure I-1-2-18. Factors limiting production in the manufacturing industry in Europe



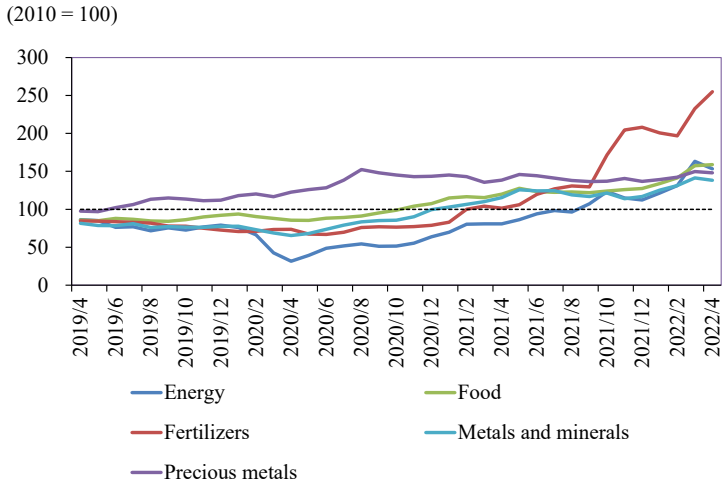
Note: Multiple responses possible.
Source: European Economic and Fiscal Authority, CEIC.

3. Increases in resource and energy prices

Resources and energy are goods whose price fluctuations and supply and demand conditions are affected by global shocks such as the spread of COVID-19 and abnormal weather associated with climate change, as well as trends in other supply-constraining factors. Furthermore, Russia and Ukraine are major suppliers of some resources and energy, as the future of the world economy is becoming increasingly uncertain due to the Russia's aggression against Ukraine, therefore, the supply volume is largely affected worldwide. Prices and supply-demand balance of resources and energy, which are affected by various factors, directly affect the stable supply of utilities and energy in households and firms, and have an indirect impact as the increase in input costs in production of goods and service provisions, which can lead to cost push inflation for a wide range of goods and services. With regard to resource and energy prices under these circumstances, we will confirm overall price trends, and then look at price rends by commodity, as well as changes in the environment surrounding each commodity and their price trends.

First, with regard to overall price trends for resources and energy, we will confirm the price trends of energy, food, fertilizers, metals, minerals, and precious metals based on the index of resources and energy prices published by World Bank (I-1-2-19).

Figure I-1-2-19. Trends in the global resource and energy price index



Note 1: Nominal value. Figures shown in dollars.
Note 2: Each index is calculated based on the following weights. Energy (coal: 4.7%, crude oil: 84.6%, natural gas: 10.8%), food (grain: 28.2%, oils and fats: 40.8%, other: 31%), fertilizers (phosphorus ore: 16.9%, phosphoric acid: 21.7%, potassium: 20.1%, nitrogen: 41.3%), metals and minerals (aluminum: 26.7%, copper: 38.4%, iron: 18.9%, lead: 1.8%, nickel: 8.1%, tin: 2.1%, zinc: 4.1%), precious metals (gold: 77.8%, silver: 18.9%, platinum: 3.3%)
Source: *World Bank Commodity Price Data (The Pink Sheet)* (World Bank Group, 2022).

The energy price index is calculated based on the price of crude oil, natural gas, and coal. The prices tumbled due to the expectation of a decline in demand caused by the worldwide spread of COVID-19, but then returned to the original level as economic activity resumed. Since then, prices have skyrocketed due to supply chain clogging and tight supply and demand for crude oil, natural gas, and coal. In addition, Russia's aggression against Ukraine has exacerbated the tight supply and demand for crude oil and natural gas, pushing up prices.

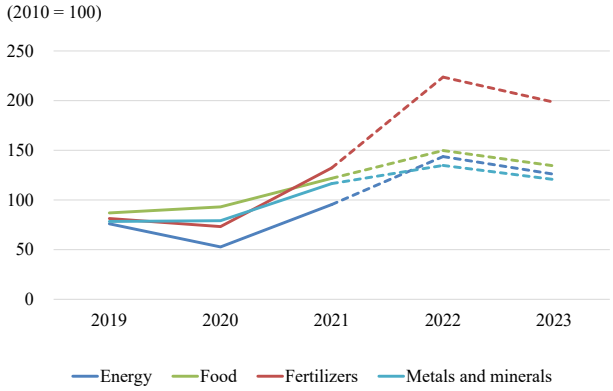
Food prices did not fluctuate significantly due to the spread of COVID-19, but the decline in production and quality affected by abnormal weather such as droughts, floods, and cold waves pushed prices up, as well as the soaring prices of input goods such as energy and fertilizer, leading to a surge in food prices.

Regarding fertilizers, prices have risen due to the decrease in the supply of ores, which are the raw materials for fertilizers, and materials necessary for the manufacturing process, and the rise in input costs due to soaring energy prices have pushed up overall prices.

As for metals and minerals, prices have risen due to the COVID-19 pandemic reflecting the soaring prices of input goods, and have remained at a high level since mid-2021. In particular, the smelting and refining of raw materials consume a large amount of electricity, and the impact of soaring energy prices is significant. In addition, in response to the global trend toward decarbonization, demand for metals such as copper and nickel, which are necessary for the production of goods that contribute to decarbonization, has increased, leading to a tightening of supply and demand. This has led to a surge in prices. Precious metals are increasing in value as safe assets reflecting the decline in the real effective exchange rate of the U.S. dollar amid the COVID-19 pandemic and uncertainty about the future of the global economy.

With regard to the outlook for these resource and energy prices, the World Bank releases the price indices for the following year in April and October every year, and shows the changes from the previous forecasted values (Figure I-1-2-20).

Figure I-1-2-20. Trends and forecasts of nominal price indices for resources and energy



	Price indices (2010 = 100)					Annual rate of change (%)		Change in forecasted value (%)	
	2019	2020	2021	2022	2023	2022	2023	2022	2023
Energy	75.9	52.7	95.4	143.6	125.8	50.5	-12.4	91.7	30.6
Food	87.0	93.1	121.8	149.7	134.2	22.9	-10.4	57.2	15.7
Fertilizers	81.4	73.2	132.2	223.7	198.3	69.2	-11.4	150.5	82.2
Metals and minerals	78.4	79.1	116.4	134.8	120.6	15.8	-10.5	55.7	3.1

Note: Nominal values. The figures for 2022 and 2023 are forecasted values. Published in April 2022. The change in the forecasted value is the change from the previous forecast (published in October 2021).
Sources: *Commodity Markets Outlook* (World Bank Group, 2022).

According to Figure I-1-2-20, the price index for energy, food, fertilizers, metals and minerals in 2021 has risen significantly compared to 2020. Going forward, although the prices are expected to peak in 2022 and decline in 2023, they are expected to be higher than 2021. For energy and fertilizers, we have revised our future price forecasts significantly upward from October 2021. In addition, it can be confirmed that the price forecast for fertilizers has been revised significantly upward not only in 2022 but also in 2023. Taking into account the overall situation of resource and energy prices, we will look at price trends of individual commodities.

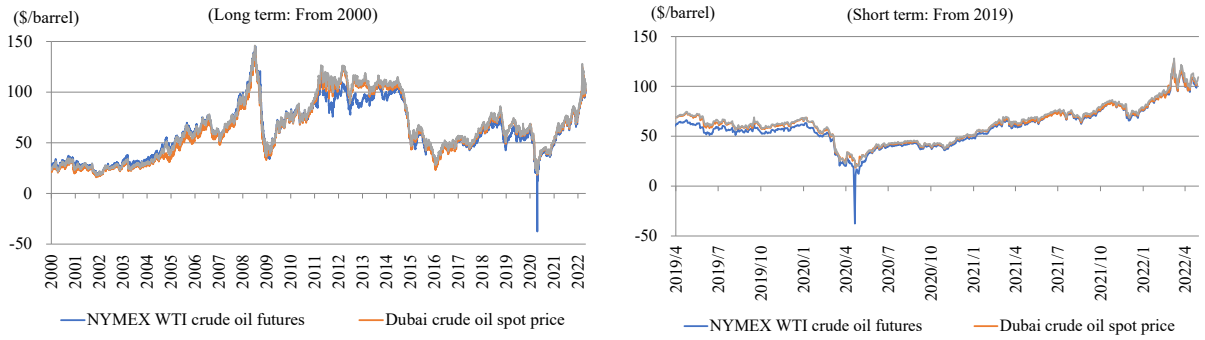
(1) Energy

As shown at the beginning of this section, the price and supply and demand balance of energy change due to various factors, but the surge in energy prices and tight supply and demand have a significant impact on utility costs and the stable supply of energy in households. Energy is also indispensable as input commodities for the production of goods, including food, fertilizers, minerals and metals, which will be discussed later. The soaring prices and tight supply and demand are directly linked to the supply constraints of goods and services. Here, we will confirm the price trends of crude oil, natural gas, and coal as major energy price trends.

(A) Crude oil price

Crude oil prices fluctuate due to a variety of factors, including supply and demand conditions, the U.S. dollar exchange rate, and trends in speculative funds. The trends in crude oil prices since 2000 and 2019 are as follows (Figure I-1-2-21).

Figure I-1-2-21. Trends in crude oil prices



Source: Refinitiv.

From January to April 2020, oil demand declined due to lockdowns, etc. around the world caused by the spread of COVID-19, and prices plummeted. Since then, the price has continued to rise from November 2020 to the present. Against this backdrop, expectations are growing for a recovery in oil demand amid the global economic recovery, and concerns are growing about tightening supply and demand due to the suspension of production in offshore oil fields due to the arrival of Hurricane Ida, and soaring prices of natural gas and coal in Europe and Asia. These led to the growing demand for oil as an alternative fuel, and the cautiousness of OPEC Plus oil-producing countries to reduce production even as oil supply and demand tightens and prices rise sharply.[19] Furthermore, in February 2022, the Russia's aggression against Ukraine started, and oil prices soared due to concerns that Russia, the world's third-largest producer of oil per day[20], would stagnate oil exports. The price of WTI crude oil futures prices temporarily exceeded $130 per barrel for March 6, 2022, the highest since July 2008. Since then, the price has fallen, but it has been at a high price of more than $100.

(B) Natural gas

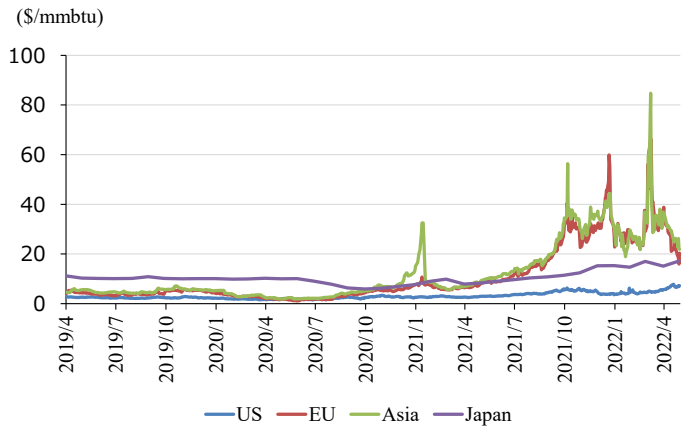
Natural gas prices have been rising since the spring of 2021. In the United States, production is possible in its own country, and the self-sufficiency rate is high, so the price continues to be stable and low. Since Japan procures liquefied natural gas under long-term contracts, the price of liquefied natural gas remains stable, but the price, including the transportation cost, is higher than that in the United States, Europe, and Asia. Since the start of 2021, spot markets in Europe and Asia have

[19] *Crude Oil Market, etc.: OPEC and Some Non-OPEC (OPEC Plus) Oil Producing Countries Decided to Reduce Production by 400,000 Barrels per Day even for March 2022 Month on Month in Accordance with the Previous Policy (Prompt Report)* (JOGMEC, 2022) (https://oilgas-info.jogmec.go.jp/_res/projects/default_project/_page_/001/009/261/2202_d_opec.pdf).

[20] Statistical Review of World Energy 2021 (BP, 2021)(https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html).

skyrocketed, and the average import price in Japan has also been on an upward trend in response to rising international prices (Figure I-1-2-22).

Figure I-1-2-22. Natural gas price trends



Note: UK NBP (National Balancing Point) spot price for Europe, HH (Henry Hub) spot price for the US, JKM (Japan-Korea Marker) spot price for Asia, and the average import price of liquefied natural gas for Japan.
Source: Platts, World Bank Group (2022).

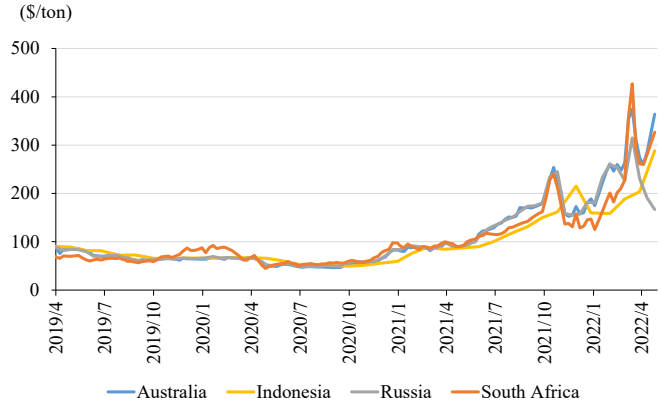
As the background of the soaring price of the natural gas in Europe, the price of natural gas in Europe rose by around 20% in November 2021 when the German energy regulator suspended the approval process for the management company of Nord Stream 2, a pipeline from Russia to Europe, because it needed to revise its independence. In January 2021, the EU-ETS (EU Emissions Trading System) price rose, encouraging the conversion of fuel for power generation from coal to natural gas, and consequently boosting the demand for natural gas. In addition, at the beginning of 2021, because most of the world's spot LNG was procured by Japan, China, and Republic of Korea due to the arrival of a cold wave in Northeast Asia, Europe has been unable to import LNG, which has led to the use of storage inventories. However, in northwestern Europe, demand increased when temperatures were about five degrees lower than usual, and the inability to store natural gas continued, consequently resulting in pushing up prices. Although demand for heating paused at the beginning of 2022 and peaked out temporarily, the situation in Ukraine has led to widespread anxiety over supply from Russia and been continuing violent fluctuations.

In Europe, about 80% of the natural gas procured is based on spot prices, so daily fluctuations in energy prices have a significant impact on electricity and gas prices, causing confusion in each country. In addition, the shift to renewable energy is rapidly progressing toward decarbonization, and at the same time, there is a movement to reduce and abolish investment in thermal power generation. Portugal and Spain had a high share of solar and wind power generation among renewable energies, and had a small share of coal and oil, and had to use natural gas as a backup power source, but the supply and demand for energy became tight due to the continued insufficient daylight hours and air flow caused by bad weather.

(C) Coal

Coal prices have been on an upward trend since the beginning of 2021 (Figure I-1-2-23).

Figure I-1-2-23. Trends in coal prices



Note: Newcastle for Australia, government-published coal index price (HBA) for Indonesia, Vostochnny for Russia, and Richards Bay in South Africa.
Source: Refinitiv.

This background includes, sluggish investment in coal development and other factors amid the global trend toward decarbonization and the suspension of coal mine operations due to coal mine accidents and natural disasters Because of the growing conflict between Australia and China., the transportation disruption caused by China's reducing its import of Australian coal and increasing procurement of coal from other coal-producing countries is also one of the background factors.

In Indonesia, the world's largest coal exporter, an increase in the number of companies that have violated their domestic supply obligations (DMO) and have pushed ahead with overseas supplies has led to a shortage of coal inventories for use in coal-fired power plants in Indonesia. In response, Indonesia suspended coal exports in January 2022. While DMO-compliant companies have resumed exports, tight supply and demand have pushed up coal prices.

In addition, following the Russia's aggression against Ukraine stated in February 2022, Europe is moving away from its dependence on natural gas through pipelines from Russia. The price of Russian coal has been pushed up as demand for coal as an alternative resource to natural gas, whose price had been soaring before Russia's aggression against Ukraine[21]. However, in light of the current situation, the move to break away from dependence on Russian coal has led to a rise in coal prices in other countries.

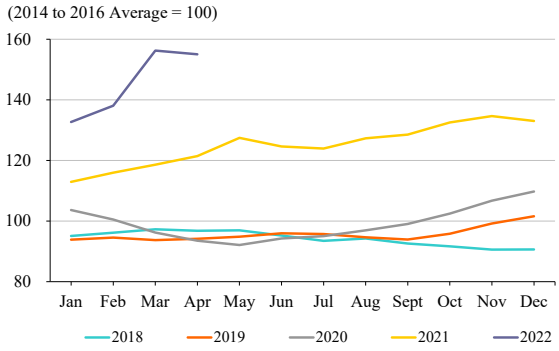
(2) Food

A rise in food prices has a direct impact on households and increases the cost of input goods such as livestock feed and raw materials for processed goods, which, together with the cost of energy and fertilizers, etc., may lead to a rise in the prices of food and services. The FAO shows the overall food

[21] *Russian Prevailing Coal Prices Soar* (JOGMEC, 2021) (https://coal.jogmec.go.jp/info/docs/210916_19.html).

price trend as a real food price index, and the indices based on the average between 2014 and 2016 shows the following trends (Figure I-1-2-24).

Figure I-1-2-24. Real food price indices

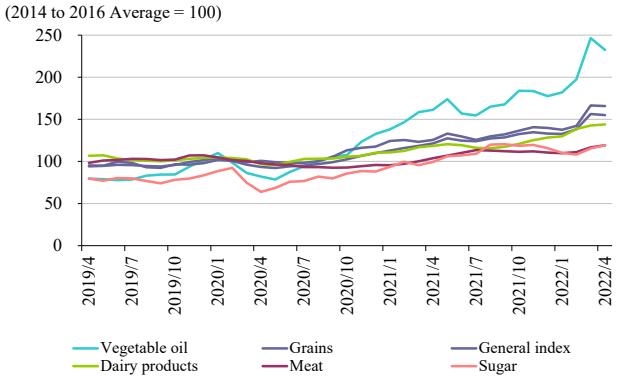


Source: FAO.

We can confirm the real food price index has been on an upward trend since May 2020. The background is considered to have multiple factors, but it is mainly due to unseasonable weather, such as high-temperature drying in North America and droughts in South America. The impact of soaring prices of production materials, and food demand associated with the increase in global population growth are also considered to be included in the factors. In addition, the impact of Russia's aggression against Ukraine has caused a partial disruption of supply chains, including Russia and Ukraine, which produce and export large amounts of grain, etc. worldwide, leading to soaring international prices.

Next, we look at price indices by item (Figure I-1-2-25).

Figure I-1-2-25. Price indices of food by item



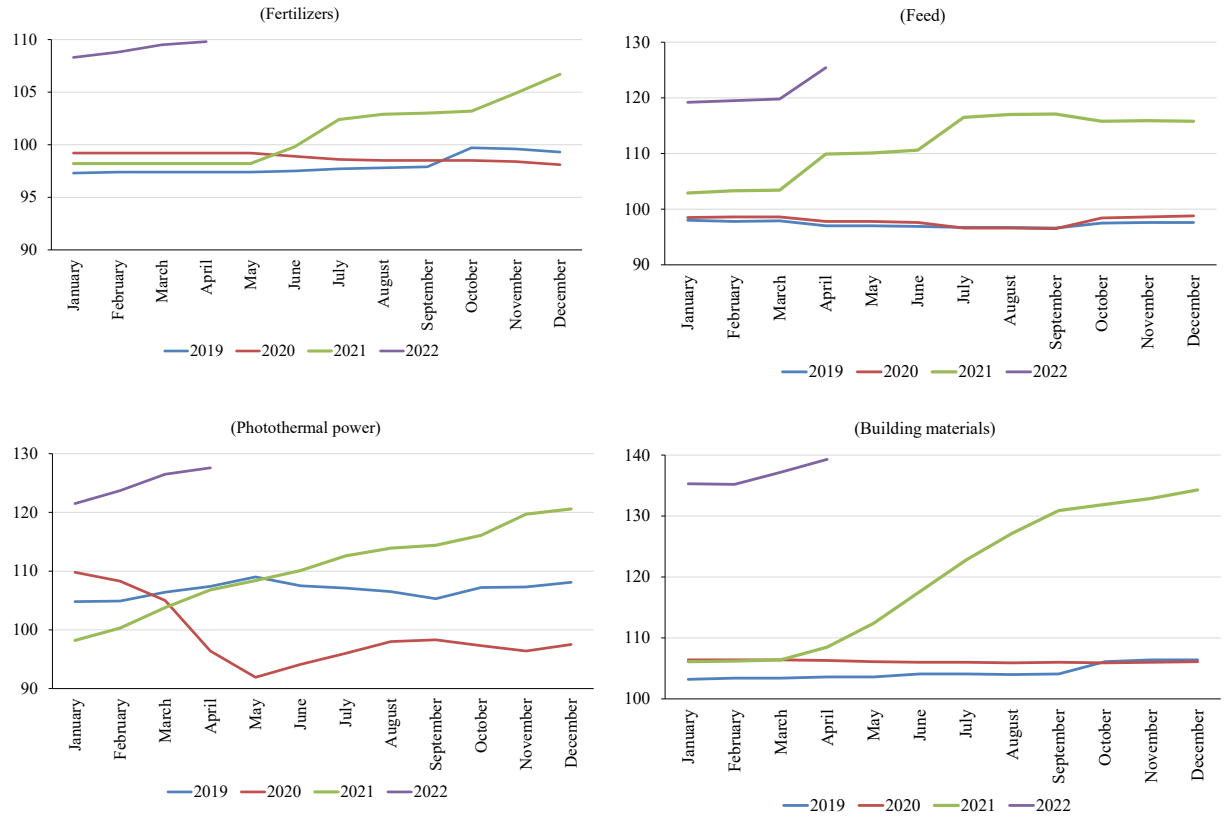
Source: FAO.

Looking at price trends by item, vegetable oil and grain are pushing up overall prices. Palm oil contained in vegetable oil has pushed up the price index of vegetable oil against the backdrop of a decline in supply in Indonesia, the world's largest producer and exporter. As for grain, Russia is the world's largest exporter of wheat, the world's second largest exporter of barley, and Ukraine is the world's fourth largest exporter of corn. Thus, both countries occupy the large percentage in the export

value of grain, and have caused the price rise due to the Russia's aggression against Ukraine. Japan imported more than 99% of wheat and barley from three countries in 2021: The United States, Australia and Canada. In terms of corn, it imports more than 80% from two countries: The United States and Brazil[22]. As a result, although the direct impact of the surge in prices is small in Japan, the decline in global supply and the change in the balance of the international grain market are likely to cause the spread of the effects of the price surge in Japan.

Food is also affected by rising prices of production materials. Fertilizers necessary for growing crops, feed necessary for raising livestock, energy necessary for controlling the temperature of livestock sheds and horticultural facilities, and covering materials used for houses and tunnels, etc. are all essential production materials and have experienced price hikes due to the COVID-19 pandemic (Figure I-1-2-26).

Figure I-1-2-26. Changes in prices of production materials (in Japan)



Note: The indices with 100 set as the value for 2015 average.
Source: *Agricultural Price Indices* (Ministry of Agriculture, Forestry and Fisheries).

J. D. Winne and G. Peersman (2019) point out that the impact of extreme weather on agricultural production volume and prices not only affects some regions and commodities, but also globally[23]. In

[22] *Information on Import and Export of Agriculture, Forestry and Fishery Products* (Ministry of Agriculture, Forestry and Fisheries, 2022).

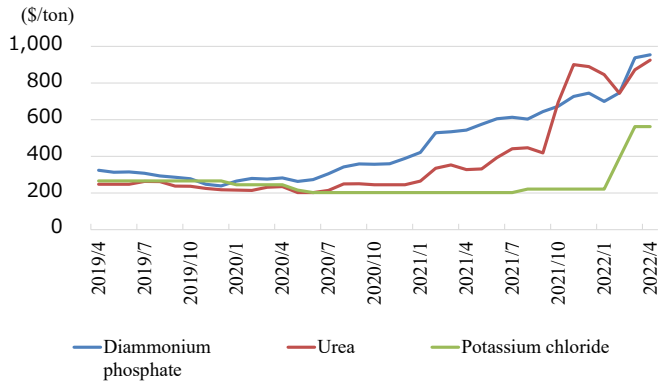
[23] Winne, J. D. and G. Peersman (2019), "The Impact of Food Prices on Conflict Revisited," *Journal of Business & Economic Statistics*, Vol. 39, Issue 2, 2021.

developed countries, despite food accounts for a lower share of household spending than in low-income countries, the impact is significant. It also suggests that the impact of climate change on developed countries may be greater than previously thought, as countries that are net exporters of agricultural products are less affected. Regarding the relationship between the global environment and food, there are concerns about the impact of the large-scale eruption of a submarine volcano in Tonga that occurred on January 15, 2022. When the eruption of Pinatubo volcano in the Philippines occurred in 1991, a large amount of sulfur dioxide contained in the ejecta reached the stratosphere, and the sunlight reaching the ground weakened. Therefore, the average air temperature on the whole Earth was lowered by about 0.5 degrees. In 1993 when two years had passed since the eruption, Japan experienced record cold summer with the average air temperature declined by two to three degrees, leading to the "Rice Riots of 1993" that the rice production volume decreased. On the other hand, the amount of sulfur dioxide in the Tonga eruption was 2.3% of that in the Philippines in 1991, and the temperature drop is expected to be limited[24].

(3) Fertilizers

Fertilizers are essential for the growth of vegetables and grains, and tight supply and demand and soaring prices of fertilizers could lead to poor harvests, poor quality, and soaring prices in food production. Fertilizers consist mainly of three elements: Nitrogen, Phosphate, and Potassium[25]. Looking at the commodity prices published by the World Bank, fertilizers containing the above three elements, i.e. diammonium phosphate, urea, and potassium chloride, the price of diammonium phosphate has skyrocketed since the second half of 2020, and that of urea has skyrocketed since 2021. Although the price of potassium chloride was relatively stable, it has skyrocketed since 2022 (Figure I-1-2-27).

Figure I-1-2-27. Changes in fertilizer prices



Note: Nominal values. Figures shown in dollars.

(https://www.tandfonline.com/doi/full/10.1080/07350015.2019.1684301?scroll=top&needAccess=true&).

[24] *Column: [Tonga Undersea Volcanic Eruption] - Can Tonga Undersea Volcanic Eruption affect the Climate?*- (JAMSTEC, 2022) (https://www.jamstec.go.jp/j/jamstec_news/tonga/column01/).

[25] *Classification of Fertilizers* (Japan Fertilizer & Ammonia Producers Association) (http://www.jaf.gr.jp/hiryou.html).

Source: *World Bank Commodity Price Data (The Pink Sheet)* (World Bank Group, 2022).

The reason for the surge in prices is the surge in the prices of logistics and input goods. Ammonia, which is necessary for the production of diammonium phosphate and urea, is manufactured using fossil fuels such as coal and natural gas as raw materials.[26] The price is skyrocketing due to the soaring prices of coal and natural gas. About 80% of ammonia is used for fertilizers, and the remaining 20% is used for industrial applications[27], such as the production of resins and synthetic fibers, and the production of urea solution necessary for the reduction process of nitrogen oxides in diesel engines. In recent years, the use of ammonia has been attracting attention as a carrier (transport medium) for hydrogen, a next-generation energy, and as a carbon-free fuel that does not emit carbon dioxide when burned, and its demand is expected to increase further in the future. Ammonia production is approximately 200 million tons per year (2019), with the top producing countries being China, Russia, the U.S., and India. China accounts for about a quarter of the total and the majority of the top four countries[28]. In China, most ammonia is produced from coal, and ammonia production has decreased due to a decrease in coal production caused by the restraint of coal production volume in response to environmental problems in China. This reduction in ammonia production has led to a tightening of supply and demand for urea and urea solution, and China has restricted the exports since October 2021. Regarding the nitrogen oxide (NOx) emitted by diesel engines, urea solution "AdBlue" is required as a consumable product to operate a urea SCR system that use the property to reduce nitrogen oxides to water using ammonia obtained by hydrolysis of urea[29]. Against this backdrop, the Republic of Korea relies on imports from China for about 60% of its urea consumed amount, resulting in soaring prices and a shortage of urea water[30]. As Japan relied on imports from China for about 30% of its urea, there was a shortage of urea solution, however, we are responding the shortage by requesting domestic companies for the maximum production increase and by increasing imports from countries, including Vietnam, other than China[31].

(4) Metals and minerals

Metals and minerals play a major role as raw materials in the production of various goods. Their prices and the tight supply and demand lead to the soaring prices of consumer goods and supply lag, and also have an impact on the manufacture of production goods and capital goods, Thus, they have a broader impact on the supply chains. In particular, demand for metals, which are the raw materials

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26 *Energy White Paper 2022* (Agency for Natural Resources and Energy, 2021).

27 *Will Ammonia Become Fuel? (First Part) - Applications of Ammonia, which Are Familiar but Not Really Known* (Agency for Natural Resources and Energy, 2021) (https://www.enecho.meti.go.jp/about/special/johoteikyo/ammonia_01.html).

28 *Mineral Commodity Summaries 2022 - Nitrogen* (USGS, 2022) (https://pubs.usgs.gov/periodicals/mcs2022/mcs2022-nitrogen.pdf).

29 Some vehicle models exceed environmental standards without using urea solution as CVD (Clean Diesel Vehicles).

30 *Korea's Shortage of Urea Solution May Disrupt Logistics* (JETRO, 2021) (https://www.jetro.go.jp/biznews/2021/11/50300a8ceb9a2545.html).

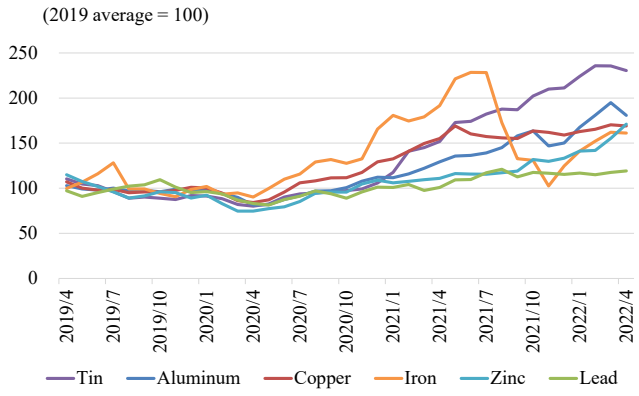
31 *Measures to Ease the Supply and Demand of AdBlue Are Ongoing* (Ministry of Economy, Trade and Industry, 2021) (https://www.meti.go.jp/press/2021/12/20211224003/20211224003.html).

necessary for the production of goods related to the energy shift toward decarbonization, increases over the medium to long term, and the effects of price hikes and tight supply and demand may be prolonged.

As for the classification of metals and minerals, metals such as iron, aluminum, and copper, which have a large amount of reserves and production and are relatively easy to refine, are called base metals. On the other hand, metals such as titanium, cobalt, and nickel, which are produced in small quantities or are difficult to extract, are called rare metals. In addition, 17 elements, which are part of rare metals, are called rare earths, and are indispensable materials for products using advanced technologies. In addition, gold, silver, and platinum are classified as precious metals and serve as assets and as raw materials for accessories, etc. Some minerals are used as catalysts for automobiles and so on.

Looking at price trends by metal type, tin is used as solder for the manufacture of electronic circuits and as a raw material for plating. In Malaysia and Indonesia, where the majority of tin ore is produced, production has been suspended due to lockdowns. As a result of the shutdown of the melting furnace in Malaysia, the supply volume has decreased and the price has risen sharply (Figure I-1-2-28). Regarding aluminum, among non-ferrous metals, the cost of electricity required for production is high, and more than half of refineries in Europe have decreased the production or have been temporarily closed, pushing up prices due to reduced supply and soaring prices of input goods. As with aluminum, prices of lead, which is the raw material for storage batteries, and zinc, which is the raw material for steel plating and die casting, are also rising due to the high cost of electricity. Copper is also related to energy transitions, but in the midst of global decarbonization, prices have been pushed up by increasing demand for copper wires for motors needed for power grids of renewable energy and the electrification of automobiles. A shift from copper to aluminum has been seen against the backdrop of rising copper prices, but the soaring price of aluminum has pushed up production costs. Iron ore prices were once stable, but demand for steel is expected to increase in the future as the Chinese government announced economic stimulus measures in the construction and infrastructure sectors.

Figure I-1-2-28. Price trends of base metals

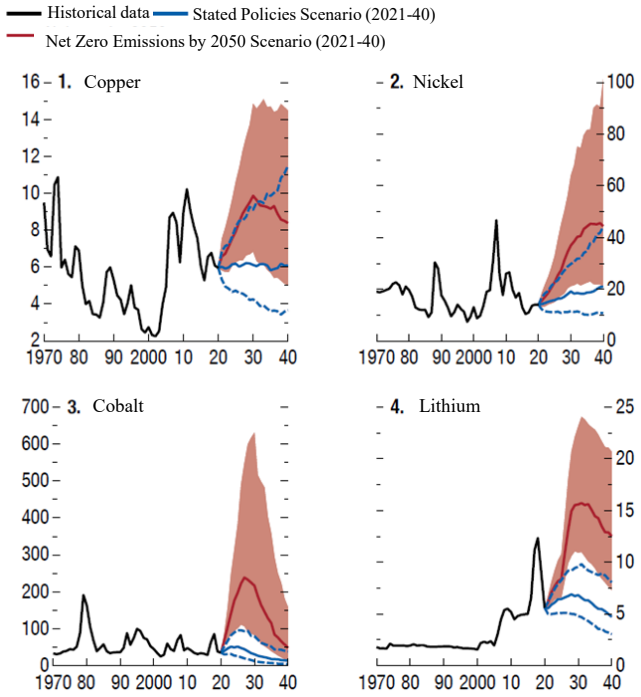


Note 1: Nominal value. The indices based on the average value of 2019.
Note 2: The prices of iron are iron ore spot prices (for China, 62% Fe content). The prices of other metals are LME average prices.

Source: *World Bank Commodity Price Data (The Pink Sheet)* (World Bank Group, 2022) (Ministry of Economy, Trade and Industry).

With regard to medium- to long-term trends in metal prices, the IMF has pointed out that as the world makes a major move toward decarbonization, the demand for metals such as copper, nickel, cobalt, and lithium, which are necessary for storing energy such as batteries for electric vehicles, will rise than ever before, and the prices may skyrocket.[32] The price forecast for each metal is shown below (Figure I-1-2-29).

Figure I-1-2-29. Scenario of major metal prices required for energy transitions



Note 1: The unit is thousand U.S. dollars. The prices are a price per ton in value as of 2020.
Note 2: The data source is IEA, Schwerhoff and Stuermer (2020), U.S. Bureau of Labor Statistics, U.S. Geological Survey, and the trial calculation conducted by IMF staff
Note 3: The prices are adjusted with the inflation rate using the U.S. Consumer Price Index. The scenario is based on demand shocks specific to metals. The swings of the "Net Zero Emissions by 2050 Scenario" from 2020 onwards (red shaded area) indicate confidence intervals with a highest posterior density of 40%.
Source: *WEO* (IMF, October 2021).

Suppose consumption under the substantial zero emission scenario must be met, these prices could reach unprecedentedly highest prices for a long time with no similar cases. Compared to 2020 levels, cobalt, lithium, and nickel are expected to increase by several hundred percent and copper by about 60 percent, reaching a peak around 2030. Copper is not expected to become a bottleneck because demand is not rising so rapidly. In addition to the four metals mentioned above, the Democratic Republic of

[32] *Soaring Metal Prices May Delay Energy Transition* (IMF, 2021) (https://www.imf.org/ja/News/Articles/2021/11/10/blogs-soaring-metal-prices-may-delay-energy-transition).

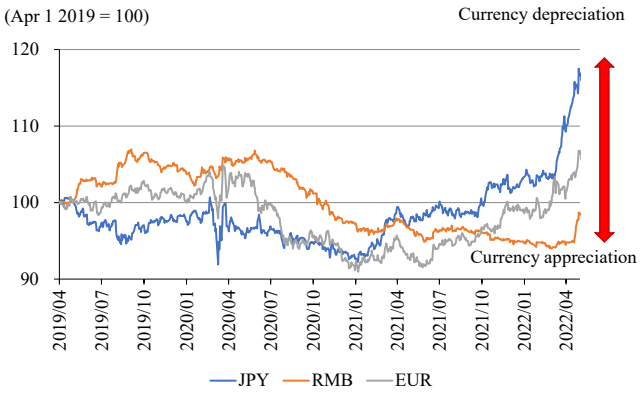
the Congo accounts for about 70% of the world's total production of cobalt and about 50% of its reserves. With the production of some minerals concentrated in some countries and regions, the report points out that some countries and regions that produce minerals may benefit as economic growth and improved fiscal balances. On the other hand, because the dependence on some countries and regions for the production of these important minerals can be a risk factor in the supply chain, it is necessary to understand the trend considering geopolitical risks in addition to such demand of important minerals and the production trend for energy transitions.

4. Exchange rate trends and changes in terms of trade

We have looked at disruptions in logistics, labor shortages, and soaring resource and energy prices. we will now look at movements in each process in the entire supply chain, and in relation, exchange rate trends and terms of trade.

Looking at exchange rate trends, the yen continues to depreciate against the U.S. dollar, pushing up prices of products imported to Japan including resources and energy (Figure I-1-2-30).

Figure I-1-2-30. Trends of indexed exchange rates against the U.S. dollar



Note: The exchange rate against the U.S. dollar is indexed with April 1, 2019 = 100.
Source: Refinitiv.

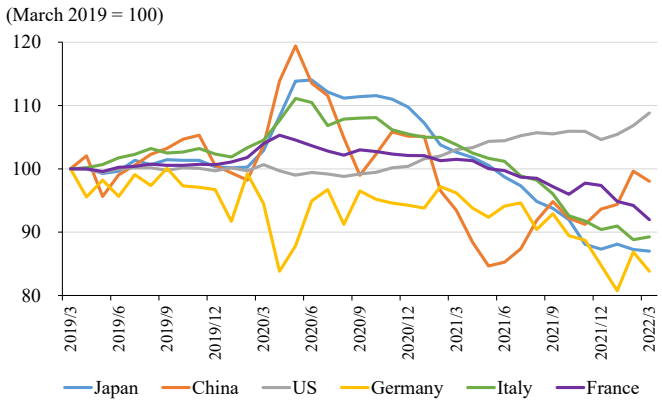
On April 13, 2022, the yen depreciated for the first time in about 20 years, at about 126 yen to the dollar. The depreciation of the yen is against the backdrop of the interest rate difference between Japan and the United States, and the establishment of a trade deficit due to soaring energy prices.

We will look at changes in terms of trade in light of exchange rate trends and increases in logistics and resource and energy prices. The terms of trade are calculated by dividing the export price of a good by its import price. When the export price is higher than the import price, the terms of trade improve, and conversely, when the import price is higher than the export price, the terms of trade worsen. Terms of trade have different trends mainly depending on the exchange rate trends of each country's currency, and their export structures and import structures. For example, if a country is rich in food and energy and has a high self-sufficiency rate, its commodity prices will fluctuate less, and

changes to its terms of trade are contained compared to those of other countries. However, for countries such as Japan that depend on countries abroad with a large amount of food and energy, their commodity prices fluctuate easily, and their terms of trade are prone to significant changes.

The following are changes in terms of trade by country (Figure I-1-2-31). Japan is highly dependent on countries abroad for resources, energy, and [33]food[34], and the impact of rising import prices is large. In addition, combined with the depreciation of the yen, this has led to worsening terms of trade. China's terms of trade worsened due to rising import prices, but they have been improving since mid-2021 due to rising export prices of electric machinery and other products. The United States' terms of trade have been improving due to rising export prices of industrial products, fuel, agricultural products, and other items that have exports with more weight than their imports. Germany depends heavily on other countries for energy sources such as natural gas and coal, and its terms of trade have worsened due to rising energy and resource prices. Italy depends heavily on other countries for raw materials, fuels, and agricultural products, and its terms of trade have been worsening together with the impact of the depreciation of the euro. France has a food self-sufficiency rate (based on calories as of 2018) of 125%, over 100%, and[35] a large percentage of its energy comes from nuclear power generation. Against this backdrop, because domestic production accounts for a high percentage of its total energy supply,[36] its commodity prices are unlikely to fluctuate. Although the terms of trade temporarily improved during the COVID-19 crisis, it did not fluctuate as much as those of other countries, and it has worsened since April 2020.

Figure I-1-2-31. Terms of trade



Note: Terms of trade = export price index / import price index. In addition, it is indexed with March 2019 = 100.
Source: Bank of Japan, National Bureau of Statistics of China, Datastream, Insee, Refinitiv.

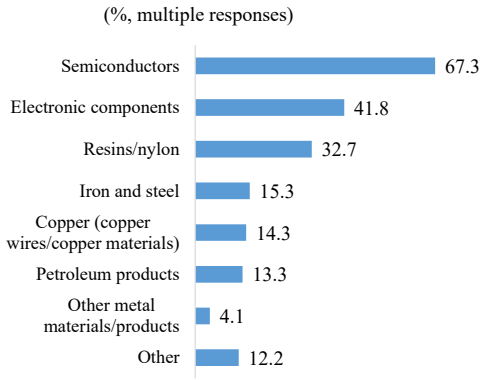
[33] Agency for Natural Resources and Energy (2022), "NIHON NO ENERGY," (https://www.enecho.meti.go.jp/about/pamphlet/energy2021/).
[34] Ministry of Agriculture, Forestry and Fisheries (2021), "SHOKURYOU JUKYUU HYOU."
[35] Same as above.
[36] IEA (2021), *France 2021 Energy Policy Review*, (https://www.iea.org/reports/france-2021).

5. Supply constraints of semiconductors and automotive parts

We will now look at supply constraints of semiconductors and automotive parts, which have had a significant impact on private consumption and corporate activities in the form of soaring prices and delays in delivery of final products.

According to a survey on supply chains conducted by JETRO on companies in ASEAN in February, semiconductors, electronic parts, and resin/nylon were given as raw materials that were in particularly short supply in the manufacturing industry (Figure I-1-2-32).

Figure I-1-2-32. Survey report on shortage of raw materials

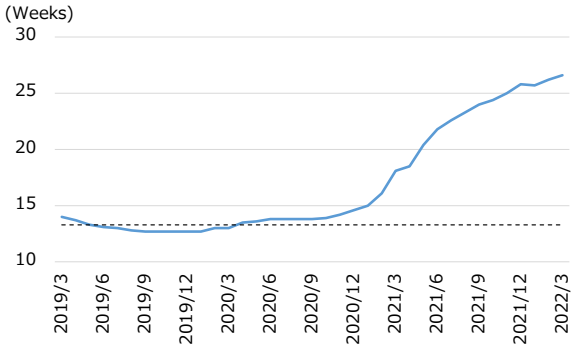


Note 1: Semiconductors refer to the product and components that contain wafers.
Note 2: Results of the emergency survey conducted on participants in the RCEP Seminar held by JETRO's offices in ASEAN on February 9, 2022. Out of the 267 companies that responded, 236 are subsidiaries in ASEAN.
Source: JETRO.

The semiconductor shortage is against the backdrop of factors such as an increase in demand for staying at home and telework during the COVID-19 pandemic, and an increase in demand for data centers due to the shift to electrification of automobiles and digitalization of services and labor. In addition, fires at factories of manufacturers of semiconductors and manufacturing facilities thereof in Japan and abroad, and the impact of factory closures due to the cold wave in the United States also contributed to the tight supply and demand.

Regarding the global semiconductor shortage, the lead time (time from order to delivery) was around 10 to 15 weeks before the COVID-19 pandemic, but as of March 2022, it has reached 26.6 weeks, the longest since 2017, and remains at a high level (Figure I-1-2-33).

Figure I-1-2-33. Lead time for semiconductors



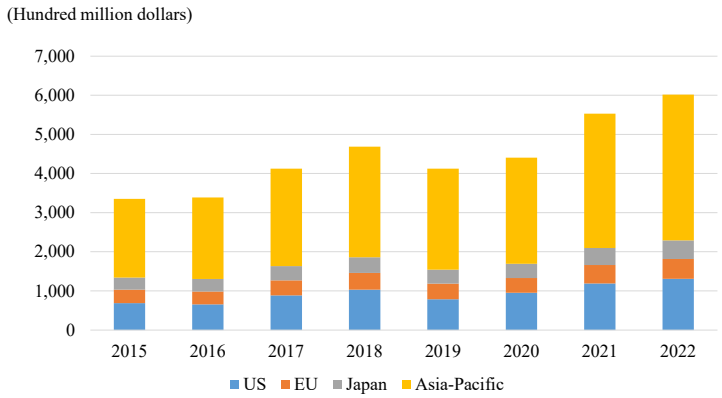
Note: The dashed line is the average value for 2019.
Source: Susquehanna Financial Group, Bloomberg.

Following semiconductors and electronic components, the next items in short supply are resin and nylon, which are widely used in automobile parts such as airbags and wiring harnesses. In particular, there has been a shortage of adiponitrile—a raw material of nylon 66, the main material for airbags and wiring harnesses—since before the COVID-19 pandemic. There is a limited number of adiponitrile manufacturers in the world. Against this backdrop, the supply shortage was caused by an explosion at a production plant in China in 2015, the suspension of plants in Europe due to strikes and natural disasters in 2018, and power outages and factory fires caused by hurricanes in the United States. In addition, a cold wave in Texas in February 2021 caused a power outage at a chemical plant and forced it to suspend production. This led to a shortage of raw materials that in turn caused several related companies to declare a force majeure. Furthermore, production in ASEAN regions—where Japanese wire harness manufacturers have placed many manufacturing bases—has been inhibited or suspended due to lockdowns, leading to supply shortages[37]. Together with the effects of soaring raw material prices and disruptions in logistics, this has led to delays in the delivery of goods and soaring prices.

The COVID-19 pandemic has caused a rapid increase in demand for telework and the need to increase the capacity of data centers, in turn tightening supply and demand of semiconductors. However, the impact of these factors may pause in the future, and there are signs that the expansion of the semiconductor market may slow down. According to the World Semiconductor Trade Statistics (WSTS), the global semiconductor market was worth about $440 billion in 2020, up 6.8% year on year, and is expected to grow significantly[38] to about $553 billion in 2021, up 25.6% year on year, as vaccinations for COVID-19 progress and economic activity resumes. However, the growth rate is expected to slow down to 8.8% year on year in 2022 (Figure I-1-2-34).

[37] Newswitch (2021), *KORONA DE HIGASHI MINAMI AJIA NO WAIYA HAANESU KOUJOU GA TEISOUGYOU, DENSEN KAKUSHA WA KOSUTO ZOU WO KENEN*, September 7th, 2021, (https://newswitch.jp/p/28681).
[38] As of November 30, 2021.

Figure I-1-2-34. Trends in the size of the global semiconductor market



Note: The figures for 2021 and 2022 are forecast values.
Source: *Results of WSTS Semiconductor Market Predictions for Fall 2021 (November 30th, 2021)* (WSTS, WSTS Japan Association). (https://www.jeita.or.jp/japanese/stat/wsts/docs/20211130WSTS.pdf)

The demand for products related to semiconductors is expected to continue to grow. In addition, as Russia produces and exports a large amount of raw materials such as platinum—which is used as a catalyst for automobiles—and palladium and rare gases such as neon gas—which are used to manufacture semiconductors—there are growing concerns in the semiconductor market that the global supply of said raw materials will decrease due to Russia's aggression against Ukraine, and there is a growing need to review the supply chain.[39]

In light of this situation, various countries have been proceeding with large-scale investments and formulating strategies with a view toward the semiconductor industry's growth and economic security (Table I-1-2-35).

Table I-1-2-35. Trends in semiconductor industry support measures in various countries and regions

Country/Region	Major industry support measure trends
The United States	・The National Defense Authorization Act (FY2021 NDAA), which includes subsidies of up to 300 billion yen per project and the establishment of the Multilateral Semiconductor Security Fund, was approved. ・President Biden voiced his approval of the CHIPS and Science Act. The Senate passed the United States Innovation and Competition Act, which includes 5.7 trillion yen's worth of investments related to semiconductors.

[39] Ministry of Economy, Trade and Industry (2022), "First Meeting of the Task Force on Strategic Goods and Energy Supply Chains Held, the Emergency Measures in Response to the Situation in Ukraine," (https://www.meti.go.jp/press/2021/03/20220331013/20220331013.html).

China	・The National Integrated Circuit Industry Investment Fund totaling 5 trillion yen was established (2014, 2019). ・In addition, local governments have funds toward the semiconductor industry totaling over 5 trillion yen (Total of over 10 trillion yen)
Europe	・A digital strategy toward 2030 was announced. Its measures include investing 134.5 billion euros (about 17.5 trillion yen) into digital transitions (e.g., logic semiconductors, HPC and quantum computers, quantum communication infrastructure) ・The enactment of the European Chips Act was declared with the aim of establishing an advanced chip ecosystem in Europe including manufacturing, ensure supply safety, and develop a new market for breakthrough technologies in Europe (2021.9)
Taiwan	・Incentives such as subsidies were launched to encourage the return of investments back to Taiwan. Investment applications with a cumulative total of 2.7 trillion yen have been accepted, mainly in hi-tech sectors. (2019.1) ・A plan was announced to invest a total of 30 billion yen's worth of subsidies into the semiconductor sector by 2021. (2020.7)
The Republic of Korea	・Invested a total of 100 billion yen into developing AI semiconductor technologies. (2019.12) ・A plan was announced for over 500 billion yen's worth of concentrated investments into developing technologies in industries for materials, parts, and equipment that include semiconductors by 2022. (2020.7) ・The K-Semiconductor Strategy was formulated for becoming a comprehensive semiconductor powerhouse (2021.5)

Source: *The 4th meeting of the Working Group on Strategy for Semiconductors and the Digital Industry* (Ministry of Economy, Trade and Industry)

In Japan, progress is being made in ensuring supplies of raw materials related to semiconductors, and in strengthening production capacity for semiconductors, manufacturing equipment, and materials. TSMC, Sony Corporation and DENSO Corporation have established JASM (Japan Advanced Semiconductor Manufacturing) in Kumamoto Prefecture as a joint venture to strengthen the semiconductor industry base and develop and secure human resources, and there are plans to invest about $8.6 billion into the production of semiconductors with processes of 10 to 20 nm. The

establishment of the base is expected to create jobs for approximately 1,700 engineers in advanced technology.

Investments are being made in the semiconductor sector to strengthen the production system in the medium to long term. However, as time is needed to build new plants and establish systems to increase production, foundries and manufacturers of semiconductor manufacturing equipment and final goods expect that the semiconductor shortage will be resolved in 2023, while the shortage of some parts will last until 2024 or 2025. In addition, semiconductor wafer manufacturers have concluded long-term contracts for the manufacture of semiconductor wafers by 2026, including those for increased production by new factories, and examples show that there will continue to be a tight supply demand.[40] With the ongoing global trend toward decarbonization, in addition to the aforementioned topics such as the electrification of automobiles, robots, AI, 5G/6G, and IoT, and the metaverse, demand for the utilization of various digital technologies is increasing, and it is possible that the tight demand-driven supply and demand will continue for products such as semiconductors, parts, and materials that are indispensable for these emerging technologies.

[40] SUMCO Corporation (2022) Financial Results Briefing for the Fiscal Year Ended December, 2021, February 9, 2022 (https://ssl4.eir-parts.net/doc/3436/ir_material_for_fiscal_ym13/112680/00.pdf).