

**ERIA Discussion Paper Series****No. 364****The Impact of COVID-19 on Global Production Networks:  
Evidence from Japanese Multinational Firms\***

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**Abstract:** *Using aggregate-level data on Japanese multinational corporations (MNCs) in major host countries and regions, this paper investigates the impact of COVID-19 on global production and supply chains with a focus on East Asia. I use the numbers of COVID-19 cases and deaths as measures of the impact of the pandemic. I find that the pandemic had substantial impacts on the performance (sales, employment, and investment) of Japanese MNCs and global supply chains (exports to Japan and exports to third countries) in Q1–Q3 2020. China recovered quickly in Q2 and grew in Q3, whilst the countries of the Association of Southeast Asian Nations and the rest of the world had still not fully recovered in Q3 2020. Importantly, lockdown and containment policies in host countries had large negative impacts on the sales and employment of Japanese MNCs. In contrast, I did not find positive effects of economic support policies on firm performance. Interestingly, whilst the firm expectations and business plans of Japanese MNCs were negatively affected by the COVID-19 pandemic, their business confidence increased with strong overall government policy responses in host countries in Q1 2020.*

**Keywords:** COVID-19; Production networks; Multinational corporations.

**JEL Classification:** F14; F23

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## 1. Introduction

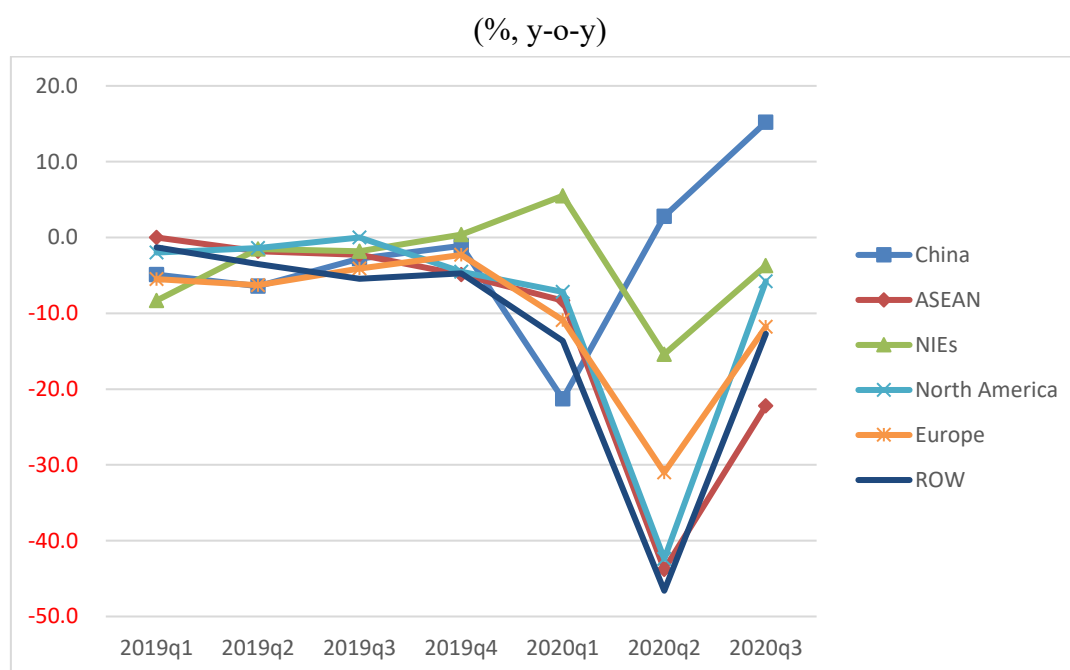
The COVID-19 pandemic has had substantial impacts on production networks in East Asia and the rest of the world. Supply chains have been disrupted and both supply and demand shocks have been transmitted through supply chains and propagated across borders. As Baldwin and Tomiura (2020) point out, COVID-19 is contagious economically as it is medically. To slow down the spread of the coronavirus, many countries imposed some form of restrictions on people and businesses. Since Japanese multinational corporations (MNCs) are important drivers and players in global value chains (GVCs), their supply chains and overseas production were hit hard by the COVID-19 shock.

In this paper, I aim to examine the impact of the COVID-19 pandemic on global production networks as well as the effects of policy responses, using country-level aggregated data on Japanese MNCs. Specifically, I investigate the following questions: (1) How large was the impact of COVID-19 on production networks and supply chains in East Asia and other regions? (2) How did country-specific government policy responses affect firm performance? (3) How did the pandemic and policy responses affect firm expectations and business plans? Utilising the latest and unique dataset on Japanese foreign affiliates in manufacturing sectors, which contains information on overseas activities and firm expectations, I wish to explore these important issues and provide evidence-based policy implications.

Figure 1 shows the year-on-year (y-o-y) changes in total sales (sum of local sales and exports) of Japanese manufacturing MNCs in major regions from Q1 2019 to Q3 2020. Due to the outbreak of COVID-19 in Q1 2020, the total sales of Japanese affiliates in China declined substantially by 21.3% y-o-y. Japanese affiliates in non-China regions except newly industrialised economies (NIEs) also saw significant declines in total sales. For example, the Association of Southeast Asian Nations (ASEAN), Europe, and North America had y-o-y decreases of 8.3%,

10.9%, and 7.2%, respectively. In Q2 2020, China had a ‘V-shaped’ recovery from COVID-19, and sales increased by 2.8% y-o-y. However, due to the fast spread of COVID-19 in non-China regions, on a y-o-y basis, total sales decreased sharply by 43.8% in ASEAN, by 42.4% in North America, and by 46.6% in the rest of the world (ROW), respectively. In Q3 2020, sales in China grew by 15.2% y-o-y, and sales in non-China partially recovered relative to Q2. However, growth rates were still very low in Europe, North America, and especially in ASEAN (–22.2% y-o-y). In fact, local sales, which account for about 70% of foreign affiliates’ total sales, also show a similar pattern (see Appendix Figure B1).<sup>1</sup>

**Figure 1. Industrial Disruption and Recovery: Total Sales by Region**



ASEAN = Association of Southeast Asian Nations, NIEs = newly industrialised economies, ROW = rest of the world.

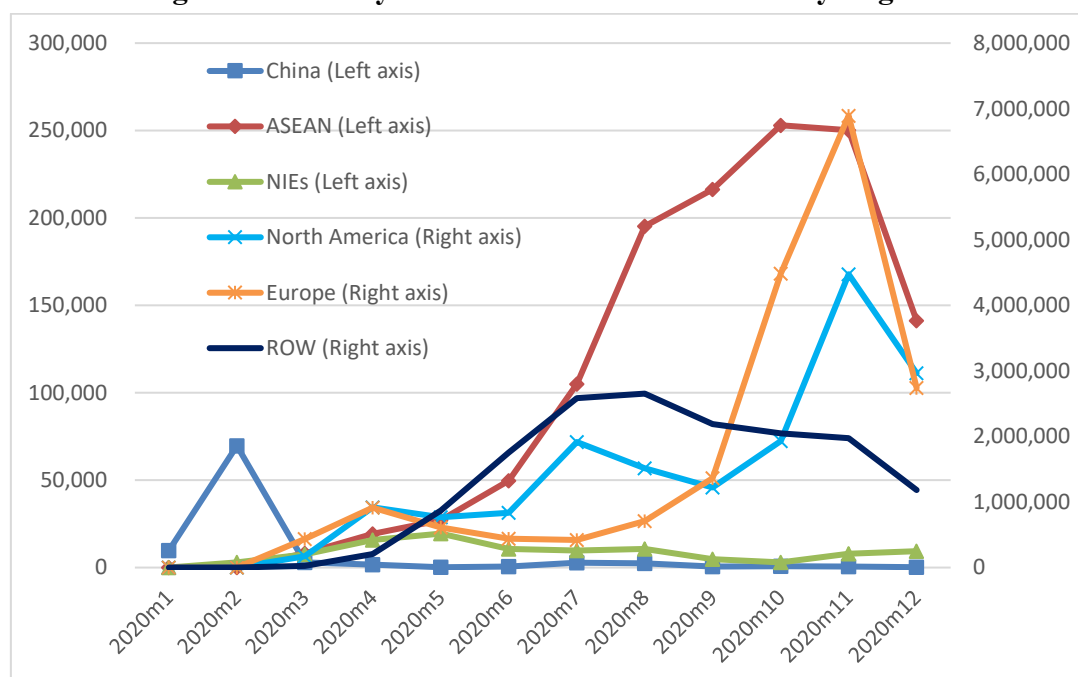
Note: Hong Kong is included in China. NIEs include the Republic of Korea, Singapore, and Taiwan. ROW include countries in Africa, Oceania, and South America. See Appendix A for the full country list.

Source: Author’s own compilation based on the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry.

<sup>1</sup> Furthermore, employment and investment by foreign affiliates decreased significantly in all regions between Q1 and Q3 2020 (see Appendix Figure B2 and Figure B3).

To understand the overseas business environment for Japanese MNCs, Figure 2 and Figure 3 provide an overview of COVID-19 and policy responses in the host countries and regions. Figure 2 depicts the monthly number of COVID-19 cases in the world. China was at the height of the COVID-19 pandemic in February, with more than 60,000 cases in 1 month. Afterwards, owing to China's extremely restrictive measures, there was a significant decline in the number of new cases in March, and the spread of coronavirus was almost under control after Q1 2020. However, the virus spread fast around the world and cases increased exponentially in ASEAN, Europe, North America, and the ROW. The severity of the pandemic in ASEAN, Europe, and North America had substantial negative impacts on the total sales of Japanese firms in Q2 and Q3 2020 as shown in Figure 1.

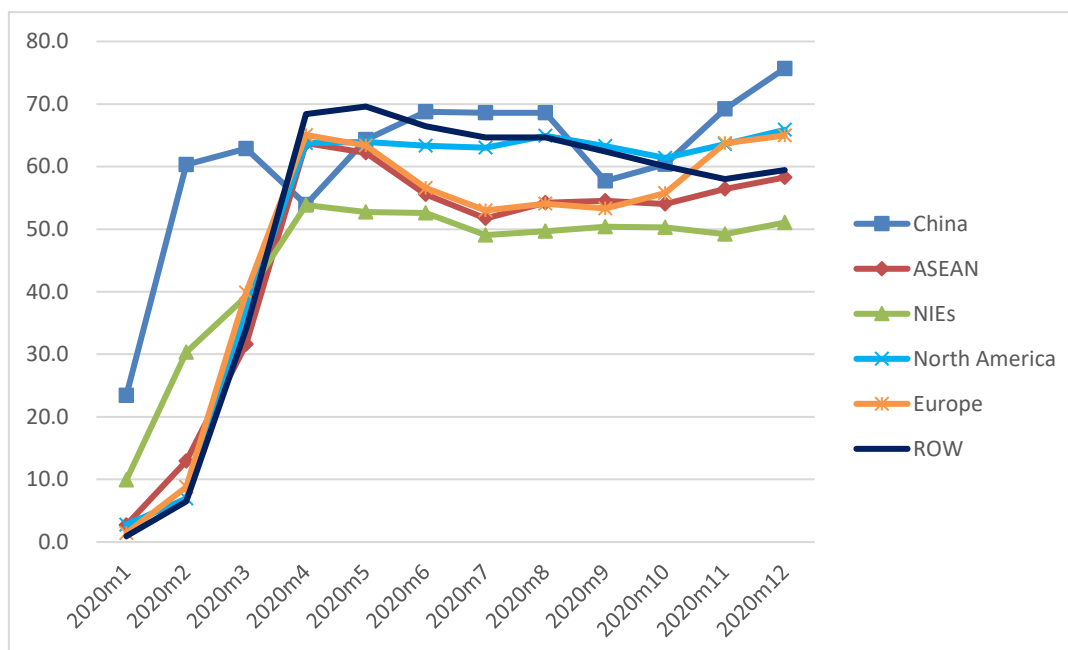
**Figure 2. Monthly Number of COVID-19 Cases by Region**



ASEAN = Association of Southeast Asian Nations, NIEs = newly industrialised economies, ROW = rest of the world.

Source: Author's own compilation based on data from the Johns Hopkins Coronavirus Resource Center.

**Figure 3. Monthly Government Response Index by Region**



ASEAN = Association of Southeast Asian Nations, NIEs = newly industrialised economies, ROW = rest of the world.

Source: Author's own compilation based on data from the Oxford COVID-19 Government Response Tracker.

Figure 3 shows the monthly government policy responses in major regions in 2020. The government response index measures the strength of policy responses, with larger numbers signifying stronger levels of government action (see Section 2 for details). The index for China jumped from January to February and stayed at a very high level during the period. The index for ASEAN, Europe, North America, and the ROW soared in February and March and remained at relatively high levels as well. The performance of Japanese MNCs is likely to have been heavily affected by the strong policy responses in the host countries.

This study is closely related to recent studies on the impact of COVID-19 and policy response in the context of production networks and supply chains. Using a unique Japanese firm-level survey conducted in January 2020 that contains information on sales forecasts, Chen, Senga, and Zhang (2020) find that the outbreak of COVID-19 in late January led to a substantial increase in firms'

subjective uncertainty. This effect is especially large for Japanese firms that have direct exposure to China with supply chains and overseas production. Using monthly trade data, Hayakawa and Mukunoki (2020) investigate the impacts of COVID-19 on the GVCs of machinery products and find there were large negative supply chains effects, i.e. countries that export machinery parts to countries exporting finished machinery products were affected the most relative to countries mainly importing or exporting finished products. Based on quantitative estimations, Bonadio et al. (2020) show that the average real gross domestic product downturn due to the pandemic is expected to be  $-32.6\%$ , with one-fifth of the total due to transmission through global supply chains. Importantly, they argue that the renationalisation of global supply chains does not make countries more resilient to pandemic-induced contractions in the labour supply.

Baldwin and Freeman (2020) argue the possibilities of manufacturing contagion and reinfection from the ‘COVID concussion’. As manufacturers around the world rely on inputs from China, the industrial disruption in China hit the rest of the world via supply-chain contagion first. However, after that, the pandemic in other manufacturing giants, such as Germany and the United States (US), is likely to create a reverse effect, i.e. supply-chain reinfection. As policy responses, Baldwin and Freeman (2020) argue that international coordination on containment exceptions for essential goods may reduce the chances that multiple waves of supply-chain contagion hobble global production. Furthermore, Kimura et al. (2020) find that regional policy coordination is critical to mitigate and isolate COVID-19 shocks and note the importance of identifying pandemic events early to flatten the pandemic curve at the national and regional levels. They also emphasise that the stability of the GVC network is critical during the pandemic.

I find that the pandemic had substantial impacts on the performance of Japanese MNCs and global supply chains in Q1–Q3 2020. Importantly, the sales and employment of Japanese MNCs were also affected by the lockdown and containment policies in host countries, whilst economic support policies did not have positive effects on firm performance. This paper complements previous studies by examining the impact of the pandemic on global production networks and the effects of COVID-19 policy responses in host countries. Based on empirical results, this study provides policy implications for international production networks in the policy framework initiated by Kimura (2020) for overcoming COVID-19.

The rest of the paper is organised as follows. Section 2 introduces the data and variables; Section 3 presents the descriptive evidence; and Section 4 presents the empirical results. Section 5 concludes.

## **2. Data and Variables**

### **2.1. Aggregate-level data on Japanese multinational firms**

To implement the analysis, I use the Quarterly Survey of Overseas Subsidiaries (QSOS) collected by the Ministry of Economy, Trade and Industry (METI), Japan. This survey covers Japanese foreign affiliates with 50 or more employees in manufacturing industries.<sup>2</sup> For simplicity, I refer to affiliates and subsidiaries as firms, and I use Japanese MNCs and Japanese foreign/overseas affiliates interchangeably. The QSOS data contain information on country and industry classifications, sales, acquisitions of tangible fixed assets (excluding land),

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<sup>2</sup> Specifically, this survey targets overseas subsidiaries of Japanese parent firms that meet all of the following criteria as of the end of the surveyed quarter: manufacturing subsidiaries; subsidiaries with 50 or more employees; and subsidiaries with 50% or more of their capital coming from parent firms, including both direct and indirect funds (such as funds provided via local subsidiaries).

and the number of employees. Importantly, a firm's total sales can be decomposed into local sales, sales (exports) to Japan, and sales (exports) to third countries (other than Japan). This allows me to investigate the impact of COVID-19 on the global production of Japanese MNCs as well as regional and global supply chains. I use country-level and industry-level aggregate data based on the quarterly surveys conducted in 2018–2019, and Q1–Q3 2020.<sup>3</sup>

The QSOS data also has unique information on qualitative forecasts of sales (local, to Japan, and to the third countries), capital investment, and the number of employees. I use the Diffusion Index (DI), which captures the business confidence of Japanese MNCs. In the survey, answers from the responding foreign affiliates ('Increase, Unchanged, and Decrease') are aggregated into the DI as follows: DI (percentage points) = percentage share of firms responding 'Increase' minus the percentage share of firms responding 'Decrease'. For instance, 'investment DI' indicates a respondent's judgement on the 'acquisition of tangible fixed assets'. Foreign affiliates are asked to choose one out of the three judgments, 'Increase', 'Unchanged', and 'Decrease'. The percentage share of the number of firms for each judgment is calculated, and the percentage share of those which replied 'Decrease' is subtracted from those that replied 'Increase'. I use this index to see how well Japanese foreign affiliates are performing in terms of their forecasts by comparing the 'forecast DI' of the previous survey with the 'actual DI' of the present survey. Unfortunately, since questions on firm expectations are excluded from the survey form after Q2 2020, I use information on forecasts for the period Q1 2019–Q1 2020 only in my analysis.

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<sup>3</sup> Firm-level data is not available for the time being, and I leave it as future work. In a previous study using the firm-level data of QSOS, Sun et al. (2019) find that relative to affiliates in other Asian countries, Chinese affiliates, especially those with high exposure to trade with North America, in general see a decline in sales since the US–China trade war began in March 2018.



## **2.2. COVID-19 confirmed cases and deaths**

The number of COVID-19 confirmed cases and the number of deaths are obtained from the Johns Hopkins Coronavirus Resource Center.<sup>4</sup> These data are recorded daily. I use the number of cases and the number of deaths in each country by the end of each quarter as measures of the impacts of the COVID-19 pandemic.

## **2.3. Government response tracker**

The measures of country-specific government policy responses to COVID-19 shocks are constructed by the Oxford Blavatnik School of Government Coronavirus Government Response Tracker (Hale et al. 2020; henceforth, GRT).<sup>5</sup> Specifically, the GRT includes (1) an overall government response index, which measures how the response of governments has varied over all indicators in the database, becoming stronger or weaker over the course of the outbreak; (2) a stringency index, which measures the strictness of lockdown policies that primarily restrict people's behaviour; (3) an economic support index, which records measures such as income support and debt relief; and (4) a containment and health index, which combines lockdown restrictions with measures such as testing policies and contact tracing, as well as investment in health care and vaccines. Each index ranges from 0 to 100, and a larger number reflects stronger levels of government action. These data are recorded daily. I take the average value for each index by host country and year-quarter. As the results of the stringency index and the containment and health index are quite similar, I focus on the first three indexes.

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<sup>4</sup> <https://coronavirus.jhu.edu/map.html>

<sup>5</sup> <https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker>

### **3. Descriptive Evidence**

Based on the dataset on Japanese MNCs, COVID-19 cases/deaths, and the GRT, I document three sets of descriptive evidence: (1) supply chain disruption, (2) COVID-19 shocks and global production, and (3) government policy responses and firm performance.

#### **3.1 Supply chain disruption**

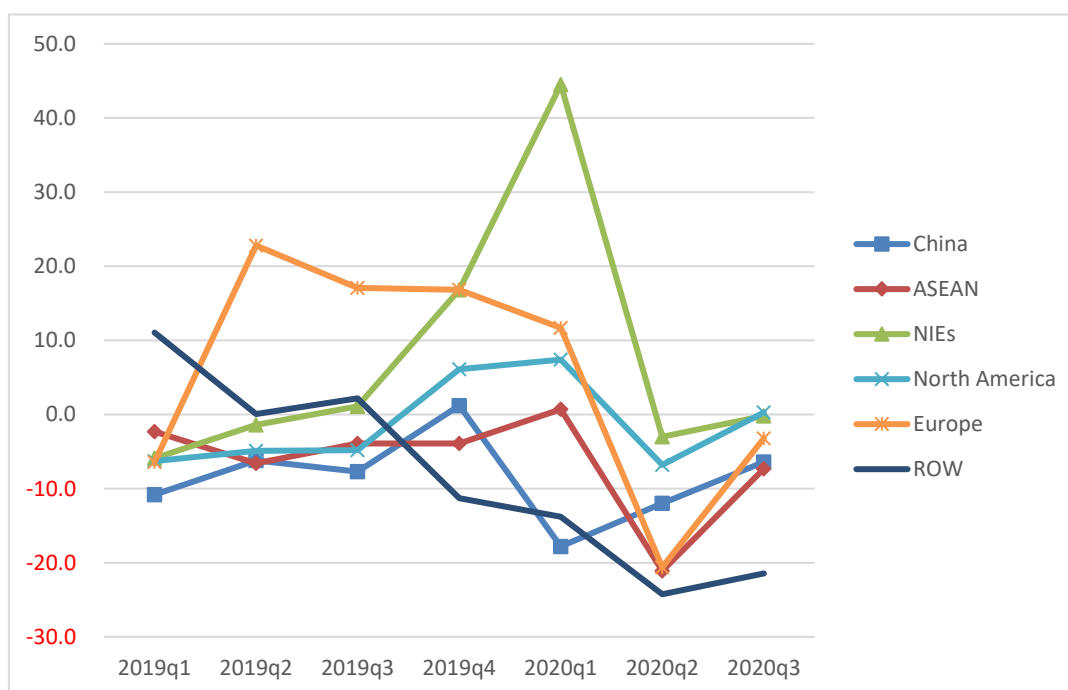
COVID-19 disrupted supply chains regionally and globally. COVID-19 shocks hit China–Japan trade hard as the supply chains of Japanese firms rely heavily on China. According to the QSOS data, the total sales of Japanese overseas affiliates was US\$1,129.6 billion in 2019, of which China accounted for 21%. Importantly, amongst total sales, sales (exports) to Japan were US\$100.5 billion, and China accounted for 37.5%. This is the intra-firm trade only. If the sourcing from other Chinese firms is included in, the dependence on China is even higher.

Figure 4A shows the y-o-y changes of overseas affiliates' exports to Japan by region from Q1 2019 to Q3 2020. In Q1 2020, affiliates' exports from China to Japan had a substantial decrease by 17.8% y-o-y. On the contrary, in ASEAN, NIEs, North America, and Europe, exports to Japan increased by 0.7%, 44.5%, 7.4%, and 11.7% y-o-y, respectively. The sudden increase in NIEs, especially the Republic of Korea and Taiwan, may reflect the substitution effect as imports from China was disrupted in Q1. However, in Q2 2020, although Japanese affiliates' local sales in China almost recovered and increased by 6.7% y-o-y, their exports to Japan continued to see a y-o-y decrease of 12%. The situation in non-China regions such as ASEAN and Europe was even worse (about –20% y-o-y), implying that the supply shock was larger in non-China regions relative to China. Exports to Japan were recovering in all regions in Q3 2020, but partially due to the decrease in

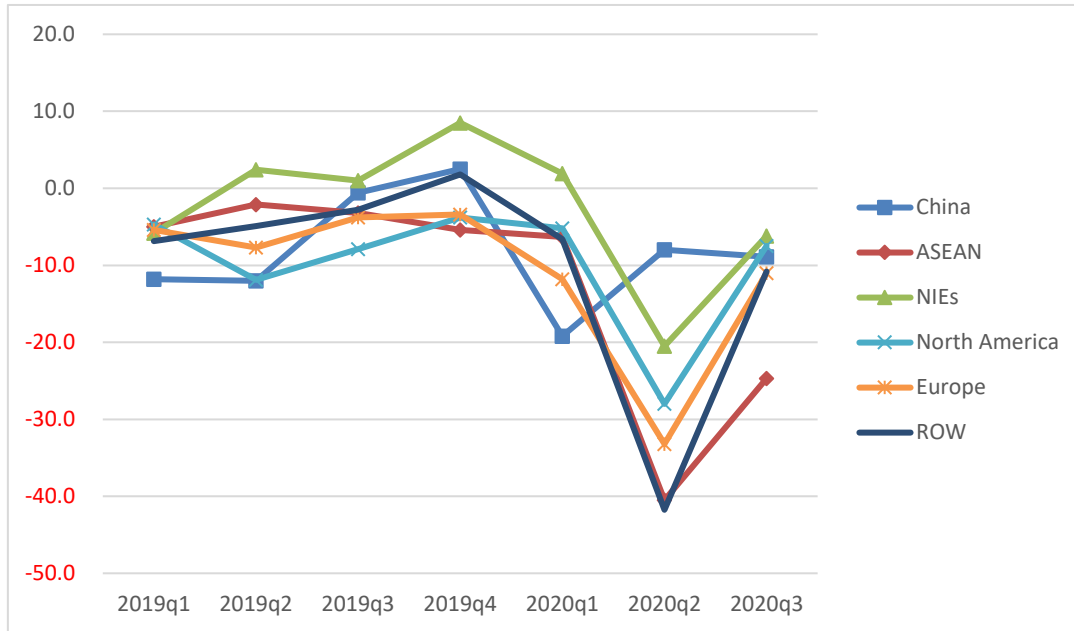
demand in Japan, exports to Japan still saw declines in almost all regions.

Similarly, Figure 4B shows that Japanese affiliates' exports to third countries fell sharply during Q1–Q2 2020. Importantly, the impact was much larger relative to exports to Japan. On average, the y-o-y changes of exports to third countries were –9.5% and –33.4% in Q1 and Q2, whilst the y-o-y changes of exports to Japan were –5.5% and –16.5% during the same period. As exports to third countries involve more complex production networks and coordination costs relative to exports to the home country (Japan), the disruptions in global supply chains were much more severe. Foreign affiliates' exports to third countries were recovering in Q3 2020 but did not return to pre-COVID-19 levels. It is also worth noting that ASEAN-based affiliates had the lowest recovery in Q3. Whilst their exports to Japan were –7.2% y-o-y in Q3, their exports to third countries were much lower, at –24.7% y-o-y. This suggests that the negative demand shock was much larger in the third countries relative to Japan.

**Figure 4A. Exports to Japan (% , y-o-y)**



**Figure 4B. Exports to Third Countries (% , y-o-y)**



ASEAN = Association of Southeast Asian Nations, NIEs = newly industrialised economies, ROW = rest of the world.

Source: Author's own compilation based on the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry.

COVID-19 had heterogeneous effects on supply chains by industry. Table 1 presents foreign affiliates' exports to Japan by industry in China and ASEAN in Q1–Q3 2020. First, in China, all industries (excluding lumber) had sharp declines in exports to Japan since Q1. Compared with the industry average of  $-17.9\%$ , textiles and transportation equipment dropped by  $24.8\%$  and  $28.6\%$  y-o-y in Q1, respectively. Exports to Japan did not fully recover in Q2–Q3 largely due to the demand shock in Japan. Second, ASEAN, which is expected to be an important alternative sourcing origin, also experienced significant decreases in all industries (excluding electrical machinery). The supply chains between ASEAN and Japan were in crisis as well. Third, there were large variations across industries. One possible explanation is that compared with consumption goods, such as foods and

textiles, durable goods, such as cars and other transportation equipment, are more likely to be hit hard by the pandemic. This is similar to the great trade collapse during the global financial crisis (GFC) in 2008–2009. The disruption of supply chains may lead to significant declines in trade in capital goods (general machinery) and intermediate inputs for production (iron and steel, parts and components), which rely heavily on international production networks. Furthermore, the relatively small impact on electronic machinery may reflect the increasing work-from-home demand for computers and other related electronic products.

**Table 1. Exports to Japan by Industry (% , y-o-y)**

Year 2020	Q1		Q2		Q3	
Industry/Region	China	ASEAN	China	ASEAN	China	ASEAN
Food and tobacco	-21.9	-9.7	6.8	-12.7	-16.2	-11.3
Textiles	-25.2	-8.5	-29.4	-12.8	-26.8	-13.6
Lumber, pulp, paper and paper products	8.6	-6.4	16.8	-12.1	-8.0	-30.9
Chemicals	-5.3	-12.9	-1.2	-19.7	-3.2	-19.8
Ceramic, stone and clay products	-39.7	-14.0	-31.8	-35.0	-34.9	-19.6
Iron and steel	-44.0	-7.8	-16.2	-31.4	-22.9	-15.6
Non-ferrous metals	-22.3	-8.9	-12.1	-2.4	-0.7	1.5
Fabricated metal products	-22.4	-9.4	-19.5	-20.6	-9.2	-29.5
General-purpose, production and business oriented machinery	-27.5	-5.0	-23.9	-22.7	-9.6	-18.6
Electrical machinery	-9.9	18.8	-2.6	-11.5	-0.7	8.0
Transportation equipment	-27.6	-17.6	-25.5	-39.5	-16.7	-26.3
Miscellaneous manufacturing	-32.5	-10.8	-34.0	-39.9	-29.0	-11.0
Total	-17.9	0.8	-12.1	-21.2	-6.4	-7.3

ASEAN = Association of Southeast Asian Nations.

Source: Author's own compilation based on the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry.

### 3.2. COVID-19 shocks and global production

Next, I document the impact of COVID-19 on the performance of Japanese MNCs in major host countries. Figures 5A–5C show the relationship between the number of COVID-19 cases (in logarithms) and the y-on-y changes of total sales (the sum of local sales and exports), the number of employees, and capital

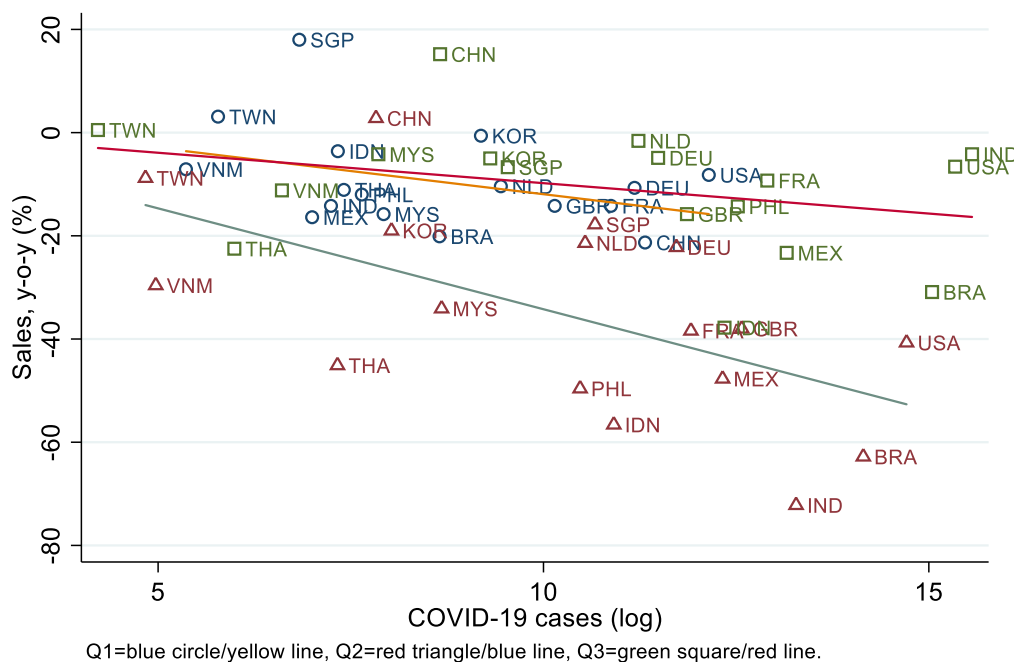
investment, respectively. In each figure, the blue circles indicate Q1, the red triangles represent Q2, and the green squares represent Q3.

First, in Figure 5A, the plots of y-o-y changes in sales against COVID-19 cases across countries show that sales decline significantly with increases in COVID-19 cases. In other words, COVID-19 cases are significantly negatively associated with sales of Japanese MNCs in major countries. In Q1 2020, affiliates' sales in China, Brazil, and Malaysia sharply decreased by about 20% y-o-y, whilst sales in Taiwan and Singapore only increased. In Q2, whilst China had almost recovered from the COVID-19, the sales of Japanese MNCs dropped substantially in all other countries. India, Brazil, and Indonesia were the worst amongst them. Importantly, the fitted lines for Q1 and Q2 show that the negative correlations between COVID-19 cases and sales growth rates became significantly stronger from Q1 to Q2 2020. This suggests that the pandemic and the performance of Japanese MNCs were getting worse in major countries, except China. In Q3, affiliates' sales in China continued to increase. The situation in other countries was getting better relative to Q2, but most of them still had large decreases in sales.

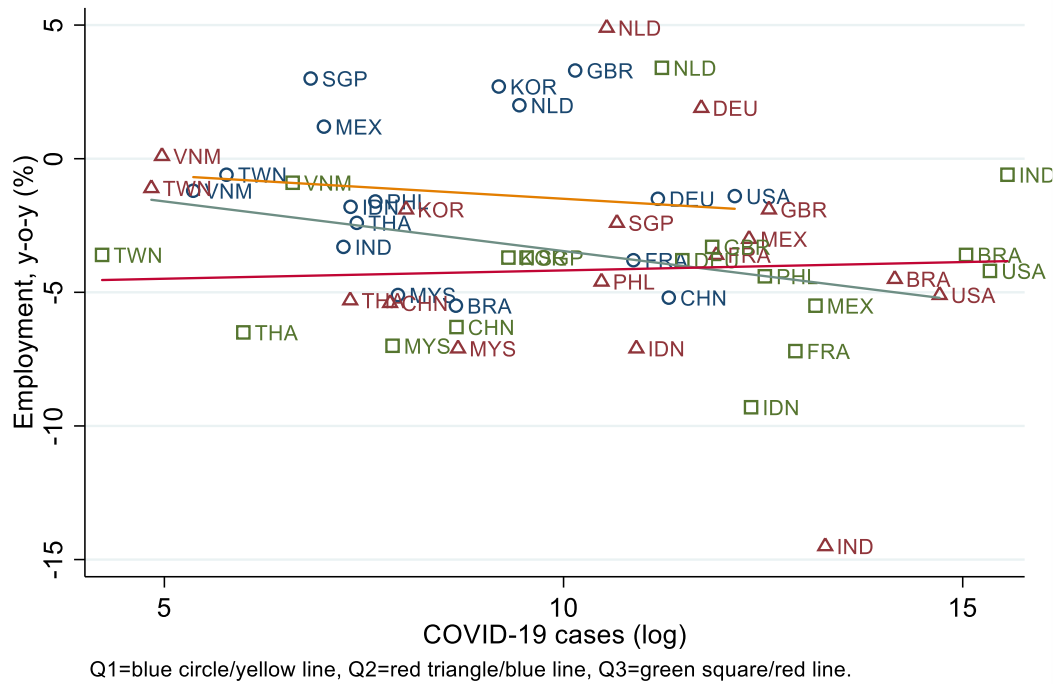
Second, the shock of COVID-19 also had large negative impacts on the local employment of Japanese MNCs in host countries during Q1–Q3 2020. Figure 5B shows that declines in employment are large, especially in China (Q1), India (Q2), Indonesia and Malaysia (Q2 and Q3), and France (Q3). Compared with Q1, employment was getting worse in many countries in Q2 and Q3, but the correlation between COVID-19 cases and employment growth rate was not significant in Q3, suggesting that, on average, affiliates' employment was recovering along with their total sales.

Third, capital investment dropped significantly in many countries in Q1–Q3 2020, amongst which, investment in India, Indonesia, Malaysia, Singapore, and even Taiwan decreased by about 50% y-o-y in Q2. Surprisingly, Figure 5C shows that the correlations between the number of COVID-19 cases and capital investment were *not* significantly negative. Since COVID-19 was a global shock, it seems that Japanese MNCs reduced their global investment even in counties relatively less affected by the pandemic in Q2. There were substantial variations across countries in Q3, and it is worth noting that investment significantly increased in Mexico, the Netherlands, and Viet Nam. Investment in these countries may suggest the possibility of the supply chain reorganisation of Japanese MNCs in ASEAN, Europe, and North America.

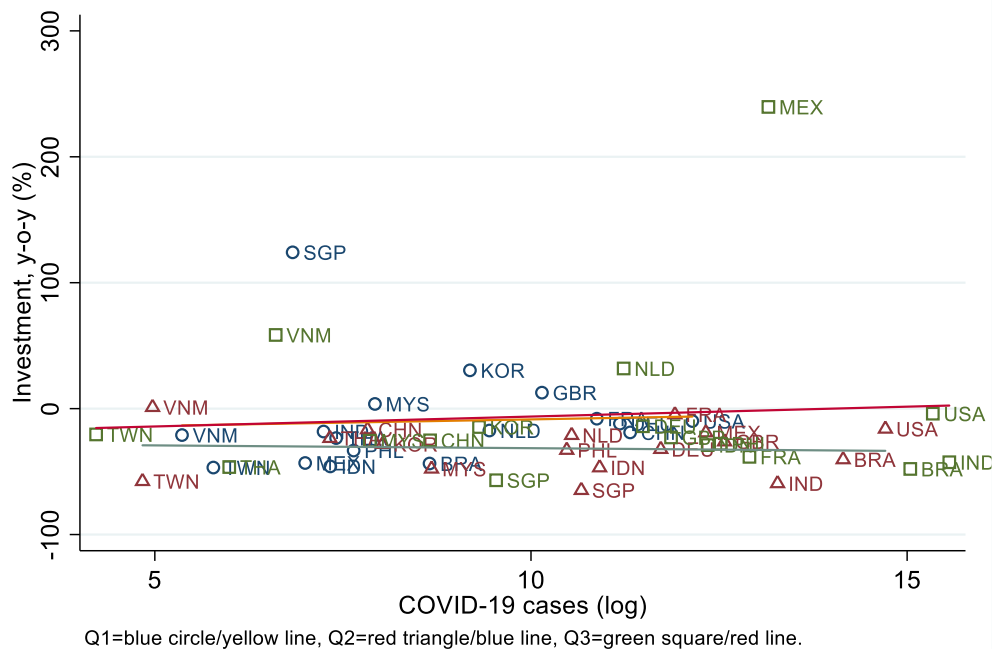
**Figure 5A. COVID-19 and Global Production: Sales**



**Figure 5B. COVID-19 and Global Production: Employment**



**Figure 5C. COVID-19 and Global Production: Investment**



y-o-y = year-on-year.

Source: Author's own compilation based on data from the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry, and Johns Hopkins Coronavirus Resource Center.

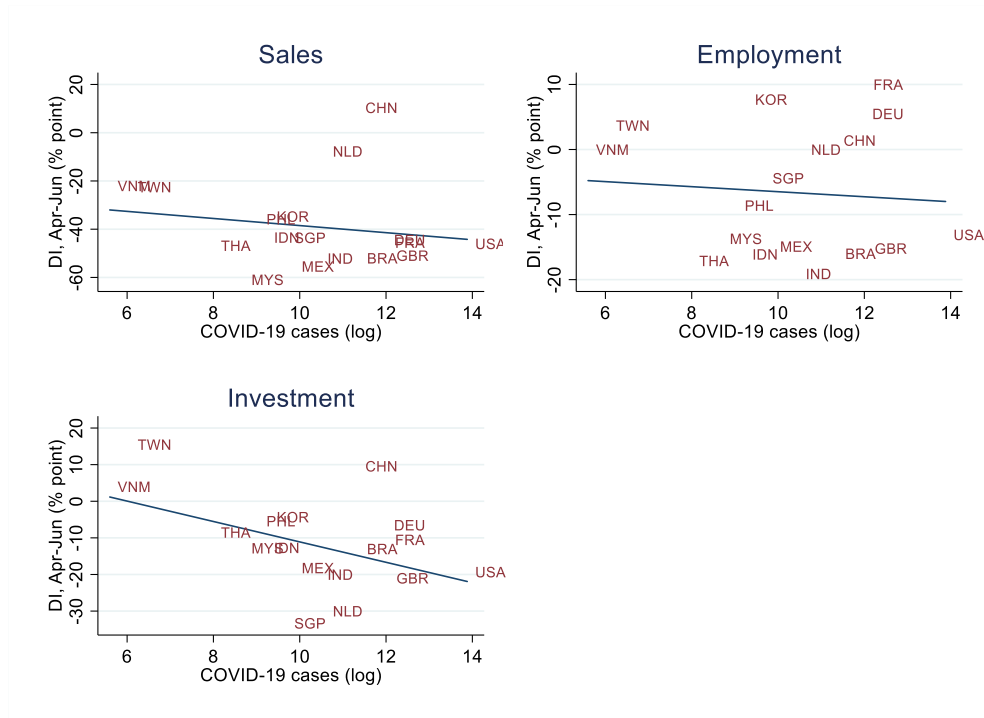


To better understand the impact of COVID-19 on firms, it is useful to take a look at firms' judgement on business conditions. Figure 6A shows that relative to Q1 2020, the current (Q2) DI of total sales, employment, and investment is significantly negatively correlated with the number of COVID-19 cases, respectively. Specifically, compared with the previous quarter (Q1), the business confidence of Japanese MNCs in the current quarter (Q2) was getting worse very quickly in countries such as Indonesia, India, Brazil, the US, and the United Kingdom, which were hit hard by COVID-19. This was especially true in terms of investment, which is costly and irreversible relative to employment. Interestingly, since the COVID-19 pandemic was almost under control in China in April, the DI of sales and investment in China improved by approximately 10 percentage points. The investment DI in Taiwan was even higher as Taiwan has been one of the most successful regions in fighting against COVID-19. Figure 6B presents the next DI, i.e. business outlook on Q3 relative to Q2. It is clear that more Japanese MNCs answered that they will not increase their investment and hiring in Q3 relative to Q2. In sum, COVID-19 had substantial impacts not only on firm performance but also on firm expectations and business plans.<sup>6</sup>

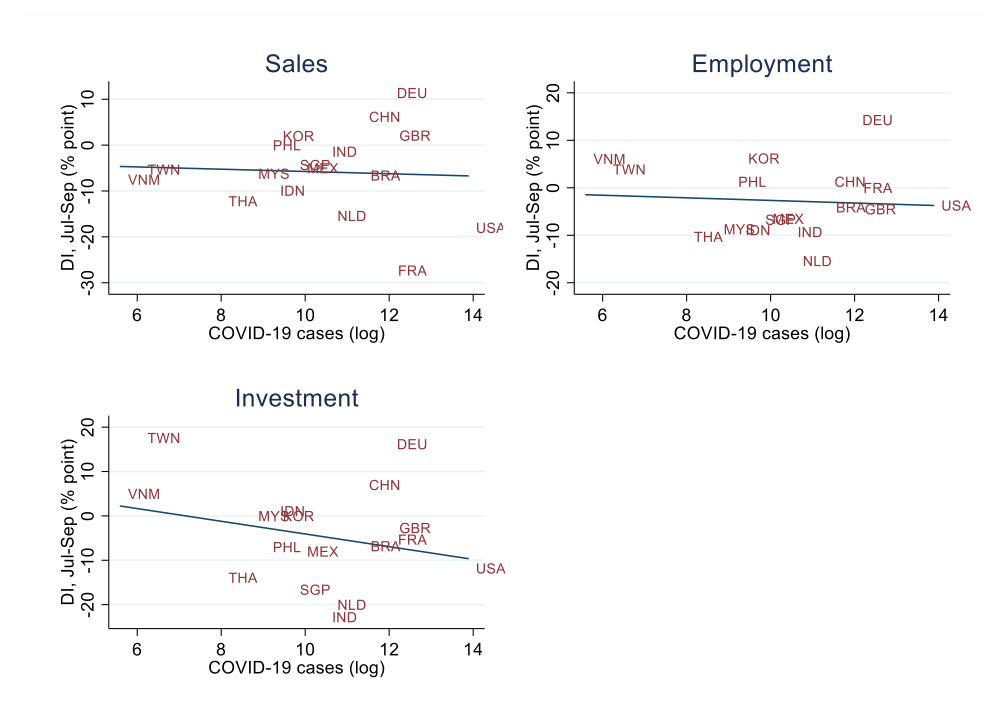
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<sup>6</sup> Figures B4–B6 in the Appendix show that the sales and exports expectations in major regions changed dramatically after the outbreak of COVID-19.

**Figure 6A. COVID-19 and Firm Expectations: Current DI**



**Figure 6B. COVID-19 and Firm Expectations: Next DI**



DI = Diffusion Index.

Source: Author's own compilation based on data from the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry, and Johns Hopkins Coronavirus Resource Center.

### 3.3. Policy responses, firm performance, and expectations

To mitigate and isolate the COVID-19 shock on firms and the economy, the governments in all countries and regions have enacted various COVID-19 policies. The Oxford COVID-19 GRT points out that ‘government responses vary significantly from one country to another, and like any policy interventions, their effect is highly contingent on the local political and social context. COVID-19 Government Response Indices, like all aggregate indices which combine different indicators into a general index, should not be interpreted as measuring the appropriateness or effectiveness of a country’s response.’<sup>7</sup> Thus, it is not easy to estimate the impact of such policies and evaluate which COVID-19 policy is effective or not. However, it would be interesting to investigate the relationship between COVID-19 policy and the performance and expectations of Japanese MNCs in host countries since the government responses can influence the activities of both domestic firms and foreign firms through global supply chains.

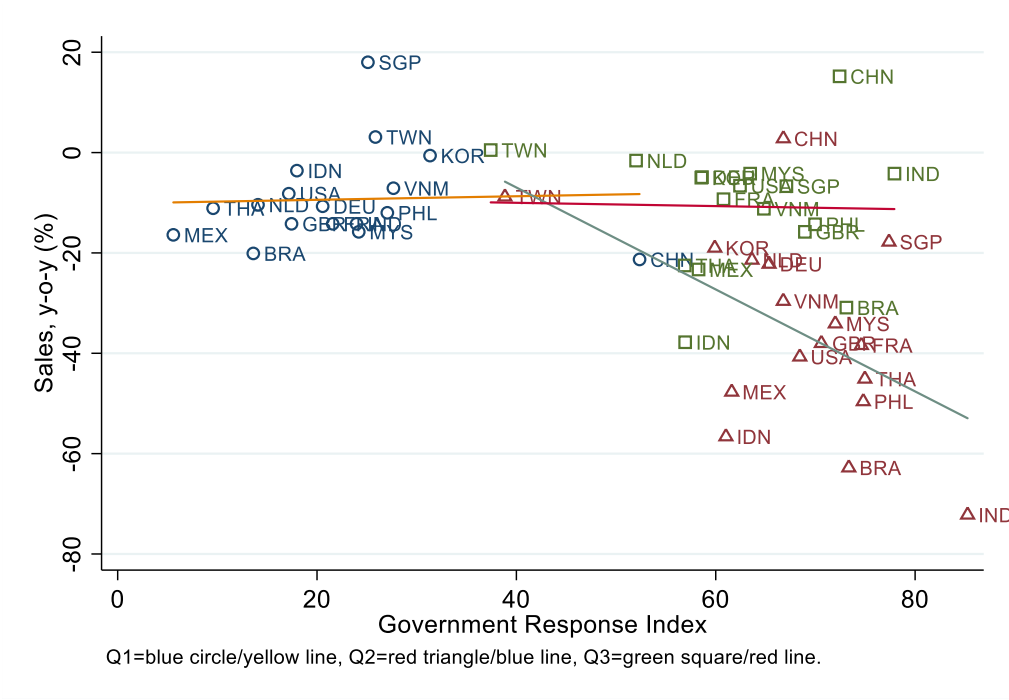
Figures 7A–7C show the correlations between the overall government response index and the y-o-y changes of Japanese foreign affiliates’ total sales, employment, and investment in major countries, respectively. In each figure, the blue circles indicate Q1, the red triangles represent Q2, and the green squares represent Q3. The overall government response index records how the response of governments become stronger or weaker over the course of the outbreak of COVID-19. It is obvious that the index shifts significantly to the right, suggesting that COVID-19 policy became very strong in all countries in Q2–Q3 relative to Q1 2020. The stronger policy responses are significantly negatively associated with declines in total sales and employment but not capital investment in Q2. This is quite similar to the effects of COVID-19 cases on firm performance shown in Figures 3A–3C.

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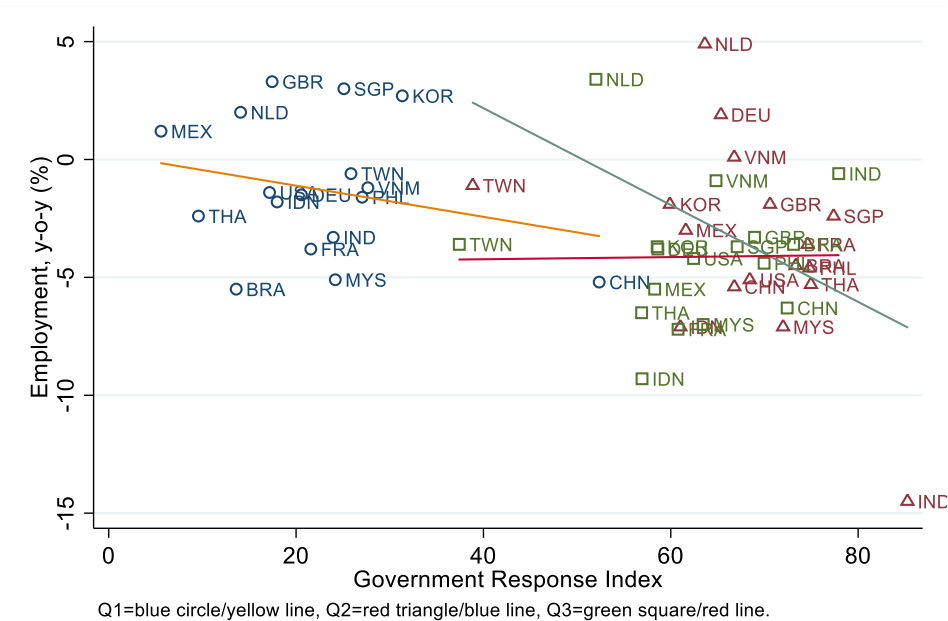
<sup>7</sup> <https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker>

As the overall government response index consists of various indicators, from lockdown restrictions to income support, it seems that the overall policy responses did not have positive effects on Japanese MNCs.

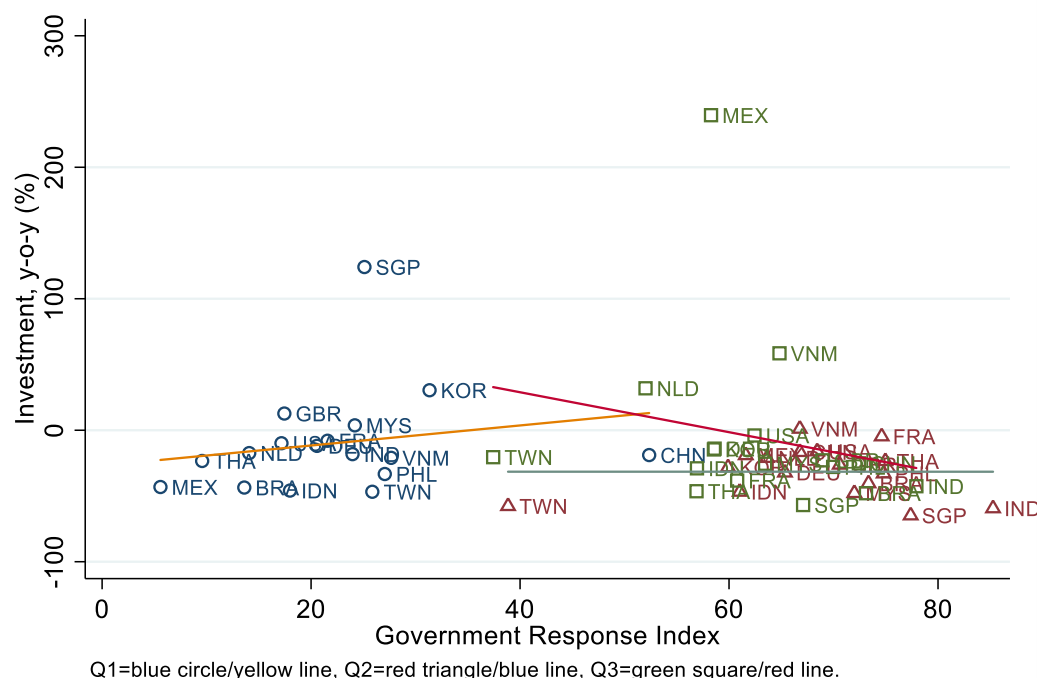
**Figure 7A. Policy Responses and Firm Performance: Sales**



**Figure 7B. Policy Responses and Firm Performance: Employment**



**Figure 7C. Policy Responses and Firm Performance: Investment**

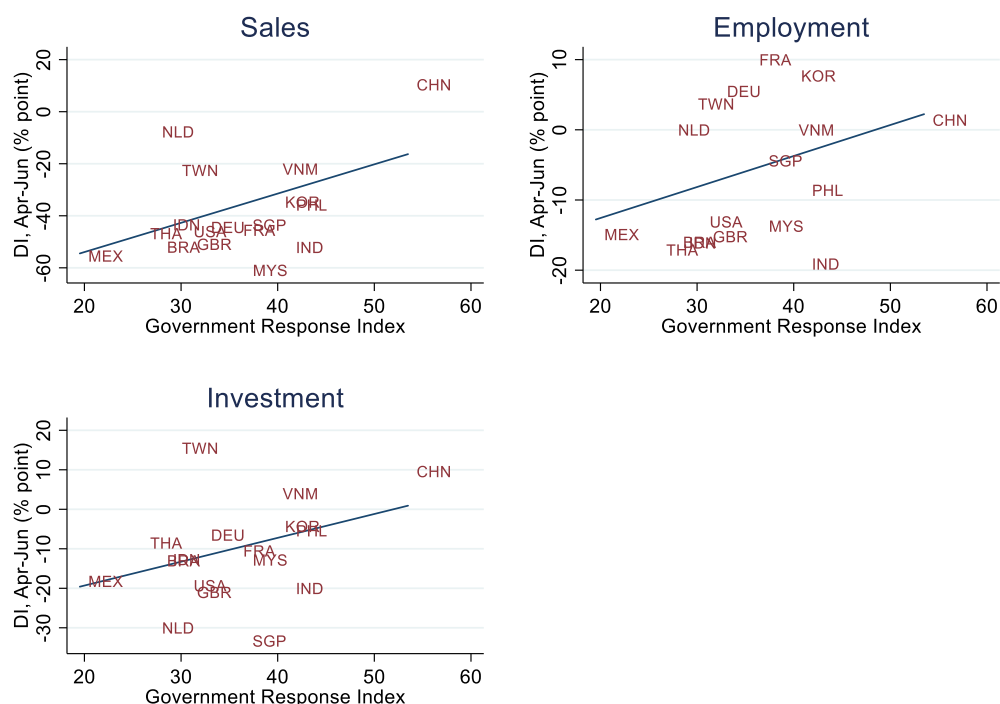


y-o-y = year-on-year.

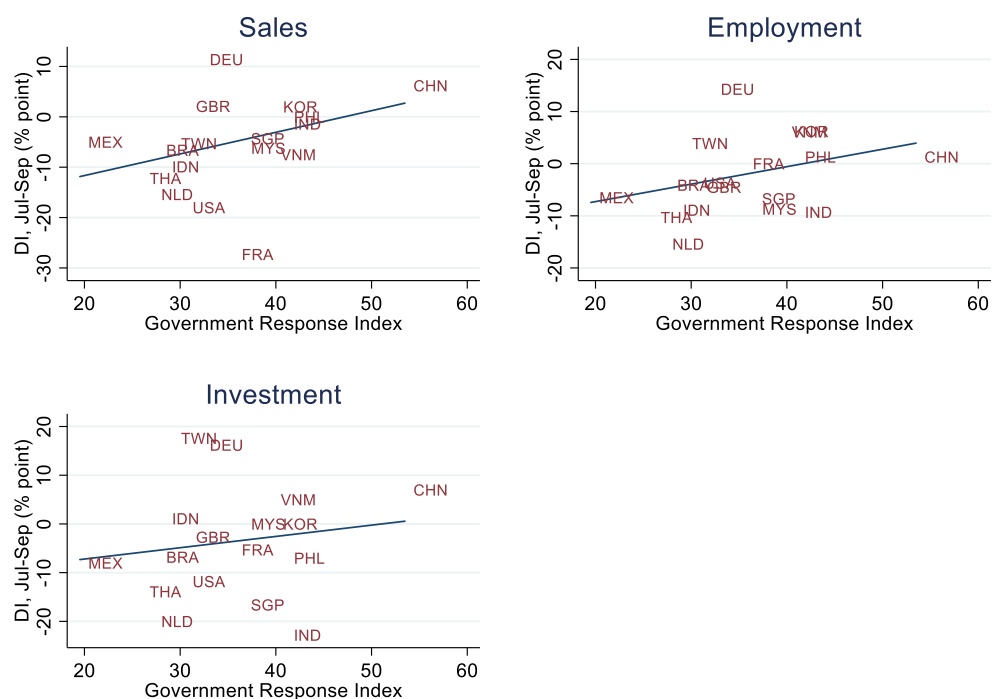
Source: Author's own compilation based on data from the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry, and Oxford COVID-19 Government Response Tracker.

To take a look at the effects of COVID-19 policy on firm expectations, in Figures 8A and 8B, I plot the DI of sales/employment/investment against COVID-19 cases across countries in Q1 2020. It is clear that the government policy response indices are strongly positively associated with the current (Q2) DI of sales, employment, and investment relative to Q1. This implies that stronger overall government responses likely gave more business confidence to Japanese MNCs in host countries such as China and Viet Nam. This is also true for next (Q3) DI relative to current (Q2) DI. Unfortunately, limited data availability makes it hard to examine the relationship between the changes in policy responses and updating of firm expectations.

**Figure 8A. Policy Responses and Firm Expectations: Current DI**



**Figure 8B. Policy Responses and Firm Expectations: Next DI**



DI = Diffusion Index.

Source: Author's own compilation based on data from the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry, and Oxford COVID-19 Government Response Tracker.

## 4. Empirical Analysis

### 4.1. Specifications

The empirical specification explores the across-country variations in COVID-19 cases and deaths and governments' policy responses. First, I estimate the impact of the COVID-19 shock on firm performance as follows:

$$Y_{ct} = \alpha_0 + \alpha_1 COVID_{ct} + FE_c + FE_t + \varepsilon_{ct}$$

(1)

where  $Y_{ct}$  is the y-o-y change (%) or the logarithm of total sales, number of employees, and capital investment of Japanese foreign affiliates in country  $c$  and year-quarter  $t$ .  $COVID_{ct}$  is the logarithm of the number of COVID-19 cases or the number of deaths, which measures the impacts of COVID-19 pandemic in country  $c$  and year-quarter  $t$ . I also include country fixed effects and year-quarter fixed effects to eliminate the time-invariant differences across countries and control for various other macroeconomic shocks.<sup>8</sup>

Second, to estimate the effects of COVID-19 policy on the firm performance of Japanese affiliates, I run the regressions as follows:

$$Y_{ct} = \beta_0 + \beta_1 GRT_{ct} + FE_c + FE_t + \varepsilon_{ct} \quad (2)$$

where  $GRT_{ct}$  measures the country-specific government policy response to the COVID-19 pandemic, including measures such as the overall government response index, stringency index, and economic support index.

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<sup>8</sup> The aggregate-level data of QSOS publicly available at the METI's website only contains information on exports to Japan and exports to third countries by major regions (China, ASEAN, NIEs, North America, etc.), not by country, so it is not possible to estimate the impacts of the demand shock in destination countries.

The coefficients of interest are  $\alpha_1$  and  $\beta_1$ . I expect  $\alpha_1$  is negative, but the sign of the coefficient  $\beta_1$  is not clear. It could be negative if the business activities of Japanese affiliates were affected by lockdowns and severe mobility restrictions in the host countries. On the other hand, it could be positive if COVID-19 policy is effective and the impacts of COVID-19 on Japanese MNCs were mitigated in the host countries. Using the combined datasets, I estimate  $\alpha_1$  and  $\beta_1$  in equations (1) and (2). The summary statistics and correlation matrix of the variables used in the estimation are reported in Tables B1 and B2 in the Appendix, respectively.

## 4.2 Empirical results

Table 2 reports the estimation results of equation (1). Panel A presents the results using the number of COVID-19 cases and panel B presents the results using the number of deaths. The dependent variables, i.e. sales/employment/investment, are in y-o-y changes in columns (1)–(3) and in logarithms in columns (4)–(6) in both panels. In panel A, it is evident that COVID-19 has statistically significant negative impacts on the total sales and employment of Japanese MNCs in host countries. The magnitude of the impact is big. A 1% increase in the number of COVID-19 cases lead to a 2.2% decrease in sales y-o-y (column 1). Similarly, a 1% increase in the number of COVID-19 cases decreases sales by 3.3% (column 4) and employment by 0.3% (column 5). However, the impact on investment is not significant by the end of Q3 2020. This probably implies that it takes time for firms to adjust capital investment. Panel B shows that the number of deaths has similar impacts on firm performance. It is reasonable that compared with the number of COVID-19 cases, the magnitude is a little small. Given that the pandemic was accelerating over time in the world, the effects of COVID-19 on firm performance differ by quarter. To examine this difference, I interact the number of cases (deaths) with quarter dummy variables and set Q1 as the base quarter. As reported in Table



B3 in the Appendix, the coefficients for COVID-19 cases and the interaction terms with Q2 dummy are significantly negative. Importantly, the magnitude of the interaction term with the Q2 dummy for sales is bigger, implying a significant increase in the negative effects on Japanese MNCs in Q2 2020.

**Table 2. Impact of COVID-19 on Firm Performance**

	(1)	(2)	(3)	(4)	(5)	(6)
	sales_yoy	emp_yoy	invest_yoy	logsales	logemp	loginv
<b>Panel A:</b>						
COVID-19 cases (log)	-2.231*** [0.747]	-0.269 [0.174]	1.982 [2.453]	-0.033*** [0.010]	-0.003* [0.001]	0.006 [0.017]
R-sq	0.717	0.615	0.374	0.988	1.000	0.944
<b>Panel B:</b>						
COVID-19 deaths (log)	-1.569*** [0.569]	-0.097 [0.143]	3.691 [2.789]	-0.024*** [0.007]	-0.002* [0.001]	0.017 [0.018]
R-sq	0.702	0.606	0.392	0.987	1.000	0.945

Note: Country fixed effects and year-quarter fixed effects are included in all columns. The number of countries is 17 and observations is 119. The sample period is Q1 2019–Q3 2020. Robust standard errors are in brackets. \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% levels, respectively. Source: Author.

Table 3 shows the estimation results for equation (2). Panels A–C show the results for the stringency index in panel A, the economic policy support index in panel B, and the overall government response index in panel C. Panel A shows that the strict lockdown policies that primarily restrict people’s movement have significant negative impacts on the total sales and employment of Japanese MNCs, but the impact on investment is not significant. Panel B shows that the economic support policies, such as income support and debt relief, do not have positive effects on firm performance. In fact, the effect on employment and investment are even negative in columns (2)–(3) and (6). The coefficients are close to zero in columns (1) and (4)–(5). This suggests that on average, the economic support policies in host countries are not likely to help Japanese MNCs in recovering from the COVID-19

crisis. Panel C shows that the effects of overall government policy responses are quite similar with those of lockdown-style policies in panel A. Since relative to economic support, the lockdown restrictions and closures have much larger impacts on firms, the overall effects of COVID-19 policies are negative.

**Table 3. Effect of Policy Responses on Firm Performance**

	(1)	(2)	(3)	(4)	(5)	(6)
	sales_yoy	emp_yoy	invest_yoy	logsales	logemp	loginv
<b>Panel A:</b>						
Stringency index	-0.407*** [0.132]	-0.015 [0.032]	0.668 [0.565]	-0.006*** [0.002]	-0.001** [0.000]	0.005 [0.004]
R-sq	0.708	0.605	0.382	0.987	1.000	0.945
<b>Panel B:</b>						
Economic support index	0.002 [0.089]	-0.031* [0.017]	-0.998* [0.512]	0.000 [0.001]	0.000 [0.000]	-0.005* [0.003]
R-sq	0.713	0.611	0.572	0.985	1.000	0.955
<b>Panel C:</b>						
Government response index	-0.426** [0.197]	-0.047 [0.049]	-0.136 [0.425]	-0.008*** [0.003]	-0.001** [0.000]	0.001 [0.005]
R-sq	0.693	0.609	0.369	0.987	1.000	0.944

Note: Country fixed effects and year-quarter fixed effects are included in all columns. The number of countries is 17 and observations is 119. The sample period is Q1 2019–Q3 2020. Robust standard errors are in brackets. \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% levels, respectively. Source: Author.

To examine the relative effects of the pandemic and policy responses on firm performance during the same period, I include both COVID-19 measures and policy responses in the specification and reran the regression. Table 4 shows that the coefficients for COVID-19 cases and deaths are significantly negative in columns 1 and 4, whilst the coefficients for the overall government policy responses index are relatively small and not significant. This suggests that the effect of COVID-19 dominates the effect of policy responses during the sample period.

**Table 4. COVID-19, Policy responses, and Firm Performance**

	(1)	(2)	(3)	(4)	(5)	(6)
	sales_yoy	emp_yoy	invest_yoy	logsales	logemp	loginv
<b>Panel A:</b>						
COVID-19 cases (log)	-1.899** [0.726]	-0.239 [0.166]	2.817 [3.117]	-0.024*** [0.009]	-0.001 [0.001]	0.005 [0.020]
Government response index	-0.192 [0.192]	-0.018 [0.048]	-0.484 [0.601]	-0.005* [0.003]	-0.001* [0.000]	0.001 [0.006]
R-sq	0.721	0.616	0.377	0.988	1.000	0.944
<b>Panel B:</b>						
COVID-19 deaths (log)	-1.242** [0.550]	-0.049 [0.143]	4.435 [3.186]	-0.017** [0.007]	-0.001 [0.001]	0.018 [0.020]
Government response index	-0.284 [0.198]	-0.041 [0.050]	-0.646 [0.563]	-0.006** [0.003]	-0.001* [0.000]	-0.001 [0.006]
R-sq	0.711	0.609	0.398	0.988	1.000	0.945

Note: Country fixed effects and year-quarter fixed effects are included in all columns. The number of countries is 17 and observations is 119. The sample period is Q1 2019–Q3 2020. Robust standard errors are in brackets. \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% levels, respectively. Source: Author.

## 5. Concluding Remarks

Using aggregate-level data on Japanese MNCs collected by the Japanese government, I examined the impact of COVID-19 pandemic and policy responses on global production networks. Not surprisingly, COVID-19 had large negative impacts on global supply chains, firm performance, expectations, and the business plans of Japanese MNCs in major host countries. Relative to Q1 2020, Japanese affiliates in China recovered in Q2–Q3 but the effects of COVID-19 became worse in other major countries during the same period. Importantly, I did not find that overall COVID-19 policy responses in host countries have positive effects on firm performance. As the effects of the containment and lockdown policies dominated the effects of economic support policies, the overall effect was actually negative. However, stronger government policy responses are likely to improve firm expectations of their sales, employment, and investment, at least in the short term.

The ongoing COVID-19 pandemic will likely transform global production. UNCTAD (2020) shows that reshoring, diversification, and regionalisation will drive the restructuring of GVCs in the coming years. My findings provide some evidence-based policy implications for global production and the re-evaluation of supply chain strategy in the post-COVID era. To reduce the reliance on supply chains in China, in April 2020, the Japanese government approved a fiscal stimulus package including ¥220 billion (US\$2 billion) for manufacturing firms to move production home and ¥23.5 billion (\$0.2 billion) to move it to ASEAN countries. However, China has brought the spread of COVID-19 under control, and the supply chains and economic activities have recovered since Q2 2020. On the other hand, Japan, ASEAN, and the ROW were hit hard by the pandemic at the same time. Therefore, it is geographical diversification in sourcing and sales, not the reallocation of production and supply chains, that makes firms and the economy more resilient to supply chain disruptions and disasters. For example, it is estimated that the 2003 SARS epidemic reduced Chinese firm imports by 8% on average, but it was as much as 56% for firms without any diversification (Huang, 2017). Resilience in global supply chains can be increased through building buffer stocks and making standardised inputs easier to be replaced, identifying places and suppliers less subjective to risk, and assessing the time to recover for each type of supplier (Miroudot, 2020). Policies in the future should support business efforts to build more robust and resilient supply chains. Furthermore, mega free trade agreements, such as the newly signed Regional Comprehensive Economic Partnership in December 2020, are expected to promote trade, investment, and supply chain diversification in the post-COVID-19 world.

Finally, as this study uses aggregate-level data, there are many limitations to the analysis. When micro-level data is available, it will be interesting to investigate how did Japanese MNCs adjust their global production and whether they reorganise their global supply chains. To separate and estimate the supply shock and demand shock on global productions is also challenging. I leave these research questions as future work.

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## **Appendix A. Regions and Countries**

The classification of countries and regions is based on the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry.

**China:** CHN, HKG

**ASEAN:** BRN, IDN, KHM, LAO, MMR, MYS, PHL, SGP, THA, VNM

**NIEs:** KOR, SGP, TWN

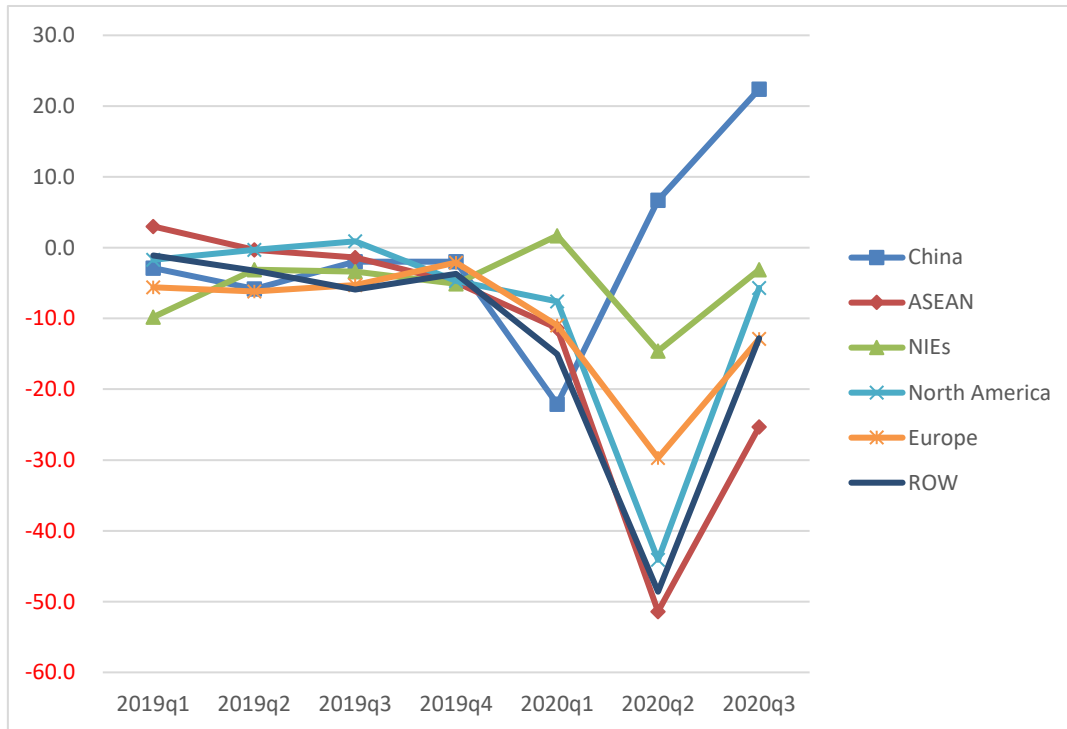
**North America:** CAN, USA

**Europe:** AUT, BEL, BGR, CHE, CZE, DEU, DNK, ESP, FIN, FRA, GBR, GRC, HUN, IRL, ITA, LUX, MNE, ROM, NLD, POL, PRT, RUS, SVK, SWE, TUR, UKR

**ROW:** ARG, AUS, BRA, CHL, COL, CRI, EGY, GTM, ISR, KEN, MAR, MEX, NGA, NZL, PER, SAU, SLV, SWZ, TUN, URY, VEN, ZAF

## Appendix B. Figures and Tables

**Figure B1. Local Sales by Region (% , y-o-y)**

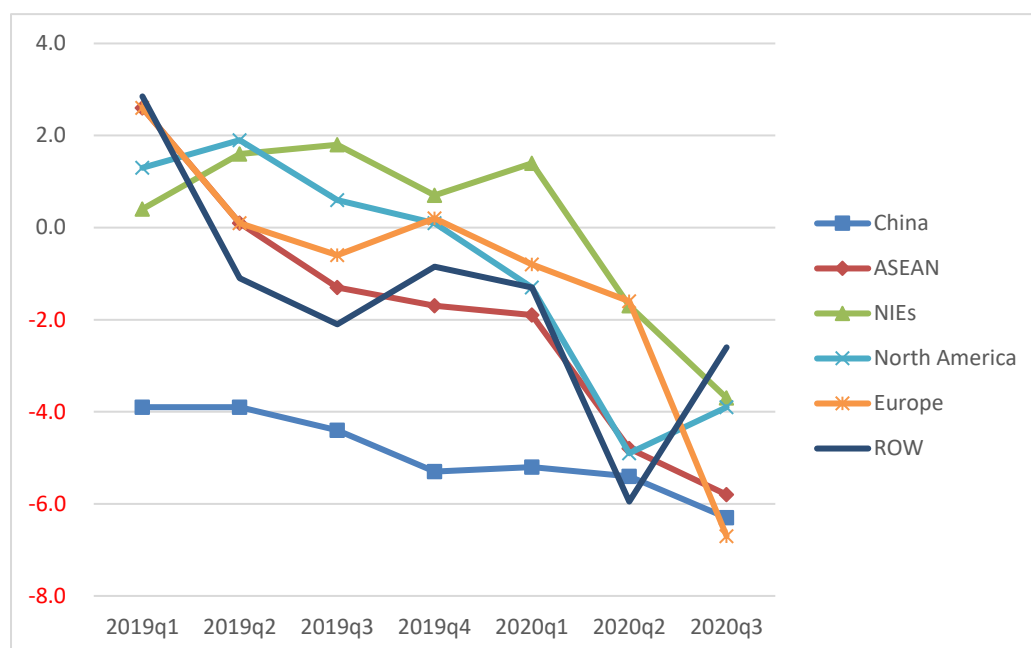


ASEAN = Association of Southeast Asian Nations, NIEs = newly industrialised economies, ROW = rest of the world.

Source: Author's own compilation based on the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry.



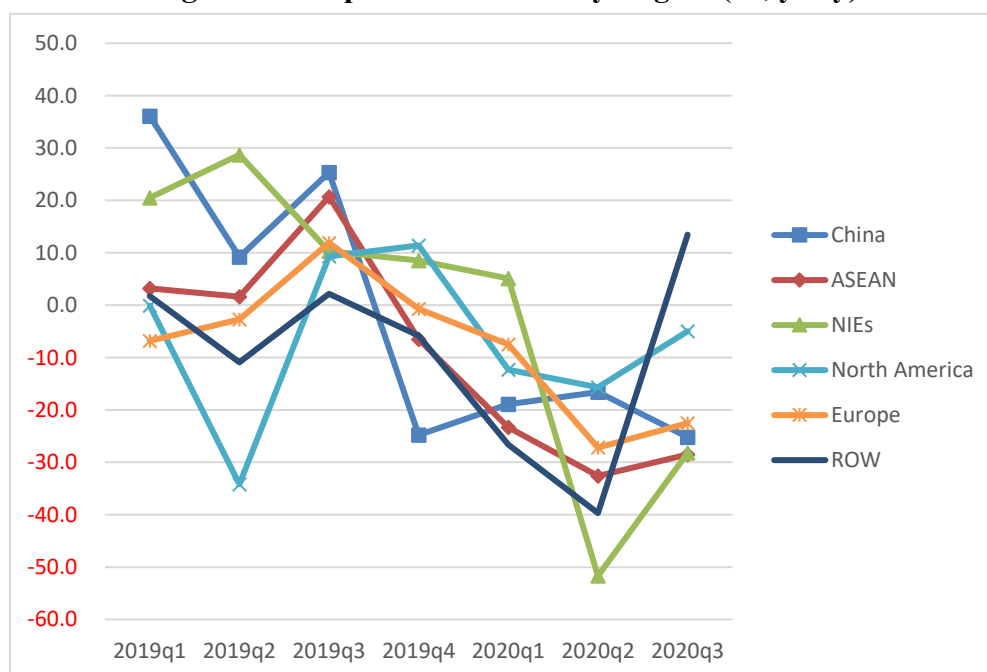
**Figure B2. Employment by Region (% , y-o-y)**



ASEAN = Association of Southeast Asian Nations, NIEs = newly industrialised economies, ROW = rest of the world.

Source: Author's own compilation based on the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry.

**Figure B3. Capital Investment by Region (% , y-o-y)**



ASEAN = Association of Southeast Asian Nations, NIEs = newly industrialised economies, ROW = rest of the world.

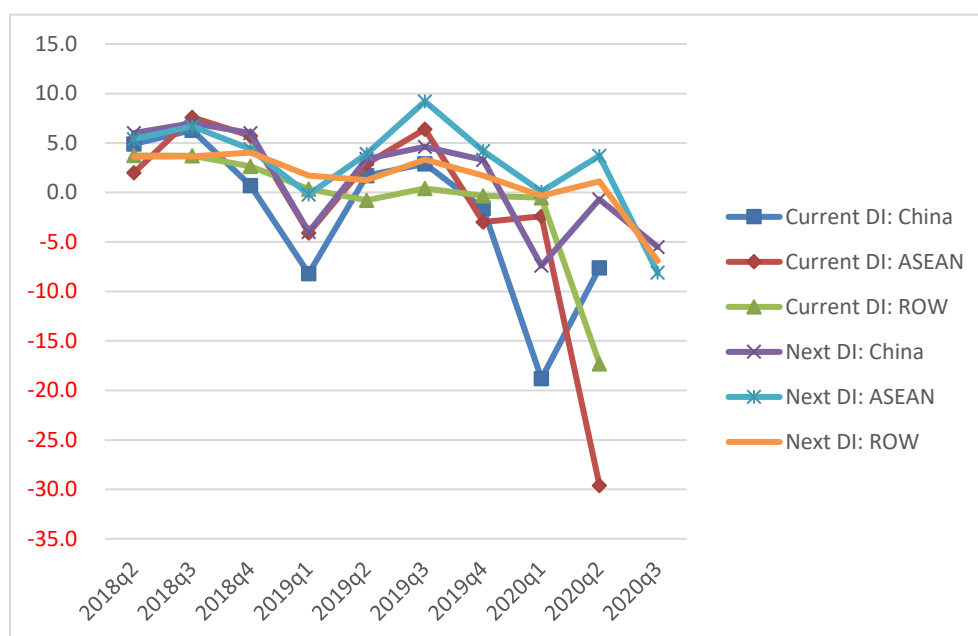
Source: Author's own compilation based on the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry.

**Figure B4. Diffusion Index: Local Sales (percentage points)**



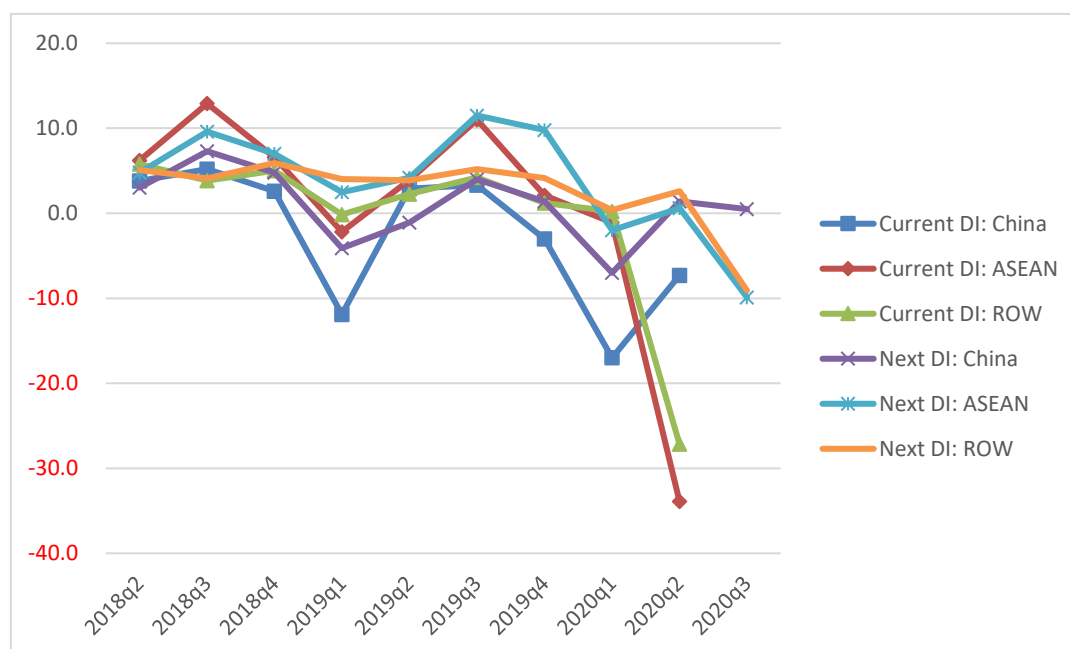
ASEAN = Association of Southeast Asian Nations, DI = Diffusion Index, ROW = rest of the world.  
Source: Author's own compilation based on the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry.

**Figure B5. Diffusion Index: Exports to Japan (percentage points)**



ASEAN = Association of Southeast Asian Nations, DI = Diffusion Index, ROW = rest of the world.  
Source: Author's own compilation based on the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry.

**Figure B6. Diffusion index: Exports to Third Countries (percentage points)**



ASEAN = Association of Southeast Asian Nations, DI = Diffusion Index, ROW = rest of the world.

Source: Author's own compilation based on the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry.

**Table B1. Summary Statistics**

Variables	Obs	Mean	Std. Dev.	Min	Max
COVID-19 cases	119	179,565	774,840	0	5,727,091
COVID-19 deaths	119	5,372	18,733	0	123,547
sales_yoy (%)	119	-10.0	14.8	-72.2	18.0
invest_yoy (%)	119	-0.3	43.1	-64.8	239.6
emp_yoy (%)	119	-1.1	3.7	-14.5	10.3
logsales	119	13.5	1.0	12.1	15.9
loginv	119	10.1	1.0	8.1	12.5
logemp	119	11.8	1.1	10.1	13.9
Government response index	119	21.8	29.3	0	85.3
Economic support index	119	16.5	28.7	0	100
Stringency index	119	22.0	29.9	0	91.7

Source: Author's own compilation based on the data from the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry, Johns Hopkins Coronavirus Resource Center, and Oxford COVID-19 Government Response Tracker.

**Table B2. Correlation Matrix**

	1	2	3	4	5	6	7	8	9	10	11
1 COVID-19 cases	1.00										
2 COVID-19 deaths	0.85	1.00									
3 sales_yoy (%)	-0.19	-0.40	1.00								
4 invest_yoy (%)	-0.12	-0.04	0.27	1.00							
5 emp_yoy (%)	-0.15	-0.21	0.47	0.21	1.00						
6 logsales	0.10	0.08	0.19	-0.04	-0.14	1.00					
7 loginv	0.15	0.15	0.07	0.06	-0.17	0.92	1.00				
8 logemp	0.08	0.08	-0.03	-0.11	-0.31	0.84	0.87	1.00			
9 Government response index	0.38	0.46	-0.62	-0.31	-0.50	-0.12	-0.12	0.01	1.00		
10 Economic support index	0.33	0.39	-0.50	-0.36	-0.40	-0.14	-0.18	-0.10	0.85	1.00	
11 Stringency index	0.38	0.48	-0.66	-0.28	-0.49	-0.11	-0.09	0.05	0.99	0.79	1.00

Source: Author's own compilation based on the data from the Quarterly Survey of Overseas Subsidiaries, Ministry of Economy, Trade and Industry, and Johns Hopkins Coronavirus Resource Center, and Oxford COVID-19 Government Response Tracker.

**Table B3. Impact of COVID-19 by Quarter**

	(1)	(2)	(3)	(4)	(5)	(6)
	sales_yoy	emp_yoy	invest_yoy	logsales	logemp	loginv
<b>Panel A:</b>						
COVID-19 cases (log)	-0.793*** [0.291]	-0.365*** [0.108]	-1.978* [1.092]	-0.012*** [0.003]	-0.001 [0.001]	-0.019* [0.010]
*Dummy (Q2=1)	-2.358*** [0.433]	-0.040 [0.140]	-1.754 [1.369]	-0.034*** [0.007]	-0.003** [0.001]	-0.018 [0.012]
*Dummy (Q3=1)	0.139 [0.399]	0.075 [0.136]	0.392 [2.098]	0.001 [0.005]	-0.003** [0.001]	0.000 [0.013]
R-sq	0.733	0.618	0.349	0.989	1.000	0.941
<b>Panel B:</b>						
COVID-19 deaths (log)	-1.527*** [0.437]	-0.540*** [0.161]	-3.545** [1.597]	-0.021*** [0.006]	-0.001 [0.001]	-0.033* [0.017]
*Dummy (Q2=1)	-2.317*** [0.670]	0.046 [0.195]	-0.428 [1.859]	-0.038*** [0.010]	-0.003 [0.002]	-0.008 [0.019]
*Dummy (Q3=1)	0.494 [0.612]	0.194 [0.203]	3.253 [3.563]	0.003 [0.007]	-0.003* [0.002]	0.018 [0.023]
R-sq	0.687	0.574	0.318	0.987	1.000	0.936

Note: Country fixed effects and quarter fixed effects are included in all columns. The number of countries is 17 and observations is 119. The sample period is Q1 2019–Q3 2020. Robust standard errors are in brackets. \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% levels, respectively. Source: Author.

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