ERIA Discussion Paper Series

No. 545

Global Pandemic Shocks, Foreign Exposure and Firm Productivity: Evidence from Korean Firm-level Data

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March 2024

Abstract: *This study analyses the impact of the COVID-19 pandemic on a firm's total factor productivity (TFP) using Korean firm-level data from 2016 to 2021. The study reveals that the pandemic had a heterogeneous impact on firm TFP depending on the firm's operational characteristics, specifically whether the firm is a multinational enterprise (MNE) or a pure exporter (non-MNE). Whilst the pandemic had a more significant negative impact on the TFP of pure exporters than other firms, MNEs were less affected by the pandemic shock than pure exporters. This implies that whilst both firms were exposed to negative demand shocks on a global scale, MNEs were better equipped to handle supply-side uncertainties through international diversification. The study identifies certain characteristics of MNEs that helped buffer the pandemic shock, such as shedding labour, high R&D intensity, and more diversification via foreign subsidiaries. These characteristics enabled MNEs to mitigate the pandemic shock and even increase their TFP during the pandemic.*

Keywords: Global Pandemic, COVID-19, firm productivity, resource allocation, labour shedding, R&D, MNEs, international diversification, pure exporting firms

JEL classifications: D24, F23, F40, H12, I18

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1. Introduction

The COVID -19 pandemic was a global threat, impacting our lives regardless of where we lived in the world. To prevent the spread of the COVID-19 virus, many countries closed their borders and implemented nationwide lockdowns. The consequent halting of production and closing of borders created obstacles to international business and threatened firms on a global scale. The 2020 Annual Capital Expenditures Survey (ACES) revealed a stark reality related to business operations in the United States (US) during the pandemic. According to the survey, 62.8% of the participating firms applied for financial assistance. These data also underscore that amidst the global challenge posed by COVID-19, businesses found it difficult to survive (United States Census Bureau, 2020). Whilst it is commonly believed that the pandemic negatively impacted firm performance and caused many small firms to shut down, there have been few studies exploring the heterogeneity of this impact and how resilient firms reacted differently (Ciravegna et al., 2023). This paper seeks to delve into several interesting, timely, but previously underexplored questions. We aim to answer the following questions: How did the pandemic shock affect firm productivity? How did the impact vary across firms' operational characteristics, such as pure-exporting firms and multinational enterprises (MNEs)? Identifying the pandemic shock (supply and demand) is a challenging task, but using firm characteristics and government policies, we are able to identify the COVID-19 shock and examine the heterogenous consequences for productivity amongst the survivors.

This study, using novel Korean firm-level data from 2016 to 2021, finds that the regionally identified pandemic shock led to a decrease in total factor productivity (TFP) that is more significant for exporters (not MNEs) than for other firms, which is consistent with previous studies (e.g. Guedhami et al. (2022)). However, we discover nuanced differences when comparing pure exporters to MNEs, even though most MNEs are exporters. We find that MNEs experienced less negative TFP growth than domestic firms during the pandemic. This finding indicates that MNEs are better equipped to handle uncertainties and mitigate these risks. In addition, by focusing on MNEs during the pandemic, we find that those able to reallocate their resources effectively – through shedding labour, having high R&D intensity before the pandemic, and diversifying via foreign subsidiaries – were better equipped to handle the pandemic shock. In particular, we find that MNEs with at least two foreign subsidiaries and possessing both foreign and domestic subsidiaries effectively buffered the negative pandemic shock. This strategy not only buffered

them from adverse impacts but also enabled them to exhibit positive TFP growth during the pandemic, thereby providing opportunities for productivity enhancement.

The disruption in global value chains (GVCs) driven by the pandemic caused confusion in the relationship between supply and demand shocks driven by COVID-19[1] (Barrero, Bloom, and Davis, 2020; Baqaee and Farhi, 2022; Guerrieri et al., 2022; Krueger, Uhlig, and Xie, 2022). For instance, the rapid spread of the pandemic limited mobility, resulting in adverse effects on face-to-face transactions and demand for goods and services (demand shock). Additionally, firms in countries that introduced strict policy measures either temporarily shut down their production or even exited the business altogether (supply shock). From a global perspective, China, the world's production centre, was the first hit by the pandemic shock, which then spread to other countries. Many countries introduced strict measures, including workplace lockdowns, border closures, quarantines, and restrictions on social gatherings. The demand shock was distributed along with the rising number of infections in individual countries, whilst the supply shock in countries with strict policies was rapidly transmitted through the global value chain. These two shocks occurred simultaneously and overlapped, but they could be differentiated based on the differences in government policies.

Previous studies have examined the effects of the pandemic shock at the firm or investor level, but they have yet to differentiate how the detailed nature of the pandemic shock (supply and demand) affected the performance of firms in different ways. Our study seeks to understand how these different shocks affected firms based on their operational characteristics, such as being MNEs, pure exporters without foreign subsidiaries, or firms operating solely domestically (i.e. MNEs that are diversified are less affected by supply-side shock, whilst exporters are more affected by demand-side shock since both home and foreign markets were disrupted simultaneously). We can conduct pure experiments by tracing the survivors before and after the pandemic. This approach enables us to identify the specific mechanisms through which these traits influenced firm-level productivity adjustments, making firms less vulnerable in the face of the global pandemic.

[1] Baqaee and Farhi (2022) demonstrate that negative sectoral supply shocks can lead to stagflation, which can be amplified by complementarities in production. Supply and demand shocks each explain about half of the reduction in real GDP from February to May 2020. Barrero et al. (2020), Guerrieri et al. (2022), and Krueger et al. (2022) also investigate the differentiation between the COVID-19 shock's demand and supply components and the sectoral reallocation it triggers.

Moreover, we focus on within-firm TFP as a measure that captures how efficiently a firm employs its resources and tacit knowledge (see İmrohoroğlu and Tüzel (2014))[2]. Previous studies, such as Guedhami et al. (2022), have addressed that, except in the South Asia region, domestic firms rebounded from the negative pandemic impacts more quickly than MNEs, as evidenced by stock price recovery. Yet, due to the use of stock prices reflecting investors' perspectives, not firms' operations, concrete evidence is still lacking to determine which firms or industries might be winners or losers during global pandemic shocks.

The novel feature of this study is that we discover new empirical findings that challenge the conventional wisdom of negative pandemic shocks. We find that MNEs even benefited from the pandemic's shock under specific conditions. An MNE's ability to leverage foreign knowledge and resources proves critical in managing global uncertainties and stabilising performance (Puhr and Müllner, 2022). During the crisis, MNEs' internal resource allocation, propensity for R&D, and the geographic diversification of MNEs through their subsidiaries enabled them to mitigate the impact of national disruptions.

Whilst we see negative impacts of the pandemic shock,[3] some studies also discuss the possible opportunities. Lamorgese et al. (2024) show that using firm survey data in Italy, firms with more structured managerial practices were more likely to respond to a large and unanticipated shock like COVID-19, including adopting more intense use of remote work and experiencing sales growth during the pandemic. Andrews, Charlton, and Moore (2021) find that firms with high productivity that increased labour turnover during the pandemic were more likely to expand. These instances imply that the consequences of the global pandemic are not inherently negative and highlight the necessity for research to embrace and consider various dimensions of heterogeneity. By focusing on MNEs' internal flexibility and their diversification strategy through production facilities abroad, this study demonstrates which types of MNE diversification were more effective during the pandemic by employing information about MNE subsidiaries.

[2] İmrohoroğlu and Tüzel (2014) stress that firm-level TFP strongly correlates with various firm characteristics, such as the size, book-to-market ratio, investment, and hiring rate. Therefore, firm TFP is an essential indicator to capture a firm's characteristics.

[3] For example, Bloom et al. (2023) used a unique firm-level survey to decompose the drivers of labour and TFP in the United Kingdom during the COVID-19 pandemic. They found that TFP fell by up to 6% in 2020–2021 due to reduced within-firm productivity, offset by positive effects from contracting less productive firms and sectors.

The remainder of the paper is organised as follows. Section 2 explores the theoretical background, discussing how various characteristics of a firm influence productivity changes during a global pandemic crisis and proposes hypotheses. In Section 3, we introduce the dataset and formulate the empirical specification for our analysis using the difference-in-differences estimation model. Section 4 outlines the main empirical results. Discussions and concluding remarks follow in Section 5.

2. Theory and Hypotheses

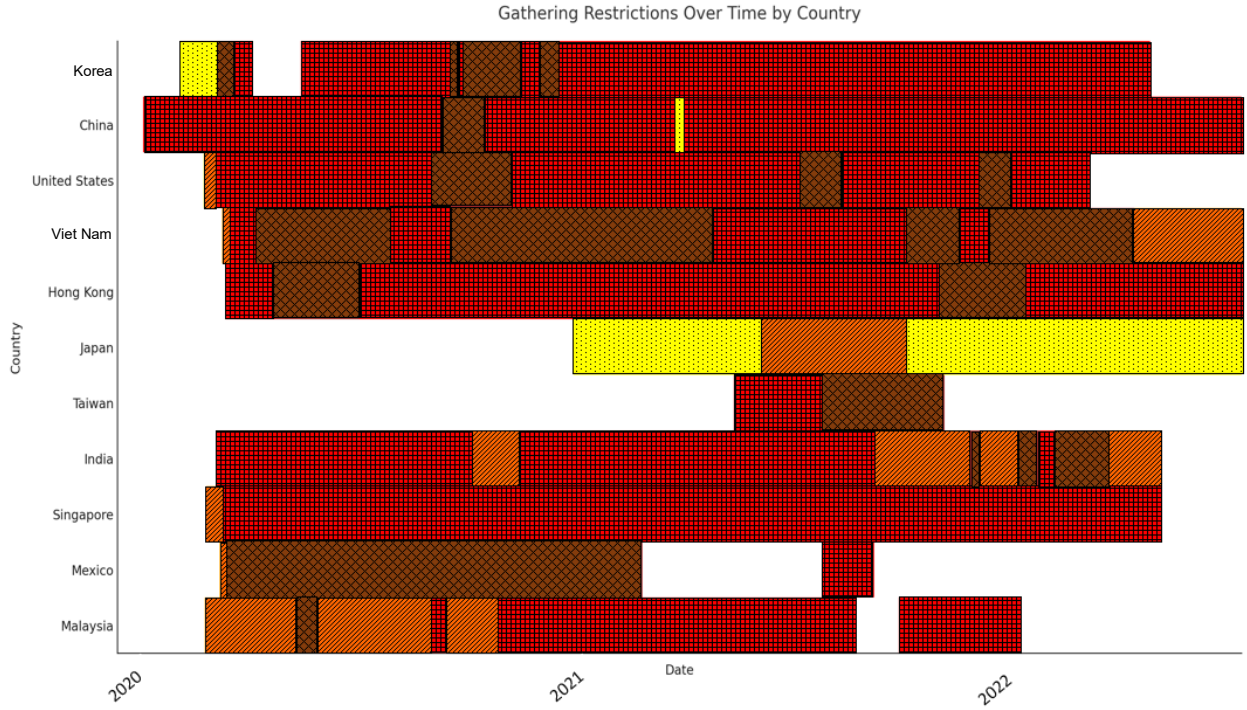
2.1. Pandemic hocks on firms' TFP between pure exporters and MNEs

2.1.1. Negative exposure to exporting firms

The COVID-19 pandemic caused an unprecedented global health crisis, leading to panic amongst people and affecting mobility both within countries and across borders. This resulted in disruptions to both domestic and foreign trade, causing a double-dip demand shock that hit exporting firms particularly hard. Bricongne et al. (2022) highlight that the COVID-19 pandemic led to a collapse in exports due to demand shock components, although their focus is mainly on large exporting firms.

At the same time, government responses to the global pandemic, including border lockdowns and social distancing policies, posed a threat to demand in individual countries. Social distancing measures that limited face-to-face transactions and quarantine regulations proposed by individual governments exacerbated negative demand shocks. Although basic demand for goods and services continued through online platforms, these negative demand shocks persisted gradually during the pandemic period. Liu et al. (2022) focus on import flows from China (country demand) in response to country-level COVID-19 intensity and policy response and show that the negative demand effect was greater than the negative supply effect.

Figure 1: Restrictions on Gatherings Over Time



Notes: The author created this figure based on data from the 10 countries with the most active export trade with Korea. In this index, white signifies that there are no restrictions in place; a dotted pattern in yellow marks restrictions on very large gatherings, allowing for groups larger than 1000 people; diagonal stripes in orange represent limitations on the size of gatherings to between 101 and 1,000 people; a crosshatched pattern in sandy brown is used to indicate stricter restrictions on gatherings, with the allowed group size ranging from 11 to 100 people; a vertical hatched pattern in red signals the most stringent restrictions, permitting gatherings of only 10 people or fewer.
Source: Oxford COVID-19 Government Responses Tracker, BBC Research.

Figure 1 displays the restriction policies on public gatherings, categorised into four stages, which can be seen as influencing the consumption behaviours of the general public. Strong restrictions are represented in red with a vertical hatched pattern, followed by sandy brown (crosshatched pattern), orange (diagonal stripes), yellow (dotted pattern), and nearly no restrictions in white. These restrictions began in China, but many important trading partners with the Republic of Korea (hereafter, Korea) (except Japan and Taiwan using border lockdowns) introduced very strict distancing policies, and these restrictions overlapped. In this regard, we can argue that exporting firms were hit harder by dual negative demand shocks compared to domestic ones, leading to more serious negative consequences for exporting firms. In this regard, we hypothesise as follows:

Hypothesis 1: A decrease in productivity was greater for pure exporting firms than for non-pure exporting firms during the global pandemic.

2.1.2. Possible buffer for MNEs

MNEs and exporting firms tend to be more affected by negative demand shocks than pure domestic firms. However, MNEs have an advantage in that they can buffer such shocks by having supply chains that stretch across borders. By investing capital or assets in different countries and geographic regions, MNEs can diversify their operations internationally, which can make them less susceptible to negative demand shocks. This expansion can take various forms, such as the establishment of strategic alliances or joint ventures with international partners.

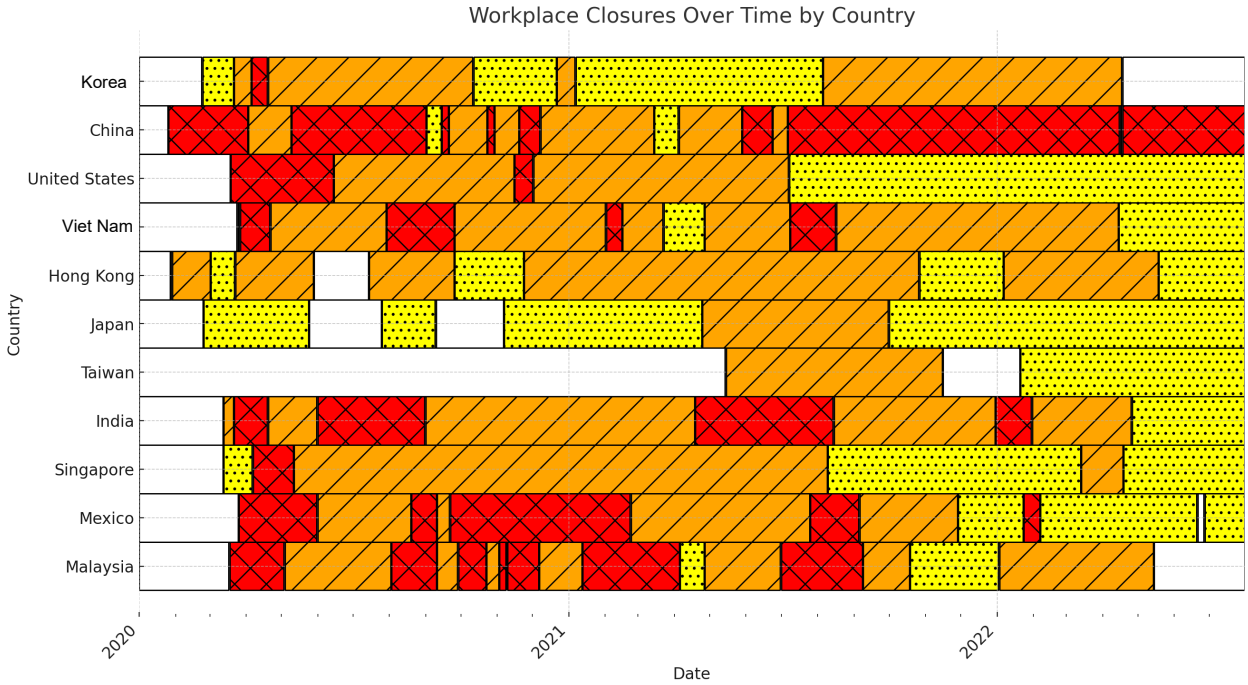
Although research has shown inconsistent results regarding the correlation between the geographic reach of a firm and its overall performance (Schmuck, Lagerström and Sallis, 2023), many studies have indicated that international or geographic market diversification has a positive impact on a firm's overall profits through varying factors in markets, such as labour or capital diversification (Caves, 1996; Goerzen and Beamish, 2003; Kim, Hwang and Burgers, 1989). According to Goerzen and Beamish (2003), a survey of 580 Japanese MNEs operating in more than six countries indicates that a greater dispersion of assets is positively associated with firm performance. A similar study of 62 US MNEs confirms that firms engaged in a highly diversified global market, particularly those with related diversification, tend to achieve greater corporate profit growth compared to firms with low global market diversification and unrelated diversification (Kim et al., 1989).

It can be argued that the COVID-19 pandemic caused an unprecedented disruption in the 'global' supply chain, unlike any other past shock. However, the impact of GVC disruption driven by the pandemic also varied across firms due to their varying exposure to GVCs (Lebastard, Matani, and Serafini, 2023). Indeed, MNEs could still operate their businesses by accessing multiple sources of inputs and being more financially stable during the pandemic (Waldkirch, 2021). So, MNEs managed to stay resilient by utilising dynamic capabilities to navigate uncertainties stemming from the pandemic shock.

In addition, another (external) reason for the valid buffering effect of MNEs during tough times is the varying timing of lockdown restrictions across different countries. During the pandemic, the government's policy measures directly impacted firms, and the response of

producers helped identify supply-side shocks. Government lockdown measures were a source of the supply-side shock, reducing production.

Figure 2: Workplace Closures Over time



Note: The author created this figure based on data from the 1- countries with the most active export trade with Korea. White indicates the absence of any restrictions; a dotted pattern in yellow suggests the recommendation to close, or that all businesses are open with modifications; diagonal stripes in orange reflect the requirement for certain sectors or categories of workers to close; a crosshatched pattern in red denotes the enforcement of closures for all but essential workplaces from normal operations due to COVID-19.
Source: Oxford COVID-19 Government Responses Tracker, BBC Research.

Figure 2 displays the workplace shutdown policies of the top 10 countries where Korean firms were exporting: China, the United States, Viet Nam, Hong Kong, Japan, Taiwan, India, Singapore, Mexico, and Malaysia. Yellow with a dotted pattern indicates recommendations to close, orange with diagonal stripes reflects the requirement for certain sectors or categories of workers to close, and red with a crosshatched pattern indicates mandatory closures for all but essential workplaces, such as grocery stores or doctors. This illustration demonstrates that individual countries implemented shutdown policies at different times, thereby providing a buffering factor that allowed MNEs with production facilities in various countries to mitigate negative impacts. MNEs could achieve this by utilising production facilities to manufacture goods and generate demand in those nations' markets. Therefore, MNEs could reduce the negative effects

because they were able to respond with diversified strategies according to individual government policies. For example, China employed strict COVID-19 measures for a long time, but Turkey did not introduce any lockdown for its suppliers. Indeed, the effects experienced by firms in different countries varied depending on their respective COVID-19 measures. Hence, a firm that conducted business exclusively within its domestic borders without establishing potential alternatives overseas may have faced more significant challenges during the pandemic crisis compared to a firm with subsidiaries in other host countries.

Hypothesis 2: A decrease in productivity was greater for domestic firms than multinational firms during the global pandemic.

2.2. Why were MNEs more resilient during the pandemic?

Although the COVID-19 pandemic negatively impacted many businesses, some firms were able to boost their productivity by reallocating their resources (Andrews et al., 2021; Hyun, Kim, and Shin, 2020). For instance, Andrews et al. (2021) discover a positive job-reallocation effect amongst small businesses in Australia, New Zealand, and the UK during COVID-19. Using near-real-time data, they show that through labour reallocation, high-productivity firms were more likely to expand and low-productivity firms were more likely to contract, despite a fall in labour turnover in response to the pandemic. Prior to the COVID-19 pandemic, some studies showed that effective resource allocation driven by macro shocks could help firms withstand negative shocks and even lead to improvements in productivity.

Tougher competition caused by trade liberalisation can prompt firms to restructure. In response to the intense competition, firms may choose to discontinue underperforming products and concentrate on core business lines. This strategic decision enables firms to reallocate more workers to the production of essential items, leading to an increase in overall labour productivity (sales per worker) (Mayer et al., 2014). In addition, Ekholm et al. (2012) find that a significant real exchange rate appreciation rather enhanced (survived) Norwegian firms' productivity by prompting their labour shedding. In this regard, effective resource redistribution strategies, such as labour shedding, automation, the substitution of labour with other factors, or organisational restructuring can help firms defend against decreased productivity during times of crisis. MNEs, possessing subsidiaries across various countries, are likely to benefit more from such resource allocation compared to domestic firms. This advantage arose particularly during the pandemic, as MNEs could allocate resources more flexibly in response to differing government policies across

countries. For instance, if production operations became untenable in a country, an MNE could reduce labour there, and the cost savings from labour reduction could be redirected towards capital or R&D investments, thereby creating a more efficient production base.

Hypothesis 3-1: Multinational firms with effective resource reallocation (via labour shedding) were more likely to mitigate productivity declines during the crisis than domestic firms.

The pandemic also expedited technological innovations and digitalisation whilst restricting people's movement and halting factory operations. The distribution and utilisation of software for virtual communication enabled seamless communication even amongst those whose movements were limited. Moreover, smart factories could be operated via remote control. Previous studies have shown that firms that integrated new technologies into their operations were likely to respond well to the pandemic (Bloom et al. 2023; Li et al., 2022). For instance, Bloom et al. (2023) find that the pandemic had a varied effect on firm productivity: firms that allowed remote work (work from home) and had less face-to-face contact with customers were more likely to experience an increase in productivity. Although it is challenging to gauge the extent to which firms introduced new technologies, we contend that firms with a consistent focus on R&D are more likely to have a propensity for adopting new technology, which makes them better prepared to cope with unexpected disruptions.

In addition, R&D investment can also help firms secure resources that can be utilised during a crisis. Magerakis et al. (2022) find that during the global financial crisis, UK-listed non-financial firms with high R&D investments demonstrated significant cash holdings, which could be used as resources to overcome the crisis. Since it can be difficult to find external financial sources during a crisis, firms strive to immediately convert assets that can be liquidated into cash internally. Thus, R&D expenditures reasonably accounted for the increase in cash ratios amongst UK firms following the crisis. This suggests that as the business environment becomes more complex, R&D investment becomes a viable strategy for survival in the post-crisis era. In this regard, we examine whether MNEs with higher R&D intensity prior to the crisis were better able to manage the negative impact. Based on these insights, we have formulated the following hypothesis:

Hypothesis 3-2: Multinational firms with higher R&D intensity prior to the global pandemic were more likely to counter productivity declines during the crisis.

In addition, MNEs often have headquarters or production facilities located across various countries as part of their diversification strategies. Some papers argue that international diversification can entail higher costs and efforts for a firm's survival due to the liability of

foreignness, greater risk exposure, and agency cost (Olibe, Michello, and Thorne, 2008; Reeb, Kwok and Baek, 1998). Conversely, diversification strategies can give firms a competitive advantage (Caves, 1996; Kim et al., 1989). International (final product) market, labour, or foreign capital diversification is crucial for mitigating risks, leveraging resources like labour and finance across subsidiaries, optimising production factors, and reducing costs through economies of scale. Fluctuations in exchange rates and terms of trade work asymmetrically. They often benefit profits in one country whilst negatively affecting them in others. Empirical data confirm that MNEs experience more significant benefits from diversification compared to domestic firms. The greater the proportion of foreign operations in total sales, the lower the volatility in a firm's return on equity capital (Rugman, 1979).

In light of this, we contend that despite national border lockdowns during the pandemic, MNEs continued to operate their businesses through their subsidiaries. This diversification of their portfolio, particularly through geographical diversification, was able to help MNEs mitigate idiosyncratic shocks. Puhr and Müllner (2022) conduct an empirical laboratory on S&P 500 firms during COVID-19 and find that whilst internationalisation and the liability of foreignness amplified systematic risk, the asset of multi-nationality played a crucial role. This asset, capable of learning from foreign operations and transferring knowledge, significantly aids during crises of non-ergodic uncertainty, countering the effects of systematic risk. According to this argument, the more diverse the knowledge about the host country, the more effective the diversification asset of an MNE can be. By having more subsidiaries, a firm can acquire and utilise a broader range of knowledge, especially during a cross-border pandemic such as COVID-19. Therefore, possessing more subsidiaries can enhance an MNE's ability to respond during moments of crisis. These observations form the basis for our subsequent hypothesis:

Hypothesis 3-3: Multinational firms with more foreign subsidiaries (extensive margins) were likely to exhibit a lesser reduction in productivity during the global pandemic, whilst those with higher average investments for their subsidiaries (intensive margins) were not.

3. Data and Methodology

3.1. Data

This study introduces a firm-level panel dataset for Korean manufacturing industries for the period 2016–2021. Statistics Korea started to construct firm-level data from the Survey of Business Activities in 2006. These data are now collected annually and cover all enterprises operating in

Korea that have 50 or more regular workers and capital of 300 million Korean won or more each year when the survey is conducted. This survey includes both the manufacturing and services sectors. However, this study uses data on manufacturing industries that are classified into 24 industry types based on the Korea Standard Industrial Classification (KSIC). This dataset provides various firm-level information about sales, exports and imports, employees, wages, material costs, foreign capital share, assets, etc. The data also identify the location of firms at the regional level. The regions include nine provinces (Gyeonggi, North Chungcheong, South Chungcheong, North Jeolla, South Jeolla, North Gyeongsang, South Gyeongsang, Gangwon, and Jeju); six metropolitan cities; one special self-governing city, Sejong; and one special city, Seoul. Moreover, it releases information on the inter-firm investment from Korean parent firms to their domestic or foreign subsidiaries/affiliates as well as the country where foreign subsidiaries are located.

To analyse the impact of the COVID-19 shocks, we introduce data that measure the intensity of COVID-19. Globally, as of October 2023, there had been 771,549,718 confirmed cases, including 6,974,473 deaths, reported to the World Health Organization. Regardless of these statistics, we experienced severe negative impacts on our daily lives due to the pandemic. Panel A of Figure 3 shows the daily new confirmed COVID-19 cases and deaths per million people in Korea between 2020 and 2023. According to official data from the World Health Organization, the first report of confirmed cases was on 19 January 2020 in Korea and for confirmed deaths was on 20 February 2020. During our sample period (2016–2021), the highest daily increase in confirmed COVID-19 cases occurred on 14 December 2021, with 7,850 citizens testing positive in a single day. Additionally, within the same period, the highest daily death toll due to the pandemic was recorded on 22 December 2021, with 109 people losing their lives. In this regard, we designate the years 2020 and 2021 as the global pandemic shock periods in our baseline analysis, corresponding to the onset of the COVID-19 pandemic in Korea.

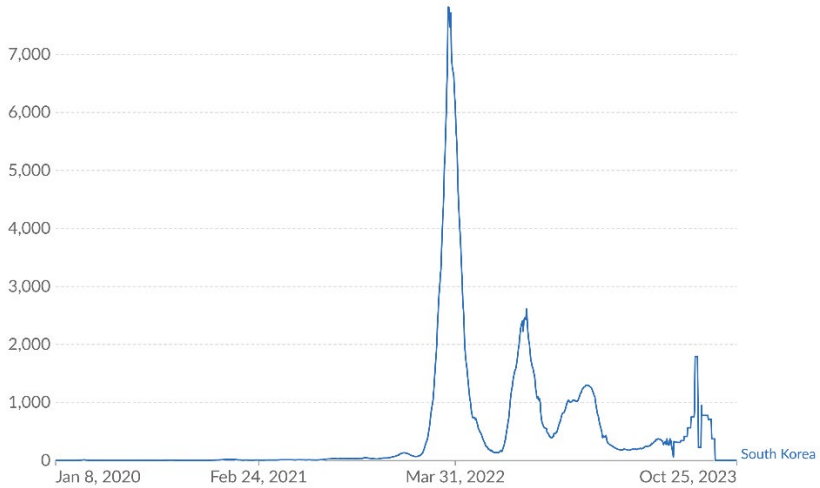
It can be difficult to measure the impact of COVID-19 on individual firms using yearly variations in the number of infected or deceased people. This is due to the fact that other macro factors can contaminate this yearly measure. Therefore, it is more effective to examine COVID-19 measures at the regional level where individual firms are operating. This region-year variation of COVID-19 helps identify the impact of COVID-19 intensity on firm TFP. Panel 3 of Figure 3 shows that whilst COVID-19 cases were concentrated in the Seoul and Gyeonggi areas, we observe regional dispersion of the pandemic's intensity.

We estimate firm-level TFP by industry. Various methods are used to estimate TFP by using the standard production function of each industry. Firm-level TFP demonstrates the efficiency of the production of firms, indicating the portion of the growth in output not explained by the growth in traditionally measured inputs, such as labour and capital. For instance, even though firm A and firm B input similar levels of labour and capital, the final product may differ because of the productivity differences. Prior literature understands those unobserved productivities as technology, knowledge, management strategies, regulation, or institutions. We use Wooldridge's (2009) method to estimate the TFP of Korean firms by each manufacturing industry. The production function for each industry is calculated as follows: $Y_{it} = \alpha + \beta L_{it} + \gamma K_{it} + v_{it} + e_{it,}$ where Y_{it} refers to the growth of value-added in firm i during the time period t, L_{it} is the labour (employment) in firm i, and K_{it} is firm i's capital stock. v_{it} is an unobserved productivity component, and e_{it} is the error term. Levinsohn and Petrin (2003) propose a firm's unobserved productivity by using intermediate inputs as a proxy: $v_{it}=g(K_{it,} m_{it})$, where m_{it} refers to the intermediate inputs. If a firm has positive v_{it}, there would be simultaneity issues when a firm increases input factors, such as K_{it}. However, m_{it} is relatively independent of productivity changes compared to K_{it}, and we can use it as an instrumental variable.

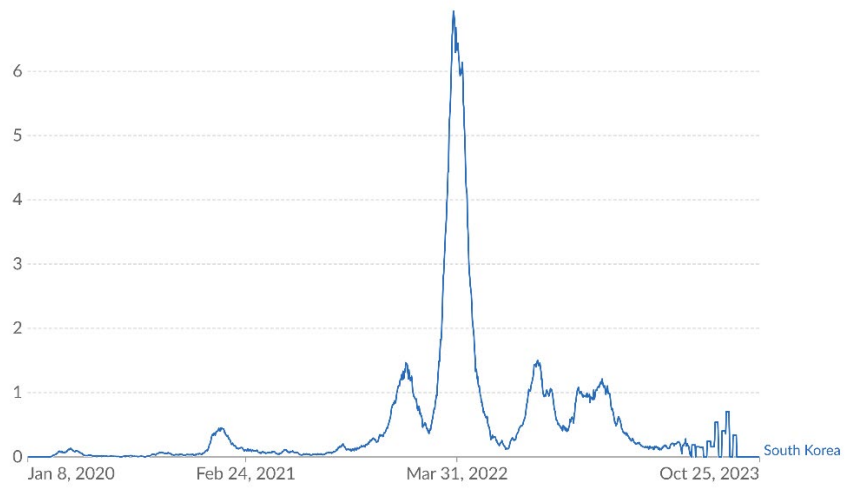
Panels A and B of Figure 4 illustrate industries that experienced negative and positive TFP growth in 2020, respectively. The majority of industries experienced TFP declines during the pandemic, whilst some showed positive TFP growth during the same period, as observed in Panel B. Not only did industry heterogeneities play a significant role but individual firms' unique characteristics also influenced TFP during the global pandemic. It is essential to take into account various factors, including firm-, industry- and regional-level characteristics when evaluating the heterogeneous impacts of the pandemic. In our study, we focus on specific firm operational characteristics, such as whether firms are exporters or MNEs.

Figure 3: COVID-19 Measures in Korea

Panel A. Daily New Confirmed COVID-19 Cases and Deaths per Million People in Korea Between 2020 and 2023



Daily new confirmed COVID-19 cases per million people
(7-day rolling average)

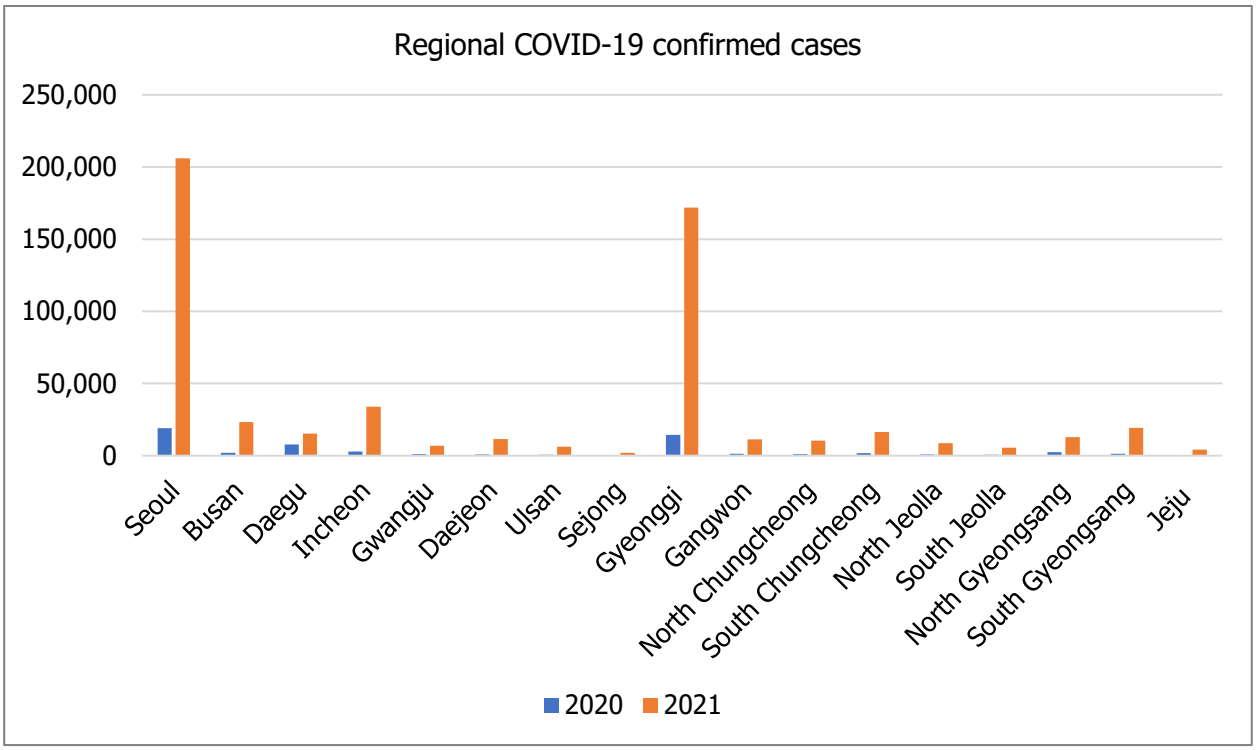


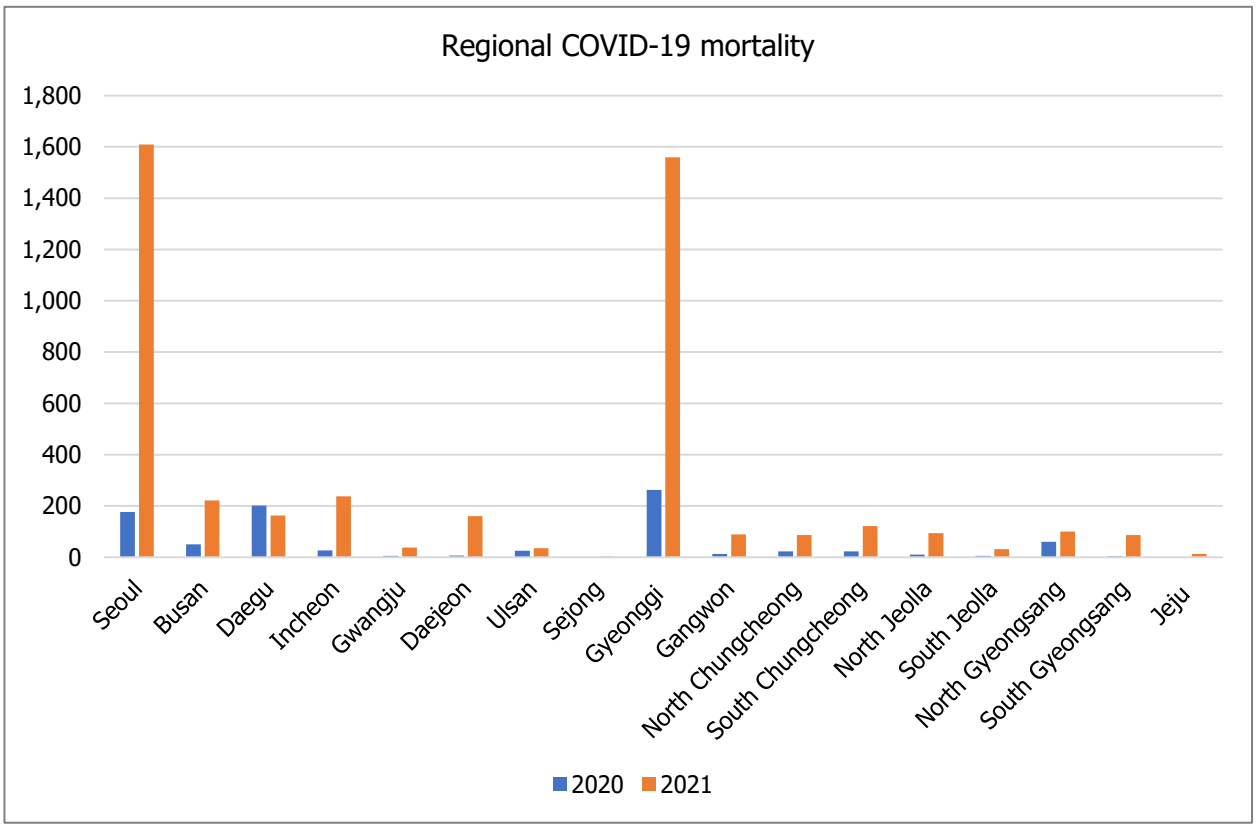
Daily new confirmed COVID-19 deaths per million people
(7-day rolling average)

Source: World Health Organization (2020).

Figure 3: ***Continued***

Panel B. Regional Variations in COVID-19

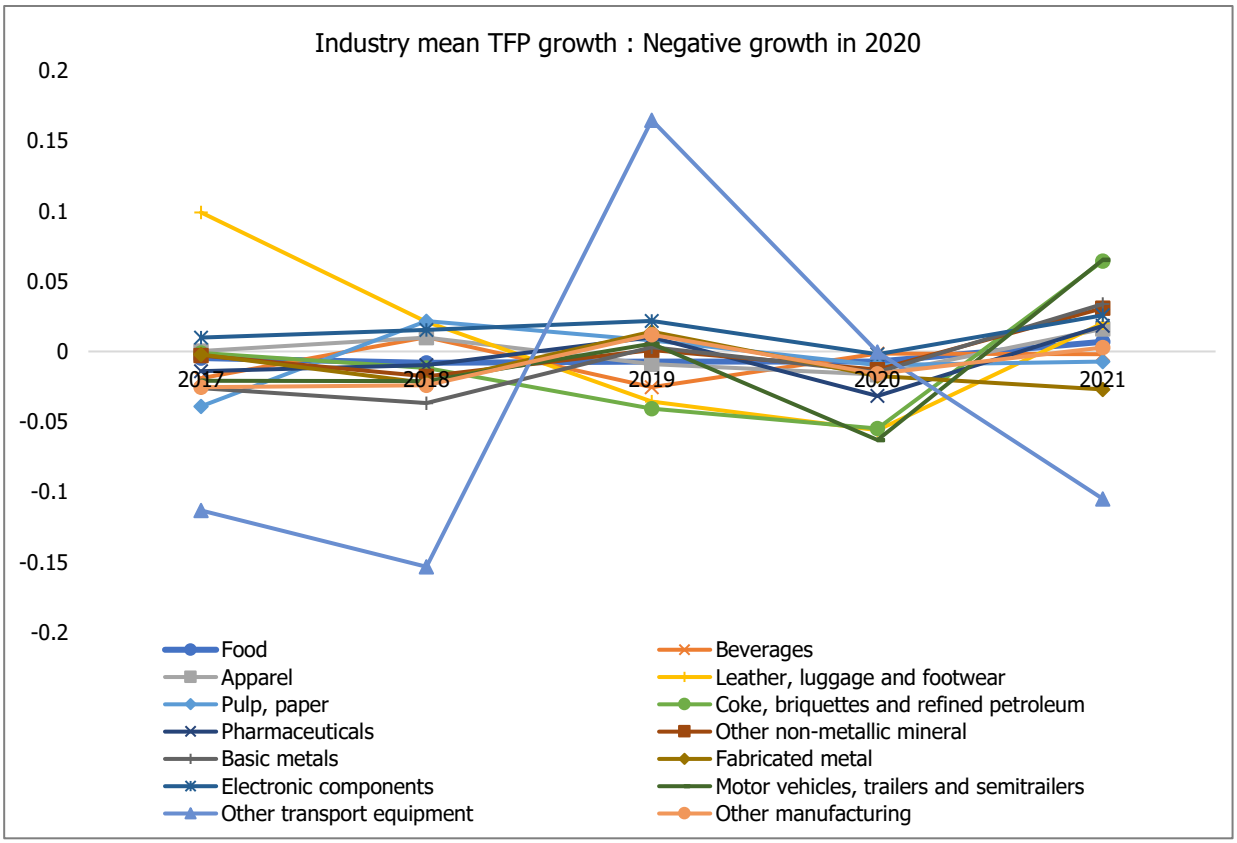




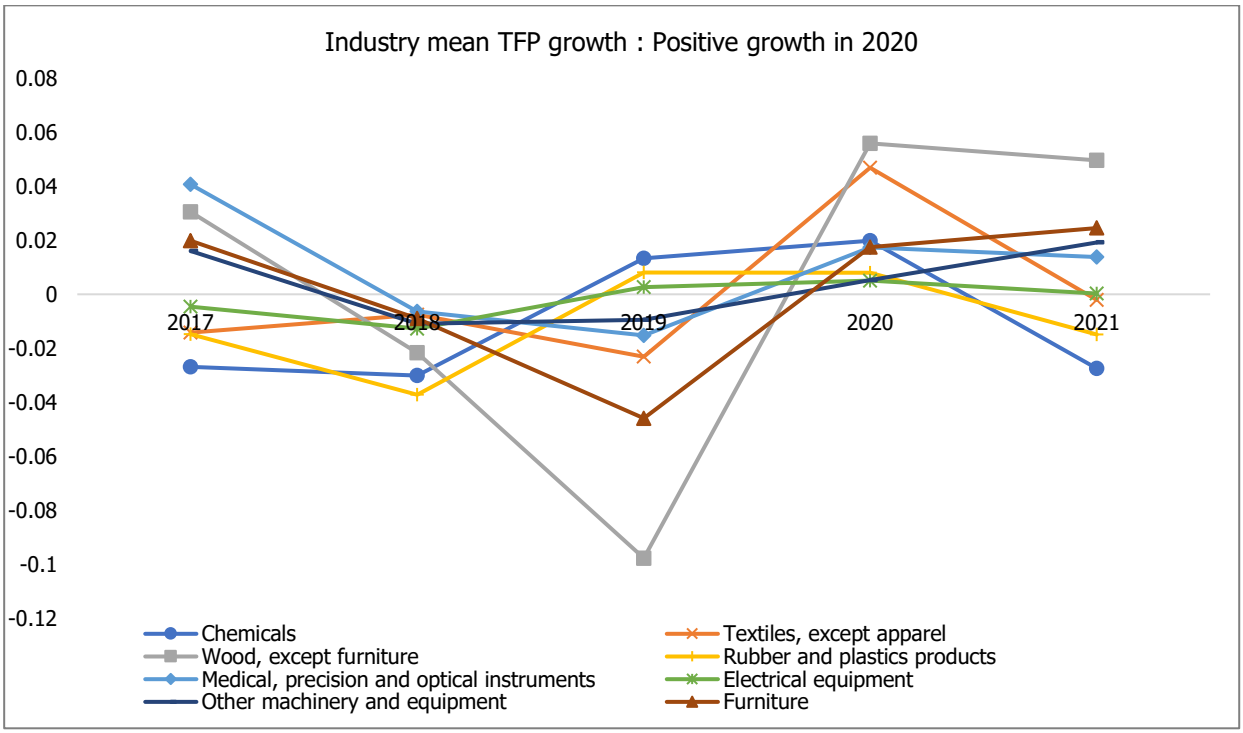
Source: Korea Disease Control and Prevention Agency, Integrated Disease Health Management System.

Figure 4: Industry Mean TFP Growth

Panel A. Industries with Negative TFP Growth in 2020



Panel B. Industries with Positive TFP Growth in 2020



Source: Survey of Business Activities, Statistics Korea, Authors' calculations.

Table 1 shows the definitions of the listed variables and the descriptive statistics. The dependent variable, log(TFP), measuring a firm's productivity, comprises 49,618 observations, whilst the rest of the variables have a similarly substantial number of observations. To examine the TFP of 'pure' exporting firms during the COVID-19 period, we consider firms that export without any foreign subsidiary, so this variable is mutually exclusive to the MNE dummy. Approximately 31.5% of firms are engaged in exporting without having subsidiaries abroad. The MNE dummy is defined as 1 if the firm possesses foreign subsidiaries. Around 31% of firms have subsidiaries abroad, making it meaningful to investigate whether these MNEs can bring about any changes during the pandemic, whereas the majority of firms are domestic in Korea. Using rich data, we have conducted a more detailed examination of MNEs. We also construct a dummy for MNEs with more than two foreign subsidiaries and those with domestic subsidiaries (representing about 17% of total firms).

Table 2 displays the results of a pairwise correlation matrix. A pairwise correlation coefficient gauges the strength and direction of a linear relationship between two variables. Typically, a correlation coefficient above 0.5 is considered indicative of a high correlation between variables and raises concerns about multicollinearity issues. Notably, the pure exporter dummy variable indicating whether a non-MNE firm is involved in exporting shows both negative relationships with a firm's productivity. In contrast, the MNEs' status exhibits a positive correlation with a firm's productivity. A critical point to consider is that a correlation between TFP and our treatment variables does not imply a causal effect. In that sense, we conduct our main difference-in-differences (DID) regression models to analyse the causal effects.

Table 1: List of Variables Used, Definitions, and Descriptive Statistics

Firm Characteristics	Definition	Obs.	Mean	SD	Code	Percent
Dependent variable						
ln(TFP)	log of firm-level total factor productivity (Wooldridge, 2009)	49,618	4.44	1.60	-	
Independent variables						
Pure exporter dummy	1 if a firm (not MNEs) is involved in exporting, 0 otherwise	32,169	-	-	0	68.50
		14,793	-	-	1	31.50
MNE dummy	1 if a firm has foreign subsidiaries, 0 otherwise	34,316	-	-	0	69.04
		15,387	-	-	1	30.96
MNE with domestic subsidiaries	1 if the firm has both domestic and foreign subsidiaries, 0 otherwise	41,313	-	-	0	83.12
		8,390	-	-	1	16.88
Control variables						
Export ratio	Annual total exports divided by total sales	46,871	0.15	0.24	-	
Intermediate import ratio	Firms' imported intermediate inputs divided by the total cost	34,571	0.01	0.06		
Import ratio	Annual total imports divided by total sales	41,077	0.12	0.28		
Debts to assets	Ratio of debts to assets	49,703	0.52	0.57		
Capital to labour ratio	Amount of capital invested per employee	49,703	3.12	1.36		
Patent	Logarithm of patents plus 1	42,062	1.75	1.52		
Firm size	Logarithm of employment	49,703	4.92	0.97		
Herfindahl index (HHI)	Degree of industry concentration capturing the level of competition	49,703	0.06	0.07		

Source: Survey of Business Activities, Statistics Korea, Authors' calculations.

Table 2: Pairwise Correlations

		1	2	3	4	5	6	7	8	9	10	11	12
1	ln(TFP)	1											
2	Pure exporter dummy	-0.0252	1										
3	MNE dummy	0.0294	-0.0734	1									
4	MNE w/ domestic sub.	0.0987	-0.0490	0.6730	1								
5	Export ratio	-0.1393	0.1620	0.2858	0.1670	1							
6	Intermediate import ratio	0.0325	-0.0133	0.0461	0.0211	0.1038	1						
7	Import ratio	0.0240	0.0138	0.0309	0.0153	0.1294	0.3460	1					
8	Debt to assets	-0.0453	-0.0137	-0.0475	-0.0485	-0.0500	-0.0196	-0.0306	1				
9	Capital to labour ratio	0.1757	0.0214	0.0359	0.1037	0.0236	0.0428	0.0979	0.0137	1			
10	Patent	-0.0392	0.0293	0.3786	0.3440	0.2750	0.0091	0.0093	-0.0569	0.0064	1		
11	Firm size	0.1646	0.0041	0.3054	0.3262	0.1285	0.0089	0.0287	-0.0663	-0.2398	0.4284	1	
12	Herfindahl index (HHI)	0.0548	0.0078	0.0746	0.0578	0.1045	0.0244	0.0528	0.0115	0.0471	0.1100	0.0478	1

Source: Survey of Business Activities, Statistics Korea, Authors' calculations.

3.2. Empirical specifications

This study uses descriptive and econometric methodologies to analyse the effect of shocks on firm productivity. We employ the double difference approach to examine the impact of COVID-19. We first trace their TFP during the sample period (2016–2021) and then focus more on continuous firms surviving during the sample period. Our treatment variables (at the firm level) are a pure exporter dummy in the year 2019 and an MNE dummy in 2019. Then, for the robustness check, we run an alternative model of double differences similar to Trefler (2004) by considering TFP growth between the pre-shock period and the shock period and different regional pandemic characteristics. Finally, we select MNE firms only and examine the possible attributes that made MNEs more resilient during the pandemic, considering MNE's internal and external characteristics such as resource reallocation, diversification, and predisposition to new technology.

First, we set up the estimation model for our analysis of the impact of the regional COVID-19 measure as follows:

$$ln\,TFP_{ijk,t} = \theta + \alpha RP_{k,t} + \gamma E_{ijk,S_0} + \tilde{\beta} RP_{k,t} \times E_{ij,S_0} + \delta W_{ijk,t} + FE + v_{ijk,t} \quad (1)$$

where *i* is the firm, *j* stands for the industry to which the firm belongs, *k* is the region in which a firm operates, and *t* is the time, where t = 0 denotes the pre-pandemic period, 2019, which is our reference point, and t = S denotes the global pandemic shock period. We define the variable RP_{kt} as a shock variable that distinguishes between the pre- and post-shock periods. We employ regional death cases as a baseline shock measure for the incidence rate of the pandemic in Korea, and regional confirmed cases are used for robustness checks. E_{ijk,S_0} is a vector of the treatment variables measuring firm-level operational characteristics, such as whether a firm is involved in exporting or MNEs with base year S_0 = 2019. $W_{ijk,t}$ is a set of firm-level controls that include the export ratio, import ratio, intermediate import ratio, capital to labour ratio (K/L), debts to assets ratio, employment (a proxy for firm size), a log of the number of patents a firm has (plus 1), and the Herfindahl index (HHI). The capital-to-labour ratio (K/L) measures the quantity of capital utilised relative to the labour force within production processes. HHI is calculated as $\sum_{m \in j} s_{mt}^2$, where s_{mt} is the market share of firm *m* in industry *j* at time *t*. This is a proxy for the degree of industry concentration capturing the level of domestic competition (high values mean high concentration). $v_{ijk,t}$ is an error term, and we introduce firm, industry, and regional fixed effects to guarantee more accurate and reliable results in the statistical

analysis. Also, we run this model only for firms that had continuously survived from 2016 to 2021 (6 years).

We report our results by applying the double difference model (e.g. Trefler (2004)) for the robustness check. Let $\Delta TFP_{ij,t}$ be the average annual log change in the outcome variable of firm *i* in industry *j* and region *k* at period *t*. The average annual log changes in the two periods are as follows:

$$\Delta TFP_{ijk,S} = \left(TFP_{ijk,2021} - TFP_{ijk,2019}\right) / TFP_{ijk,2019} \quad (2)$$

$$\Delta TFP_{ijk,0} = \left(TFP_{ijk,2019} - TFP_{ijk,2016}\right) / TFP_{ijk,2016} \quad (2')$$

Again, where the period t = 0 denotes the pre-pandemic period – our reference point – and t = S denotes the pandemic period. Choosing the year 2019 as the reference point distinguishes between the pre-pandemic and pandemic periods.

$$\Delta TFP_{ijk,S} - \Delta TFP_{ijk,0} = \varphi + \tilde{\beta} \cdot RP_{k,S=2021} E_{ijk,0} + Ind\ \&\ Region\ dummy + e_{ij} \quad (3)$$

where φ is a constant term capturing the change in ΔTFP due to the pandemic shock. $RP_{k,S=2021}$ is the regional COVID-19 intensity at t = 2021. $E_{ijk,0}$ is a vector of variables measuring firm characteristics, such as the exporter and MNE dummies in 2019 (pre-shock period). The firm-level variation in $E_{ijk,0}$ helps us interpret $\tilde{\beta}$. A negative $\tilde{\beta}$ means that the pandemic shock has a greater negative impact on firm productivity with a higher value of the variable in $E_{ijk,0}$. We also control for firm-level time-invariant characteristics by subtracting the TFP growth between the pre-shock period and the shock period. This double difference approach is identical to the model (1), but considers relatively longer-term TFP changes before and during the COVID-19 pandemic.

4. Empirical Results

We contend that the pandemic's impact on a firm's productivity varies based on the firm's operational characteristics, including its involvement in exporting or its multinational status. Table 3 reports the main results using regional variations of the pandemic measures. To begin with our main analyses, we employ a regression (1) to examine how firm characteristics shape TFP differently in response to the pandemic crisis. We prioritise the analysis of firms that survived throughout the entire period from 2016 to 2021. This is because we aim to examine firms' intensive margins and identify the particular characteristics of these firms during the COVID-19 pandemic that enabled them to endure.

Table 3: Main Results

Dependent Variable	ln(TFP)					
	(1)	(2)	(3)	(4)	(5)	(6)
	Export only	MNE only	Both	MNE w/more than 2 f. subsidiaries	MNE w/domestic subsidiaries	Alternative pandemic
	Continuous firms from 2016 to 2021					
Regional Pandemic (RP)	-0.0202	-0.1784**	-0.0634	-0.0810	-0.1307*	-0.1489**
	(0.053)	(0.070)	(0.088)	(0.062)	(0.070)	(0.068)
	0.705	*0.010*	*0.473*	*0.192*	*0.062*	*0.029*
RP ×Export status (t=2019)	-0.2520**		-0.2083	-0.2120*	-0.1590	-0.1596
	(0.112)		(0.133)	(0.116)	(0.122)	(0.121)
	0.024		*0.117*	*0.067*	*0.191*	*0.188*
RP ×MNE status (t=2019)		0.1715*	0.0559	0.1877*	0.2369**	0.2383**
		(0.090)	(0.105)	(0.110)	(0.099)	(0.098)
		0.056	*0.595*	*0.088*	*0.017*	*0.015*
Exports/Revenue	-0.0081	-0.0086	-0.0076	-0.0045	-0.0077	-0.0089
	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)
	0.894	*0.888*	*0.902*	*0.941*	*0.900*	*0.884*
Intermediate Imports/Cost	0.2784**	0.2670**	0.2769**	0.2776**	0.2716**	0.2684**
	(0.117)	(0.117)	(0.117)	(0.117)	(0.117)	(0.117)
	0.017	*0.022*	*0.018*	*0.018*	*0.020*	*0.022*
Imports/Revenue	-0.2293**	-0.2272**	-0.2291**	-0.2293**	-0.2288**	-0.2283**
	(0.112)	(0.112)	(0.112)	(0.112)	(0.112)	(0.112)
	0.041	*0.042*	*0.041*	*0.041*	*0.041*	*0.041*
MNE	-0.0640**	-0.0659**	-0.0642**	-0.0428	-0.0233	-0.0231
	(0.027)	(0.027)	(0.027)	(0.032)	(0.025)	(0.025)
	0.016	*0.013*	*0.016*	*0.177*	*0.342*	*0.347*
Debt	-0.5946***	-0.5939***	-0.5948***	-0.5991***	-0.5948***	-0.5953***
	(0.080)	(0.080)	(0.080)	(0.079)	(0.081)	(0.081)
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Capital/Labour	0.0367	0.0357	0.0363	0.0322	0.0327	0.0334
	(0.039)	(0.039)	(0.039)	(0.039)	(0.040)	(0.040)
	0.350	*0.364*	*0.355*	*0.409*	*0.409*	*0.399*
Patents	-0.0135	-0.0147	-0.0139	-0.0158	-0.0153	-0.0150
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
	0.364	*0.323*	*0.352*	*0.289*	*0.306*	*0.315*
Firm Size	-0.1398***	-0.1403***	-0.1396***	-0.1432***	-0.1443***	-0.1428***

Dependent Variable	ln(TFP)					
	(1)	(2)	(3)	(4)	(5)	(6)
	Export only	MNE only	Both	MNE w/more than 2 f. subsidiaries	MNE w/domestic subsidiaries	Alternative pandemic
	Continuous firms from 2016 to 2021					
	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)
	0.008	*0.007*	*0.008*	*0.006*	*0.006*	*0.006*
HHI	1.1958***	1.1739***	1.1858***	1.1845***	1.1784***	1.2185***
	(0.377)	(0.378)	(0.379)	(0.376)	(0.378)	(0.376)
	0.002	*0.002*	*0.002*	*0.002*	*0.002*	*0.001*
Firm, Industry, and Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,674	14,674	14,674	14,674	14,674	14,674
# of firms	3,339	3,339	3,339	3,339	3,339	3,339
R-squared	0.903	0.903	0.903	0.903	0.903	0.903

Clustered robust standard errors at the firm level in parentheses. P-values are displayed in italics below. *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

The estimated coefficients on the regional pandemic (*RP*) are all negative and significant in columns (2), (5), and (6). However, our main interest in the DID model is the coefficient ($\tilde{\beta}$) of the interaction term ($RP_{kt} \times E_{ijk,S_0}$). First, we hypothesise that the decrease in productivity is greater for pure exporting firms than for non-exporting firms. The coefficient of the interaction term of RP and the exporter dummy at S_0=2019 in column (1) is negative and significant (β= -0.2520, p=0.024), meaning that pure exporting firms experienced a greater decrease in productivity than other firms during the global pandemic (hypothesis 1 is supported). Secondly, in column (2), a firm that has foreign subsidiaries can buffer against the negative impact during a pandemic, as indicated by the positive and significant coefficient of the interaction term of *RP* and the MNE dummy (β= 0.1715, p=0.056). This also implies that MNEs can better deal with crises compared to domestic firms (hypothesis 2 is supported). In column (3), we include both the exporter dummy and MNE dummy, and the coefficients of the interaction terms with the exporter dummy and MNE dummy are negative and positive, respectively, but lose significance. The two dummies are mutually exclusive, and their

(negative) correlation may reduce the significance of the results. In columns (4) and (5), we search for a better result by refining the MNE dummy. Column (4) considers MNEs with more than two foreign subsidiaries. The coefficient of the interaction term exhibits a significant and positive coefficient (β= 0.1877, p=0.088). This can be attributed to MNEs' ability to diversify through these foreign subsidiaries and maintain greater flexibility in responding to national policies during the COVID-19 situation (Puhr and Muller, 2022). Also, the coefficient of the interaction term with the exporter dummy turns out to be significantly negative. In column (5), the buffering effect is even more pronounced when considering MNEs also have domestic subsidiaries (β= 0.2369, p=0.017). This indicates that MNEs with a greater number of subsidiaries experience a smaller reduction in productivity during the global pandemic. Lastly, column (6) uses alternative pandemic measures, such as the confirmed case ratio, and shows that the interaction term of RP and MNEs is significantly positive (β= 0.2383, p=0.015), whilst that of RP and the exporter dummy is significant but loses significance (β= -0.1596, p=0.121).

Table 4: Robustness Checks: Double Differences

Dependent Variable	**TFP Growth (Shock Period) – TFP Growth (Pre-shock Period)**				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Model	**Annual pandemic shock**	**Regional pandemic**	**Regional pandemic**	**Regional pandemic**	**Regional pandemic**
			MNE w/domestic subsidiaries	**Alternative periods**	**Alternative Pandemic measure**
Normal Period	2016-2019	2016-2019	2016-2019	2017-2019	2016-2019
Shock Period	2019-2021	2019-2021	2019-2021	2019-2020	2019-2021
RP×Export status (t=2019)	-0.0751*	-0.1513	-0.2018	-0.1726	-0.1699
	(0.044)	(0.170)	(0.155)	(0.158)	(0.180)
	0.086	*0.373*	*0.194*	*0.274*	*0.344*
RP ×MNE status (t=2019)	0.0658	0.3507**	0.4679***	0.2781*	0.3600**
	(0.043)	(0.163)	(0.176)	(0.159)	(0.172)
	0.129	*0.032*	*0.008*	*0.081*	*0.036*
Constant	0.0523	0.0353	0.0442**	0.0205	0.0361
	(0.034)	(0.025)	(0.021)	(0.024)	(0.025)
	0.122	*0.151*	*0.038*	*0.402*	*0.147*
Observations	4,033	4,033	4,033	4,033	4,033
R-squared	0.017	0.023	0.023	0.027	0.023

Dependent Variable	TFP Growth (Shock Period) – TFP Growth (Pre-shock Period)				
	(1)	(2)	(3)	(4)	(5)
Model	Annual pandemic shock	Regional pandemic	Regional pandemic	Regional pandemic	Regional pandemic
			MNE w/domestic subsidiaries	Alternative periods	Alternative Pandemic measure

Clustered robust standard errors at the firm level are in parentheses. P-values are displayed in italics below. *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

We report a double difference result for the robustness check in Table 4. We distinguish the periods before and after 2019, identified as the COVID-19 era, and analyse the differences in TFP between pure exporting firms and MNEs. By including both key variables in the same regression, we can observe how each variable operates in the presence of the other. In column (1), we examine both pure exporting firms and MNEs based on the annual pandemic shock. Pure exporting firms show negative TFP growth (β= -0.0751, p=0.086), whilst MNEs show positive but insignificant results (β= 0.0658, p=0.129). However, when introducing the regional pandemic shock in column (2), MNEs exhibit significant and positive TFP growth (β= 0.3507, p=0.032), whilst pure exporters lose statistical significance. This tendency remains consistent across all robustness checks. We focus on MNEs with domestic subsidiaries (column 3) and analyse pre-Covid periods based on different years (column 4). When using an alternative measure, such as the confirmed case ratio for COVID-19, in column (5), MNEs consistently show positive TFP growth, whilst pure exporting firms, though not significant, consistently show negative TFP growth. In conclusion, through various specifications, we have consistently found that MNEs are better suited to adapt to crises compared to firms that solely export, and can even exhibit positive TFP growth. This underscores the resilience and strategic flexibility of MNEs in navigating economic turbulence.

Table 5: MNE Results

Dependent Variable	ln(TFP)					
	(1)	(2)	(3)	(4)	(5)	(6)
						w/ Alternative Pandemic Measure
Regional Pandemic	-0.0305	-0.1502**	-0.3274**	-0.1862	-0.3732**	-0.3660**
	(0.064)	(0.072)	(0.147)	(0.232)	(0.149)	(0.153)
	0.632	*0.038*	*0.026*	*0.421*	*0.012*	*0.017*
Regional Pandemic × Labour growth (t=2019)	-0.4197*				-0.3827	-0.4728*
	(0.241)				(0.239)	(0.245)
	0.082				*0.109*	*0.054*
Regional Pandemic × R&D intensity (t=2019)		3.1480***			2.9782***	3.0104***
		(1.083)			(1.086)	(1.108)
		0.004			*0.006*	*0.007*
Regional Pandemic × # of sub. (t=2019)			0.1811**		0.1553**	0.1431*
			(0.079)		(0.078)	(0.079)
			0.022		*0.047*	*0.070*
Regional Pandemic × avg. investment to f. sub (t=2019)				0.0178	--	--
				(0.029)		
				0.543		
Export/Revenue	-0.0070	-0.0007	0.0011	-0.0257	0.0043	0.0020
	(0.068)	(0.068)	(0.068)	(0.070)	(0.067)	(0.067)
	0.918	*0.991*	*0.987*	*0.713*	*0.949*	*0.976*
Intermediate Imports/Cost	0.3954***	0.3731**	0.4045***	0.4159***	0.3851**	0.3820**
	(0.153)	(0.154)	(0.154)	(0.157)	(0.154)	(0.154)
	0.010	*0.015*	*0.009*	*0.008*	*0.013*	*0.013*
Imports/Revenue	-0.3746***	-0.3625***	-0.3764***	-0.3621***	-0.3652***	-0.3651***
	(0.135)	(0.135)	(0.136)	(0.140)	(0.136)	(0.136)
	0.006	*0.007*	*0.006*	*0.010*	*0.007*	*0.007*
Debt	-0.5331***	-0.5462***	-0.5385***	-0.4966***	-0.5476***	-0.5490***
	(0.104)	(0.105)	(0.105)	(0.112)	(0.105)	(0.105)
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Capital/Labour	0.0503	0.0424	0.0512	0.0415	0.0411	0.0421
	(0.058)	(0.058)	(0.058)	(0.061)	(0.058)	(0.058)
	0.389	*0.464*	*0.377*	*0.499*	*0.479*	*0.470*
Patents	-0.0255	-0.0244	-0.0234	-0.0201	-0.0239	-0.0241
	(0.018)	(0.018)	(0.018)	(0.019)	(0.018)	(0.018)

Dependent Variable	ln(TFP)					
	(1)	(2)	(3)	(4)	(5)	(6)
						w/ Alternative Pandemic Measure
	0.153	*0.173*	*0.194*	*0.286*	*0.181*	*0.178*
Firm Size	-0.0792	-0.1115	-0.1018	-0.1150	-0.0897	-0.0811
	(0.072)	(0.072)	(0.072)	(0.076)	(0.072)	(0.073)
	0.274	*0.123*	*0.159*	*0.131*	*0.215*	*0.266*
HHI	1.7118***	1.6119***	1.7410***	2.0209***	1.5644***	1.5954***
	(0.486)	(0.498)	(0.491)	(0.525)	(0.491)	(0.487)
	0.000	*0.001*	*0.000*	*0.000*	*0.001*	*0.001*
Observations	8,352	8,352	8,352	7,617	8,352	8,352
# of firms	1,591	1,591	1,591	1,445	1,591	1,591
R-squared	0.903	0.903	0.903	0.902	0.903	0.903

Clustered robust standard errors at the firm level are in parentheses. P-values are displayed in italics below. *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations

So far, we have demonstrated that MNEs not only exhibited stronger resilience in the pandemic but also experienced increases in TFP. However, assuming that heterogeneity within MNEs could also yield varying impacts, we conduct a more granular analysis in Table 5. First, we investigate whether MNEs achieve higher TFP by implementing more efficient resource allocation through labour shedding during the pandemic. Column (1) shows that MNEs with negative employment growth bring a positive TFP improvement with a significant coefficient (β= -0.4197, p=0.082). There is a caveat: the employment growth variable ranges from negative to positive (its median is zero). Therefore, a negative $\tilde{\beta}$ indicates a greater positive impact on firm productivity with negative employment growth due to the pandemic shock. Combining the negative coefficient of the pandemic shock, we can interpret that if firms reallocate their resources, especially labour, they can mitigate the negative pandemic shock and even have a chance to enhance their productivity. Our hypothesis 3-1 is strongly supported. Second, an MNE with higher R&D intensity before the pandemic can buffer a decrease in TFP during the global pandemic, as indicated by a positive coefficient of the interaction term (β=3.1480, p=0.004) in column (2). This finding provides support for our hypothesis 3-2. In column (3), we examine the role of the number of subsidiaries (extensive margin) and average investment

to subsidiaries (intensive margin) in shaping MNEs' TFP during the pandemic. In column (3), we find a positive coefficient (β=0.1811, p=0.022) on the interaction term with the number of subsidiaries, suggesting that a greater number of subsidiaries owned by an MNE (MNEs diversification) leads to an improvement in productivity. This supports hypothesis 3-3. However, in column (4), considering the intensive margin, the coefficient of the interaction term with average investment to subsidiaries loses statistical significance. Additionally, our findings remain robust when including all three channels together in column (5). The results demonstrate that MNEs' strategic resilience during the crisis is due to their labour shedding (β=-0.3827, p=0.109) and higher pre-crisis R&D intensity (β=2.9782, p=0.006), coupled with a larger number of subsidiaries (β=0.1553, p=0.047). To further validate our results, column (6) uses an alternative measure, such as confirmed cases, and the results are consistent with those in column (5).

5. Discussion and Conclusion

This study examines how global pandemic shocks affected firms' TFP, using detailed Korean firm-level data for 2016–2021. It also identifies the conditions that make firms less vulnerable to such shocks. We find that pure exporting firms experienced more severe negative consequences on productivity compared to non-exporters. This is because pure export firms lack diversification in the supply-side shock and also, they experienced a decrease in both home and foreign demand, caused by simultaneous government restrictions on social gatherings across important trading countries. On the other hand, MNEs with international diversification were shown to have a better buffer against negative shocks and increase in TFP even during the pandemic.

We conducted a detailed analysis to determine why MNEs were more resilient during the pandemic. Our findings reveal that MNEs that managed their resources effectively (via labour shedding) and had a predisposition to R&D were better equipped to adapt to the crisis. Efficient resource reallocation and investment in innovation and information and communication technologies were crucial in overcoming the restrictions imposed by the pandemic, enabling continuous business operations. Furthermore, MNEs with a larger number of subsidiaries were better adapted to the cross-border pandemic and even demonstrated positive TFP growth. This suggests that having more subsidiaries enabled MNEs to effectively navigate the varying government directives across different countries, thereby having a positive impact on their TFP. This effect was more pronounced for MNEs with both foreign and domestic subsidiaries. These

insights underscore the importance of strategic subsidiary management and resource allocation in enhancing resilience against global disruptions.

The results of this study offer valuable insights to management. Firstly, firms should actively implement resource allocation strategies, as suggested by this paper. They need to establish flexible regulations that allow for diversification and adjustments of their workforce, which will help increase productivity during times of crisis. This will enable agile reallocation of human resources during difficult times. Additionally, continuous investments in R&D and technological innovation should not be overlooked. The acquisition of new knowledge can help firms create dynamic capabilities that will allow them to adapt more quickly to rapidly changing environments (Teece, 2007). Finally, our study supports the idea that going multinational in some way can help a firm gain diversification benefits, particularly when the firm diversifies across different geographical locations. MNEs were capable of shifting production to overseas facilities and supplying products to markets through subsidiaries in other countries during the pandemic, whereas pure exporting firms without subsidiaries abroad were inevitably faced with decreased productivity initially because they lacked alternative means to supply products to the market. We find that only diversified MNEs could partially mitigate risks by spreading them across diverse areas, even when these risks were systematic. The business model of MNEs can remain sustainable even during a global pandemic, as evidenced by their increase in TFP. Some may question the need for management strategies based on COVID-19 research outcomes. Specifically, Ciravegna et al. (2023) argue that many international business studies have not thoroughly addressed firm responses to non-ergodic events, and emphasise that substantial research on both systematic risks and extreme events is necessary for sustainable development. For instance, unlike historical wars that affected only involved nations, modern conflicts have wider implications, impacting even non-combatant countries or neighbouring countries through international trade. Therefore, firms should not become complacent but rather prepare strategies to handle future exogenous shocks effectively.

Regarding policy implications, Syverson and di Mauro (2022) state that to prevent the global pandemic crisis from negatively impacting globalisation, labour mobility, and small businesses, it was imperative to reopen borders, avoid trade and currency wars, and implement policies that increase productivity. Indeed, our finding supports this line of suggestions, particularly for MNEs. Governments should proactively establish policies to facilitate the entry of MNEs into their countries, as well as assist their firms in entering foreign markets. Governments should focus on improving the efficiency of private sector investments and strive

to build a sustainable business ecosystem that not only attracts MNEs to their domestic markets but also helps domestic firms become more competitive in the international market.

Our research has certain limitations. It is important to have a detailed understanding of the geographical destinations where these Korean MNEs were operating to properly assess their diversification opportunities during the pandemic. Individual governments implemented different preventative measures to curb the spread of the virus, such as the closure of borders (i.e., Viet Nam and China). Moreover, these countries declared slightly different levels of restrictions. For instance, in the early days of COVID-19 in 2020, China's aim was to eliminate the coronavirus completely from within the mainland's borders under the 'zero-covid' policy (The Economist, 2021), whilst Viet Nam allowed limited mobility. This variation implies that even with similar government interventions, the specific details can differ significantly, leading to diverse economic impacts on firms' productivity. Therefore, it would be valuable to compare the different levels of government involvement in various nations for future research. Moreover, governments had different policies towards the labour market. In the US, subsidies were provided to individuals who lost their jobs due to the pandemic, whilst some European countries implemented leave of absence policies, allowing people to be away from work without pay. These subsidies affected people's behaviour and motivation in seeking employment, which in turn affected the strategies that firms adopted towards their labour force. For example, US firms may be more inclined to reduce their labour costs by laying off employees compared to European firms. Therefore, it would be intriguing to compare the labour market responses aligned with government subsidies in different countries as well.

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