COVID-19, firm exposure, and firm value: A tale of two lockdowns

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Abstract

We examine the stock market responses to two symbolic events in the outbreak of COVID-19: (1) the lockdown of Hubei province; and (2) the containment of the disease in China and its spread to overseas. Overall, market in China responded negatively (positively) to the first (second) event. Regression analysis reveals that, following the first event, firms with Hubei exposures earned significantly lower returns while those with foreign exposures earned significantly higher returns. Foreign exposures, however, had significantly negative effects on returns following the second event. The valuation effects of Hubei and foreign exposures also vary across firm ownership and industries.

Keywords: Covid-19, Foreign Exposure, Internal Network, Input-Output Linkage
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1. Introduction

First detected in Wuhan China, COVID-19 has rapidly spread to many parts of the world. The World Health Organization (WHO) on March 11 declared it a pandemic. How does a health crisis like this affect firms at different phases of outbreak? Do the effects vary across firms' exposures to the disease? In particular, how do the impacts of having an international status on firms change as the disease spread from domestic to overseas? What are the roles of networks, including both the internal networks within a firm and the between-firm input-out linkages, in the propagation of health shocks?

In this study, we aim to contribute to the literature by empirically examining the above important yet unexplored research questions. Tackling these research issues face two empirical challenges. First, severe health crises do not occur often. While the recent outbreak of COVID-19 is certainly unfortunate, it provides researchers with a rare opportunity to investigate these questions. A second empirical challenge is that it would likely take time for the economic outcomes following a large-scale adverse health shock to fully realize; but during the long time horizon many other factors can also change, which would then make it harder to distinguish the effect of a negative health shock from the effects of other concurrent changes. To overcome the second empirical challenge, we take advantage of the fact that stock market participants take into consideration future developments in the current pricing of a firm's equity and employ an event study approach.

Specifically, we examine the stock market responses to two symbolic events in the outbreak of COVID-19, the lockdown of Hubei province of China and the subsequent containment of the disease in China and its spread to overseas (the lockdown of the Lombardy region of Italy, in particular) at the same time. As we shall

discuss in more details in Section 2.2, the two effective event dates are January 23, 2020 and February 24, 2020, respectively. Our event study results suggest that a public health crisis can have a significant impact on firm value. Overall, stock market in China respond negatively to the first event but positively to the second one. The average cumulative abnormal returns (CARs) for the two events are statistically significant and quantitatively large.

To better understand the underlying mechanisms, we then conduct regression analysis to examine the potential determinants of the CARs. To proxy a firm's exposures to the disease, we construct two key measures, *Hubei_exposure* and *Foreign_exposure*. The former represents a firm's exposures to Hubei, the epicenter of the disease in China, and the latter aims to reflect the foreign exposures of a Chinese firm. To capture potential transmission mechanisms through both a firm's internal network and the input-output (I-O) based production network, we consider two sets of indictors for each exposure measure. The first set of indicators is based on within-firm internal networks across different regions (nations) while the second set of indictors reflect the between-firm I-O linkages. Detailed descriptions of these indicators are offered in Section 2.2.

Our regression results reveal a substantial amount of heterogeneity across firms and events. In the first event, firms with a higher degree of Hubei exposure experienced a significantly lower return while those with a larger foreign exposure had a significantly higher CAR. Given that the outbreak of the disease centered in China, and, in particular, the Hubei province, at the early phase, these results indicate a disadvantage of having a Hubei exposure but an advantage of having foreign operations or sales. Internationalization provides a valuable diversification.

In the second event, however, the effects of Hubei exposure on firm value became insignificant. In addition, the impacts of foreign exposures now turned negative and significant. These results are consistent with the new development of a relatively stabilized domestic market environment along with potentially risky foreign market conditions. Our findings are robust to alternative measures of firm exposures, samples, and benchmark models. They also suggest that both within-firm internal network and between-firm I-O linkages are important channels through which health shocks can influence firm value.

Finally, we also explore some potential heterogeneity to see if the effects of Hubei and foreign exposures on firm returns vary across some key firm or industry characteristics. Our results indicate that, compared to private firms, Hubei exposure had a smaller adverse effect on firm value for state-owned enterprises during the first event. There is also evidence for the special role of belonging to the pharmaceutical industry. We find a negative and significant interaction effect of a pharmaceutical industry dummy and a firm's exports to sales share in the first event regression. That is, due to high demand in the domestic market following the domestic outbreak of the disease, the positive effect of having foreign exposure is significantly smaller for pharmaceutical firms. The same interaction effect turns positive and significant in the second event regression. This is consistent with the expectation that, due to an expected high foreign demand, pharmaceutical firms benefit more from their foreign exposures after the outbreak of the disease overseas.

Our work contributes to the relevant literature in the following aspects. First, our work is also related to the large literature that examines the role of networks in the transmission of shocks. There are two strands of literature that fall into this category. One strand focuses on within-firm internal network (e.g., Desai, Foley, and Hines,

2009; Tong and Wei, 2011; Yeaple, 2013; Antràs and Yeaple, 2014; Matvos and Seru, 2014; Manova, Wei, and Zhang, 2015; Duchin, Goldberg, and Sosyura, 2016; Lin and Ye, 2018; Bena, Dinc, and Erel, 2019; and Giroud and Mueller, 2019). The other strand of literature examines the role of input-output based cross-firm production network in the transmission of shocks (e.g., Hertzel et al., 2008; Ahn, Khandelwal, and Wei, 2011; Acemoglu et al., 2012; Carvalho, 2014; Barrot and Sauvagnat, 2016; Kee and Tang, 2016; Wang, et al., 2017; Boehm, Flaaen, and Pandalai-Nayar, 2019; and Wei and Xie, 2020). Our findings complement the two strands of literature. We show that both channels are important in the propagations of health shocks.

Second, our study is also related to a growing literature that studies the effects of firms' international status (e.g., Denis et al., 2002; Baker et al., 2009; Fillat and Garetto, 2015; and Caselli et al., 2020). Existing contributions document that, on the one hand, a negative shock abroad can be a source of risk exposure to firms. On the other hand, internationalization can also have a valuable diversification effect by reducing exposure to adverse domestic shocks. Our finding that a firm's foreign exposure has different effects following the two events is consistent with the main message from this literature.

Finally, our study is related to the literature on economic outcomes of disease or health shocks (e.g., Foster, 1995; Strauss and Thomas, 1998; Zhang, Zhang, and Lee, 2003; Bloom, Canning, and Sevilla, 2004; Bleakley, 2007; Weil, 2007; Nunn and Qian, 2010). We contribute to the literature by presenting fresh evidence from the COVID-19 pandemic. In addition, while existing contributions in the literature focus mainly on either individual labor market outcomes or economic growth at the macro level, our results suggest that health shocks can also have significant consequences on corporates.

The remainder of this paper is structured as follows. In Section 2, we describe the data and methodology we use in our empirical analysis. Section 3 reports our results. Concluding remarks are offered in Section 4.

2. Data and Empirical Methodology

2.1. Data description

To carry out our empirical analysis, we combine data from several sources. The first data source is the China Stock Market & Accounting Research (CSMAR) database, which provides detailed information about firm-level stock returns and financial data. The second source is the Chinese custom data collected by the Chinese General Administration of Customs, incorporating the universe of Chinese imports and exports transactions at the HS 8-digit product level. Since there is no consistent coding system of firm identity between the Custom database and CSMAR database, we manually merge them by matching company names. In particular, we match the two databases using a name (Chinese company names) recognition program implementing the fuzzy matching method. If the names of the two databases are not exactly the same, we then manually check the matches and make necessary adjustments (abbreviations and typos) to ensure the quality of the matching procedure.

Besides financial and international trade data, we also obtain firm-level foreign direct investment and subsidiary information from Financial Time's fDi Markets database and CSMAR's Related Party Transaction database. Finally, we employ the China' 2012 province-sector-level I-O table in the construction of our I-O based firm exposure measures. After removing financial firms and special-treated firms, our sample contains 2363 observations. Details of variable definitions and data sources

are shown in Online Appendix Table A1, and summary statistics are reported in Online Appendix Table A2.

2.2. Empirical methodology

To examine the valuation effects of the COVID-19 transmission, we employ an event study approach. We first estimate a market model over a 180-day estimation window with Hushen300 index as the market return. We then CARs over the corresponding event window centered on a particular event date. In addition, we also consider a value-weighted average return and a three-factor model to ensure the robustness of our results.

2.2.1 Event dates

To implement our event study, we first need to identify the effective event dates. Specifically, we consider two symbolic events. The first one is China's announcement of lockdown of its Hubei province on January 23, 2020. This lockdown announcement was made at 0:00am of that day, and the implementation of this lockdown started at 10:00am of the same day. This announcement was unexpected and served as a wakeup call. It delivered a clear message to market participants about the severity of the outbreak of the disease in the epicenter and the potential of spreading to other Chinese provinces.

The second effective event date we consider is February 24, 2020. The previous trading day is February 21. Two important pieces of news arrived during the weekend preceding that event date. First, as shown in Figure 1, the newly confirmed cases in China hit record low for three consecutive days (February 21-February 23).[1] The newly confirmed cases outside Hubei dropped to 31, 18, and 11 in these three days, and those in Hubei also fell significantly from over one thousand to less than four

[1] The numbers of newly confirmed cases for February 21 were released after the trading day of February 21. Therefore, it is also news to market participants.

hundred. These numbers suggested that the disease became containable inside China. Second, there was also new development overseas. The newly confirmed cases in Italy started to rise, and amid a potential large outbreak, the Italian authority announced on February 23 a strict lockdown of the Lombardy region. In the U.S., officials from the Centers for Disease Control and Prevention (CDC) warned on February 21 that although the agency is taking historic measures to slow the introduction of COVID-19 into the United States, the country should prepare for the possibility of community spread. Due to the time difference, this accouchement was also news to market participants in China. News from overseas thus consistently indicate a likely outbreak in other parts of the world.

2.2.2 Regression model specification

We examine firms' heterogeneous responses by regressing the estimated firm CARs obtained from each event on firm characteristics. Specifically, we consider the following empirical model:

$$CAR_i = \alpha + \beta_1 Hubei\_exposure_i + \beta_2 Foreign\_exposure_i + \gamma C_i + \varphi_j + \varphi_k \qquad (1)$$

where CAR_i is the cumulative abnormal return of a firm i. C_i represents a set of firm-level control variables, including the log of total assets (LN_ASSET), the log of number of employees (LN_EMP), leverage ratio (LEVERAGE), and a state ownership dummy (SOE). In addition, we also consider three corporate governance measures, the log of total number of board members (LN_BOARD), the share of independent board members (INDEP), and a CEO-Chairperson duality dummy (DUALITY). φ_j and φ_k are industry and province fixed effects, respectively.

Our main variables of interest are *Hubei_exposure* and *Foreign_exposure*. The former represents a firm's Hubei exposure, and the latter captures the foreign exposure of a firm. For each exposure measure, we consider two sets of indictors. The

first set of indicators is based on within-firm internal networks across different regions (nations). Specifically, we use whether a firm has any subsidiary in Hubei province as a proxy of its Hubei exposure.[2] For foreign exposure, we obtain each firm's exports and FDI investment from China's custom data and fDi Markets database and use a firm's exports (as a share of total sales) and its foreign direct investment (FDI) (as a share of total assets or sales) as proxies.

The second set of indictors reflects between-firm I-O linkages. Since we do not have detailed firm-level Hubei-related transaction information, we make use of China's 2012 province-sector level IO table to compute the industry-level input and output shares of Hubei province for each firm to measure its Hubei exposure from the perspective of production network. For I-O based foreign exposure measure, we can obtain a firm's detailed imports of intermediate inputs from the custom data. We thus use the value of intermediate input imports scaled by sales as a firm's foreign exposure measure. In our empirical analysis, we will consider both sets of indictors. Our baseline regressions use the Hubei subsidiary dummy and firm exports to proxy a firm's Hubei and foreign exposures, respectively. We also use other measures to check the robustness of our results.

3. Empirical Results

3.1. Market responses

To compute the effects of the two events, we consider a narrow window for each event to avoid noises from other events. Specifically, we consider a 2-day (-1, 0) event window for the first event and a 3-day (-1 1) window for the second event. We use a

[2] To construct this Hubei exposure measure, we have to exclude firms headquartered in Hubei. To ensure the robustness of our results, we conduct a robustness check in which we exclude the Hubei exposure measure from the regressions but add all Hubei firms back to the sample. While not reported, we find that our results on foreign exposures are not affected.

2-day instead of a 3-day window for the first event because of a ten-day suspension of trading due to the Chinese New Year holidays right after the first event date.[3] A 2-day window, therefore, can prevent our results from being contaminated by other events occurred during the 10-day market closure period.

We find that, overall, the market responded negatively to the first event but positively to the second. Following the first event, 1423 out of the 2363 firms experienced a negative CAR. The average of the CARs is -0.53% and is significantly different from zero. On the other hand, stock market responded significantly positively to the second event. In this case, 1335 out of the 2363 firms experienced a positive CAR, and the average CAR is significant and economically large, with a magnitude of 2.84%. The initial negative and later positive stock market responses are consistent with the dynamics of the disease in China.

3.2. Baseline regression results

We have shown that stock market overall responded negatively (positively) to the first (second) event. In this subsection, we explore further firm heterogeneity. We do so by estimating Equation (1) for each event using the CARs obtained from our event study analysis as the dependent variable.

Table 1 reports the baseline regression results. The first two columns use the CARs from the first event, the lockdown of Hubei province, as the dependent variables. Column (1) regresses CARs on the Hubei and foreign exposure measures controlling only for industry and province fixed effects. In Column (2), we also include firm-level controls to the regression. We find that our measure of a firm's Hubei exposure, a Hubei subsidiary dummy, has a significantly negative effect on a firm's CAR following the lockdown of Hubei province. The estimated coefficients on

[3] The stock market closure started from January 24, 2020 and lasted till February 2, 2020. The market re-opened on February 3, 2020.

this variable carry a minus sign and are statistically significant in the two columns. The estimated effect is also quantitatively sizable. For example, the estimated coefficient in Column (2) suggests that having a subsidiary in Hubei province is associated with a return of 0.6 percentage point lower. This finding is consistent with the notion that firms have operations in the epicenter of the disease were hit particularly hard by the outbreak of COVID-19.

On the other hand, we find that foreign exposure, proxied by exports as a share of total sales, has a significantly positive effect on firm returns. The estimated effects are positive, statistically significant, and also economically meaningful. For instance, the results shown in Column (2) indicate that a one-standard-deviation increase in foreign exposure raises a firm's CAR by 0.3 percentage point.[4] This result is consistent with investors' then belief that the outbreak of the disease was mainly domestic. Foreign diversification thus should have a value-enhancing effect (e.g., Caselli et al., 2020). As for control variables, we find that employment size is associated with a higher CAR while leverage and board size are negatively related to CAR. Other controls are statistically insignificant.

[Insert Table 1 around Here]

In Columns (3) and (4) of Table 1, we conduct the same regression exercises but using the CARs from the second event as the dependent variable. The results suggest that Hubei exposure no longer has any significant effect on returns. This is consistent with the fact that there was no significant Hubei-specific news between the last trading day, February 21, and the event date, February 24. Interestingly, we also find that the coefficients on foreign exposure now become negative and significant, meaning that firms with a higher export to sales ratio have significantly lower returns.

[4] This number is obtained by multiplying the standard deviation of the Hubei exposure measure by the estimated coefficient.

Quantitatively, a one-standard-deviation increase in the exports to sales ratio lowers CAR by about 0.28 percentage point. The combination of the containment of the disease in China and its outbreak overseas puts firms with a larger foreign exposure at a disadvantage.

3.3. Robustness checks

To ensure the robustness of our main findings, we conduct a set of sensitivity analyses in this subsection. The results are reported in Table 2. For the sake of space saving, we now only report the results on our man variables of interest. The dependent variables in Panels A and B are the CARs from the first and second event, respectively. First, in Column (1) of each panel, we use a firm's foreign direct investment as an additional proxy of its foreign exposure and examine its impact on firm returns. We scale the value of a firm's FDI by its total assets and include it in Equation (1) as an additional regressor.[5] While the estimated coefficient on this additional variable is not significant in Panel A, it is significantly negative in Panel B. That is, as the disease spread to overseas, firms with a larger foreign direct investment experience a lower CAR.

Second, we consider alternative measures of a firm's Hubei exposure. The results are ported in Columns (2) and (3) of each panel. Instead of using a Hubei subsidiary dummy, Column (2) now uses the number of Hubei subsidiaries (in natural log) as a proxy of Hubei exposure. Using this alternative measure does not alter our main findings. The estimated effect of Hubei exposure remains significantly negative in the first event but insignificant in the second event. In Column (3), we conduct a similar exercise and use a Wuhan subsidiary dummy that takes the value of unity if a firm has

[5] The results are not affected if we scale it by sales.

any subsidiary in Wuhan, the city that was hit hardest by the disease. Again, we find that our main findings are not sensitive to this alternative measure.

[Insert Table 2 around Here]

Our third set of robustness checks is to consider different market benchmarks. In Column (4) of Table 2, we use value weighted average return as market benchmark and re-estimate the baseline regressions. In the last column, we also consider a three-factor model (i.e., adding the size factor and book-to-market factor as two additional factors). Using alternative market benchmarks does not change our main findings either.

So far, our measures of Hubei and foreign exposure are based mainly on within-firm internal network such as subsidiary information and foreign direct investment. In Table 3, we consider further measures based on between-firm I-O production linkages. Since we do not have information about firms' Hubei sales or imports from Hubei, we previously rely on subsidiary information to measure firms' Hubei exposure. Here, to proxy a firm's Hubei exposure from the perspective of production network, we make use of China's 2012 input-output table and calculate the total share of inputs coming from Hubei and outputs sold to Hubei for each industry (HB_share). Since this input-output based measure is only available at the industry level, we are not able to control for industry fixed effects in the regressions. Instead, we include a set of industry-level controls in the regressions, including industry wage to sales ratio and industry output (in natural log) as additional controls.

Columns (1) and (2) report the regression results using CARs obtained from the first event and the second event, respectively. The evidence suggests that I-O based production linkages are also important in the transmission of shocks. The estimated coefficient on the new measure of Hubei exposure is found to be negative and

statistically significant in Column (1), indicating that firms that have a tighter I-O linkage with Hubei experienced a significantly lower return following the lockdown of Hubei. The estimated coefficient in the second event regression remains insignificant. The results on the foreign exposure measure, exports to sales ratio, are also consistent with our previous results.

In the next two columns, we separate the industry share of inputs coming from Hubei (HB_input_share) from that of outputs used by Hubei (HB_output_share) and include both shares in the regressions. The results in Column (3) indicate that it is the share of outputs sold to Hubei that matters significantly. The coefficient on this share is negative and significant while that on the share of inputs coming from Hubei is statistically insignificant.

Finally, in Columns (5) and (6) of Table 3, we further include a firm's imports of intermediate inputs scaled by total sales (INT_IMP/SALES) in our baseline regressions to capture the potential impacts of reliance on foreign input supplies. Controlling for exposure to foreign supply of inputs does not affect our previous findings. Hubei exposure is still significantly negative in Column (5) and remains insignificant in Column (6). Similarly, foreign sales exposure is again found to be significantly positive in Column (5) and significantly negative in Column (6), respectively. The estimated coefficients on imports of intermediate inputs are found to be insignificant in both columns.

[Insert Table 3 around Here]

3.4. Heterogeneity

In this subsection, we further explore some potential heterogeneity to see if the effects of Hubei and foreign exposures on firm returns vary across some key firm or industry characteristics. We first explore the potential heterogeneity related to firm

ownership. We do so by interacting our baseline measures of Hubei and foreign exposures, the Hubei subsidiary dummy and exports to sales ratio, with a state-ownership dummy and include the interaction terms in our regressions as additional regressors. The regression results are reported in Columns (1) and (2) of Table 4. The inclusion of the interaction terms does not affect our previous findings. In addition, we also find that the estimated coefficient on the interaction term between the Hubei subsidiary dummy and state-ownership is positive and statistically significant in the first event regression, implying that state owned firms with Hubei exposures suffer less from the domestic outbreak of the disease. The interaction terms between exports and state ownership are found to be insignificant in both columns.

In the next two columns, we explore further a potential industry heterogeneity. Specifically, we interact our foreign exposure measure with a pharmaceutical industry dummy (PHARMA) and include the interaction term in the regressions. We find that, interestingly, the interaction term is negative and significant during the first event but positive and significant during the second event. During the domestic outbreak of the disease, firms in the pharmaceutical industry that sell more to the domestic market have a relatively higher return compare to firms rely more on foreign demand. Following the overseas outbreak, however, pharmaceutical firms that sell more to foreign markets benefit more due to an expected strong foreign demand for pharmaceutical products. These results are consistent with a relative increase in domestic (foreign) demand for pharmaceutical products following the first (second) event.

[Insert Table 4 around Here]

4. Conclusions

We study how a health crisis affects firms. Using the COVID-19 pandemic and an event study approach, we provide evidence that a large negative health shock can have significant impacts on firms, and the effects vary across different phases. Chinese stock market responded significantly negatively to the domestic outbreak of the disease but significantly positive to the containment of the disease in China and the outbreak overseas. Further regression analysis suggests that there is a substantial amount of firm heterogeneity. Firms with a larger degree of Hubei exposure earned a significantly lower return following the first event. A higher degree of foreign exposure has a value-enhancing diversification effect following the domestic outbreak of the disease but a value-destroying effect after an oversea outbreak. Our results also suggest that both the with-in firm internal networks and between-firm input-output based production network are important channels through which a health shock can transmit.

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Figure 1. Daily Confirmed New COVID-19 Cases in China, Hubei, and outside Hubei (in Natural Log)

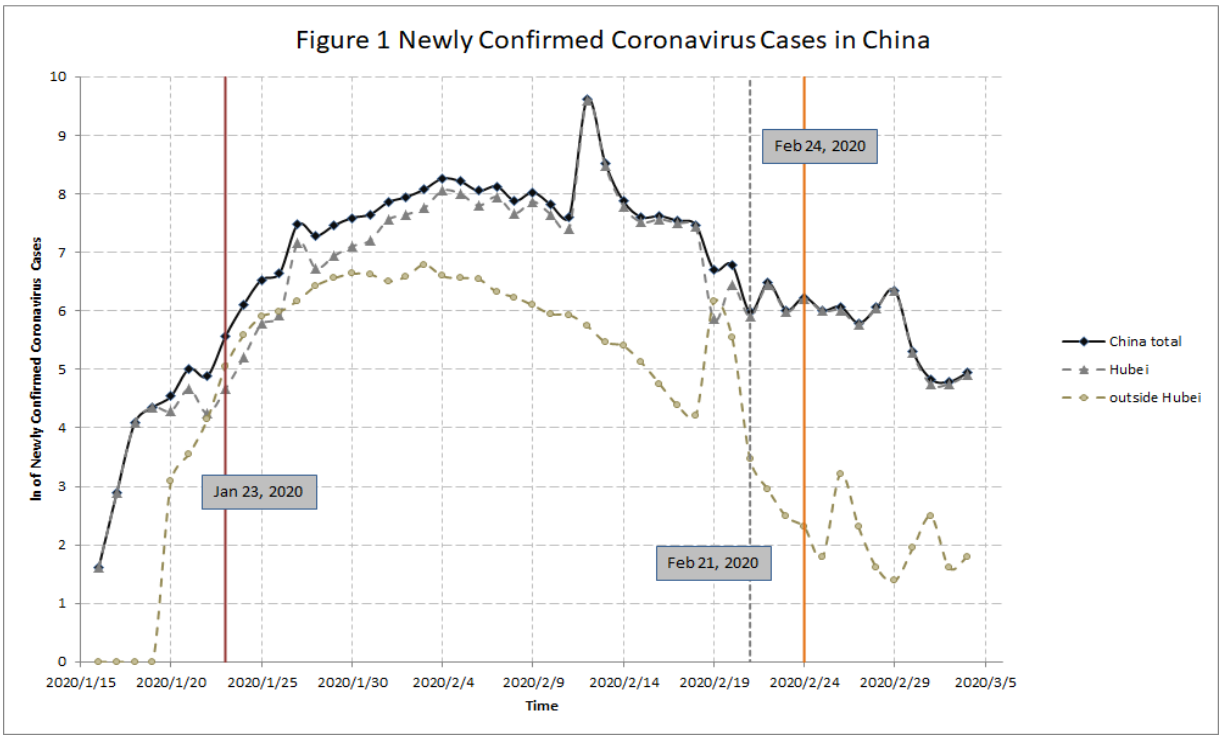

Table 1. Baseline Regression Results

	Dep = CAR_event1		Dep = CAR_event2	
	(1)	(2)	(3)	(4)
HB_sub	-0.0036**	-0.0056***	0.0031	0.0066
	(0.002)	(0.001)	(0.006)	(0.005)
EXP/SALES	0.0055***	0.0061***	-0.0056***	-0.0064***
	(0.002)	(0.001)	(0.001)	(0.001)
LN_ASSETS		0.0009		-0.0071*
		(0.001)		(0.004)
LN_EMP		0.0025***		0.0034
		(0.001)		(0.003)
LEVERAGE		-0.0097*		-0.0042
		(0.005)		(0.006)
SOE		0.0012		-0.0011
		(0.002)		(0.003)
INDEP		-0.0153		0.0067
		(0.013)		(0.021)
DUALITY		0.0007		-0.0016
		(0.002)		(0.005)
LN_BOARD		-0.0090*		-0.0029
		(0.005)		(0.006)
Industry F.E.	Yes	Yes	Yes	Yes
Province F.E.	Yes	Yes	Yes	Yes
Observations	2,289	2,250	2,289	2,250
R-squared	0.070	0.077	0.138	0.148

Notes: The dependent variables in Columns (1) and (2) are the CARs for the first event, and that in Columns (3) and (4) are the CAR for the second event. HB_sub is a dummy variable equals 1 if a firm has any subsidiary in Hubei province. EXP/SALES is firm's export value as a share of total sales. Control variables include LN_ASSETS, LN_EMP, LEVERAGE, SOE, INDEP, DUALITY and LN_BOARD. A constant, industry fixed effects and province fixed effects are included in each regression. Standard errors clustered at the industry level are reported in the parentheses. *, ** and *** denote the 10, 5 and 1 percent significance levels, respectively.

Table 2. Robustness Checks

Panel A	(1)	(2)	(3)	(4)	(5)
Dep=CAR_event1	Add FDI	Hubei number	Wuhan dummy	Value Weighted	3 Factor Model
HB_sub	-0.0056***			-0.0056***	-0.0056***
	(0.001)			(0.002)	(0.002)
FDI/ASSETS	-0.0050				
	(0.003)				
LN_HB_number		-0.0025**			
		(0.001)			
Wuhan_sub			-0.0056***		
			(0.001)		
EXP/SALES	0.0061***	0.0062***	0.0061***	0.0060***	0.0059***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry F.E.	Yes	Yes	Yes	Yes	Yes
Province F.E.	Yes	Yes	Yes	Yes	Yes
Observations	2,250	2,250	2,250	2,250	2,250
R-squared	0.078	0.075	0.077	0.079	0.080

Panel B	(1)	(2)	(3)	(4)	(5)
Dep=CAR_event2	FDI	Hubei number	Wuhan dummy	Value Weighted	3 Factor Model
HB_sub	0.0067			0.0068	0.0065
	(0.005)			(0.005)	(0.005)
FDI/ASSETS	-0.0128***				
	(0.004)				
LN_HB_number		0.0025			
		(0.004)			
Wuhan_sub			0.0066		
			(0.005)		
EXP/SALES	-0.0064***	-0.0065***	-0.0064***	-0.0063***	-0.0057***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry F.E.	Yes	Yes	Yes	Yes	Yes
Province F.E.	Yes	Yes	Yes	Yes	Yes
Observations	2,250	2,250	2,250	2,250	2,250
R-squared	0.149	0.147	0.148	0.145	0.107

Notes: The dependent variables in Panel A are CARs for the first event, and those in Panel B are CARs for the second event. We proxy Hubei exposure using the number of Hubei subsidiaries (in natural log) labeled as LN_HB_number in Columns (2) and a dummy variable that takes the value of unity if a firm has any subsidiary in Wuhan labeled as Wuhan_sub in Columns (3). We use value-weighted average return in the Columns (4) and a three-factor model in Columns (5). HB_sub is a dummy variable equals 1 if a firm has any subsidiary in Hubei province. FDI/ASSETS is firm's greenfield foreign direct investment value as a share of total assets. EXP/SALES is firm's export value as a share of total sales. Control variables include LN_ASSETS, LN_EMP, LEVERAGE, SOE, INDEP, DUALITY and LN_BOARD. A constant, industry fixed effects and province fixed effects are included in each regression. Standard errors clustered at the industry level are reported in the parentheses. *, ** and *** denote the 10, 5 and 1 percent significance levels, respectively.

Table 3. I-O Linkage based Hubei and Foreign Exposure Measures

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable	CAR_event1	CAR_event2	CAR_event1	CAR_event2	CAR_event1	CAR_event2
HB_share	-0.2057***	-0.3692			-0.2059***	-0.3692
	(0.060)	(0.222)			(0.060)	(0.222)
HB_input share			-0.1824	-0.6643		
			(0.142)	(0.431)		
HB_output share			-0.2271**	-0.0989		
			(0.098)	(0.398)		
EXP/SALES	0.0063***	-0.0055***	0.0063***	-0.0058***	0.0068***	-0.0054***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
INT_IMP/SALES					-0.0016	-0.0004
					(0.002)	(0.002)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry F.E.	No	No	No	No	No	No
Province F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,250	2,250	2,250	2,250	2,250	2,250
R-squared	0.045	0.084	0.045	0.086	0.046	0.084

Notes: The dependent variables in Columns (1), (3) and (5) are CARs for the first event, and those in Columns (2), (4) and (6) are CARs for the second event. HB_share is the input and output share of Hubei Province. HB_input_share and HB_output_share represent input and output share of Hubei province, respectively. EXP/SALES is firm's export value as a share of total sales and FDI/ASSETS is firm's greenfield foreign direct investment value as a share of total assets. Firm-level control variables include LN_ASSETS, LN_EMP, LEVERAGE, SOE, INDEP, DUALITY and LN_BOARD. Industry-level controls include INDWAGE_RATIO and LN_INDOUTPUT. A constant and province fixed effects are included in each regression. Standard errors clustered at the industry level are reported in the parentheses. *, ** and *** denote the 10, 5 and 1 percent significance levels, respectively.

Table 4. Heterogeneity across Ownership and Industry

Dep. Variable	(1) CAR_event1	(2) CAR_event2	(3) CAR_event1	(4) CAR_event2
HB_sub	-0.0065***	0.0064	-0.0056***	0.0070
	(0.001)	(0.005)	(0.001)	(0.005)
EXP/SALES	0.0061***	-0.0064***	0.0062***	-0.0072***
	(0.001)	(0.001)	(0.001)	(0.002)
HB_sub×SOE	0.0114**	0.0025		
	(0.004)	(0.012)		
EXP/SALES×SOE	0.0063	-0.0183		
	(0.015)	(0.043)		
EXP/SALES×PHARMA			-0.0125***	0.2253***
			(0.003)	(0.004)
Controls	Yes	Yes	Yes	Yes
Industry F.E.	Yes	Yes	Yes	Yes
Province F.E.	Yes	Yes	Yes	Yes
Observations	2,250	2,250	2,250	2,250
R-squared	0.078	0.158	0.078	0.148

Notes: The dependent variables in Columns (1) and (3) are CARs for the first event, and those in Columns (2) and (4) are CARs for the second event. HB_sub is a dummy variable equals 1 whether a firm has any subsidiary in Hubei province. EXP/SALES. EXP/SALES is firm's export value as a share of total sales. SOE and PHARMA are dummy variables for state ownership and pharmaceutical industry, respectively. Control variables include LN_ASSETS, LN_EMP, LEVERAGE, INDEP, DUALITY and LN_BOARD. A constant, industry fixed effects and province fixed effects are included in each regression. Standard errors clustered at the industry level are reported in the parentheses. *, ** and *** denote the 10, 5 and 1 percent significance levels, respectively.

Online Appendix (Not for Publication)

Appendix Table 1. Variable Definitions and Data Sources

Variables	Definition and Data Source
CAR_event1	CAR of the first event. *Source*: CSMAR.
CAR_event2	CAR of the second event. *Source*: CSMAR.
HB_sub	A dummy variable equals 1 whether a firm has any subsidiary in Hubei province, and 0 otherwise. *Source*: CSMAR.
HB_input_share	Input share of Hubei Province. Source: 2012 China I-O table
HB_output_share	Output share of Hubei Province. *Source*: 2012 China I-O table
HB_share	Input and output share of Hubei. *Source*: 2012 China I-O table
EXP/SALES	Exports/total sales. *Source*: CSMAR and Custom database.
INT_IMP/SALES	Imports of intermediate input/total sales. *Source*: CSMAR and Custom database.
FDI/ASSETS	Greenfield FDI/total assets. *Source*: fDi Markets.
LN_HB_number	Log of the number of Hubei subsidiaries. *Source*: CSMAR.
Wuhan_sub	A dummy variable takes the value of 1 if a firm has any subsidiary in Wuhan, and zero otherwise. *Source*: CSMAR.
LN_EMP	log of total number of employees. *Source*: CSMAR.
LN_ASSETS	log of total assets. *Source*: CSMAR.
LEVERAGE	The ratio of total debts to total assets. *Source*: CSMAR.
LN_BOARD	log of board size. *Source*: CSMAR.
INDEP	The proportion of outside (non-executive) directors on the board. *Source*: CSMAR.
Duality	A dummy variable equal to one if the CEO is also the chairman of the board, and zero otherwise. *Source*: CSMAR.
SOE	A dummy variable for private firms. *Source*: CSMAR
LNWAGE_RATIO	Industry wage to total output ratio. *Source*: 2012 China I-O table
LN_INDOUTPUT	Log of total output at that industry. *Source*: 2012 China I-O table
PHARMA	A pharmaceutical industry dummy. *Source*: CSMAR

Appendix Table 2. Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CAR_event1	2,363	-0.0053	0.0389	-0.1829	0.2388
CAR_event2	2,363	0.0283	0.0675	-0.2620	0.3207
HB_sub	2,363	0.2230	0.4164	0	1
HB_input_share	2,363	0.0295	0.0114	0.0088	0.0704
HB_output_share	2,363	0.0249	0.0122	0.0020	0.0635
EXP/SALES	2,363	0.0763	0.4336	0	17.8771
INT_IMP/SALES	2,363	0.0381	0.3614	0	9.5787
FDI/ASSETS	2,363	0.0043	0.0909	0	3.5868
LN_HB_number	2,363	0.2619	0.5911	0	4.1271
Wuhan_sub	2,363	0.2230	0.4164	0	1
LN_ASSETS	2,363	22.4481	1.3163	18.4109	28.2526
LN_EMP	2,363	7.7637	1.2909	2.7081	12.6209
LEVERAGE	2,363	0.4373	0.2003	0.0216	1.6869
SOE	2,363	0.0901	0.2864	0	1
INDEP	2,363	0.3785	0.0585	0	0.8
DUALITY	2,322	1.7304	0.4438	1	2
LN_BOARD	2,363	2.1186	0.2038	1.3863	2.8332
LNWAGE_RATIO	2,363	0.1413	0.0991	0.0386	0.5555
LN_INDOUTPUT	2,363	20.5527	0.9624	16.6494	21.8675
PHARMA	2,363	0.0546	0.2272	0	1