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Modelling economic policy issues

New evidence on COVID-19 and firm performance

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The Chinese equity market plummeted and was roiled in crisis with the rapid spread of COVID-19 in the first quarter of 2020, but it also exhibits great resilience when the pandemic is gradually under control in China. In this study, we try to quantify the influence of regional COVID-19 outbreaks in 31 provinces on the stock returns of local listed firms by using a difference-in-difference framework. To our limited knowledge, we are the first to study provincial equity market performance during the spread of COVID-19. We show that when there is a COVID-19 outbreak in a province, treated firms first underperform by daily lower returns of 0.54% but abruptly regain their value by daily higher returns of 0.76%. Even though strict lockdown restrictions deteriorate economic prosperity, negative effects on firm values are only temporary in a maximum 20-trading-day window. Our results are also robust when subsamples of provinces and companies are considered.

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1. Introduction

The outbreak of COVID-19 originated in December 2019, Hubei, China. It then quickly spread across 30 provinces in China with frequent regional outbreaks during the first half of 2020. Contagious disease and infection prevention measures (such as lockdowns) severely disrupted local economic activities. GDP contracted by 6.8 in the first quarter of 2020. Accordingly, stock price reactions are also unprecedented (Baker et al., 2020). The impacts of COVID-19 were behind most stock market fluctuations around the world in 2020. The Chinese equity market plummeted and was roiled in crisis as well. The Shanghai Shenzhen CSI 300 index lost 14.75% of its value between January 23, 2020 and March 23, 2020 with the largest daily drops of 7.88% on February 3, 2020. Table 1 lists the five largest daily drops of the Shanghai Shenzhen CSI 300 index and the simultaneous regional outbreaks of COVID-19 in China.

On the other hand, the financial crisis triggered by COVID-19 is different from past crises (see, for example, Reinhart, 2020). The Chinese equity market demonstrates great resilience against the negative impact of the pandemic. Fig. 1 plots the accumulated returns for 1 RMB invested in Shanghai Shenzhen CSI 300 index. Large losses, for example, in January and March of 2020, were always followed by abrupt recoveries. As a result, the surge in July 2020 lead the investment to increase 20% between December 2, 2019 and September 30, 2020. Meanwhile, enormous heterogeneity in stock prices was triggered by the pandemic (Ding et al., 2020). In this study, we try to discover, under the regional outbreak of COVID-9 in 30 provinces, how the Chinese equity market is affected. As the negative impacts of the pandemic gradually taper off, how the recovery of the Chinese equity market is also examined.

These areas of study are of great importance. First, changes in the return of treatment firms during the pandemic period and recovery stages could help to identify whether the shock of COVID-19 is temporary or permanent. On the other
Table 1

| Date   | Daily return (%) | COVID-19                                                                 |
|--------|------------------|---------------------------------------------------------------------------|
| 1 3-Feb| −7.88            | Zhejiang, Guangdong, etc. reach the highest single-day confirmed cases.   |
| 2 16-Jul| −4.81           | Outbreak of COVID-19 in Beijing                                            |
| 3 24-Jul| −4.38           | Xinjiang, Jilin and Liaoning                                              |
| 4 16-Mar| −4.30           | Outbreak of COVID-19 in Beijing                                            |
| 5 28-Feb| −3.55           | Outbreak of COVID-19 in Beijing                                            |

Note: This table reports the size and date of 5 largest single-day drops of Shanghai Shenzhen CSI 300 index in the sample period from Dec. 2nd, 2019 to Feb. 23rd, 2020. It also shows the associated regional outbreaks of COVID-19 on the corresponding date.

Fig. 1. Accumulated returns of Shanghai Shenzhen CSI 300 Index. Note: This figure plots the cumulative return for 1 RMB invested in Shanghai Shenzhen CSI 300 index for the sample period between Dec. 2nd, 2019 and Feb. 23rd, 2021.

hand, stock market evaluations of firms are a key indicator of macroeconomic fundamentals such as GDP growth and the business cycle. Understanding equity market performance in epidemic provinces is analogous to understanding how the pandemic affects local economic prosperity. It is also a key measure of the effects of infection prevention measures. Last but not the least, China was the epicenter of the pandemic in the first quarter of 2020, and understanding these topics is instructive to possible equity market behaviors in other epidemic regions around the world.

To shed some light on these topics, we attempt to depict the geographical heterogeneity of stock price movements, for the period from the initial outbreak of COVID-19 to the alleviation stages. We group listed firms in the Chinese A-share market by their registration provinces and compare the stock returns during the outbreak of COVID-19 in each province. We define the event day as the day that an epidemic province has the largest increase in confirmed cases to proxy for the worst time of the province in the pandemic. Difference-in-difference (DID) methods and spline regression models are employed, in which firms registered in the epidemic province on the event day are in the treatment group. We find supportive evidence in favor of the microlevel cross-sectional V-shaped trajectory of the treated firm returns around the event day. For a sample of all firms in the Main Board of the Chinese A-share market, we detect an average of 0.54% daily pandemic-induced decline in the 10-day pre-event window, compared with firms registered in the unaffected provinces. On the event day when there were the largest regional increases in confirmed cases, treated firms plummeted by 5.17% compared with the control group. However, the regional stock price recovery was also relatively strong when COVID-19 was under control. Treated firms earned an average of 0.76% daily cross-sectional return premium in the 10-day postevent window. The V-shaped pattern is even sharper in the subsample of the Small and Medium Enterprise Board (SME) and Growth Enterprise Market (GEM), because these firms generally operate their business within provinces. The cross-sectional difference on the event day and subsequent daily recoveries are 5.93% and 1.12% for SME/GEM firms, respectively.

Little paper dissects the localized impact of COVID-19 on firm-level equity returns. Chinese microlevel firm performance and equity market behaviors in the epicenter of the pandemic have drawn surprisingly little attention in academics. We try to fill this gap. It is important to evaluate the correlation or causal effects between COVID-19 and the equity market at the microlevel by combining firm locations and individual equity returns. By comparing quasi-random samples
of portfolios in different provinces, it effectively eliminates interference from other factors and could distill the effect of COVID-19.

Bretscher et al. (2020) use a sample of the United States equity market and recognize the return difference between firms headquartered in COVID-19 counties. In this study, we adopt analogous econometric models such as those used by Bretscher et al. (2020). Nevertheless, the work of Bretscher et al. (2020) is different from our study in the following aspects. First, by using the day of the first report case in a county as the event day, Bretscher et al. (2020) only consider the negative effect on the equity market in the initial infection stage of COVID-19. Second, the focal point of Bretscher et al. (2020) is the role of the labor supply channel in transmitting the COVID-19 effect to stock prices, as the firms they selected in the sample are large firms that are unlikely to have concentrated sales within local areas. In this study, we use the day of largest confirmed cases to increase as the event day for each province and focus on the cross-sectional stock return pattern both before and after the event day. Davis et al. (2020) focus on the regional impact of COVID-19 on stock prices under an international background. They find strict lockdown policies drag down stock prices. They also conclude that the pandemic has greater effects on stock market levels and volatilities in the US than in China.

Our study adds to the fast-growing literature that tries to uncover the relationship between asset prices and the impact of the pandemic. Baker et al. (2020) perform a text-based analysis and argue that the main reason for the forceful reaction of U.S. stocks to the pandemic are government restrictions and social distancing. Topcu and Gulal (2020) employ a sample of emerging market stocks between March 10 and April 30, 2020 to show that the negative impacts of COVID-19 have gradually disappeared by mid-April. The stimulus package from the government helped offset the effects of the pandemic. Corbet et al. (2020) focus on the contagion effects of COVID-19 between the Chinese equity market and cryptocurrencies. They show that cryptocurrencies cannot serve as a hedge or “safe-haven” but rather as an amplifier of the risk contagion. Zhang et al. (2020) document that the global financial market risk increased substantially during the pandemic. Unconventional policy interventions might increase economic uncertainty. A survey of the economic literature conducted by Padhan and Prabheesh (2021) suggests that adverse effects of COVID-19 are observed through the channels of the stock market, exchange rate and oil market. For the macroeconomic and international finance literature, Hu and Zhang (2021) analyze firm performance in a global background and find that countries with better healthcare systems and more advanced financial systems are less affect by COVID-19.

Our study relates to another area of literature on financial market resilience and firm sensitivities to the pandemic. Ding et al. (2020) document that firms with traits such as stronger financial conditions, less affected international supply chains, stronger corporate social responsibility (CSR) policies, less entrenched executives and stocks owned by nonfinancial corporations, tend to be immune to the pandemic. Shen et al. (2020) find that the negative impact of COVID-19 is more pronounced for Chinese firms when the firm’s investment scale or sales revenue are smaller. Qiu et al. (2021) use a sample of hospitality firms to show that investment in corporate social responsibility increases company value. Onali and Mascia (2020) focus on the role of corporate diversification in alleviating increased idiosyncratic and total volatilities due to the pandemic. Cui et al. (2021) show that Chinese firms with more conditionally conservative accounting practices have better stock returns during the pandemic period.

Greenwald et al. (2020) try to find the driving forces of quick recovery for the U.S. equity market under the theoretical model of Greenwald et al. (2019). They demonstrate that plausible fluctuations in aggregated economic activities, corporate profit shares or short-term interest rates have difficulty explaining the V-shaped pattern and argue that fluctuations in risk aversion or beliefs/sentiment play a vital role. By employing a high-frequency event study framework, Greenwald et al. (2020) also show that Federal Reserve actions in response to COVID-19 play a positive role in stock market recovery. Gormsen and Koijen (2020) reach a similar conclusion by evaluating the dynamics of the estimated lower bound of growth expectations for the stock and dividend futures market during the pandemic. Borgards et al. (2021), by studying the intraday trading data of 20 commodity futures, argue that there are vast overreaction behavior biases among the markets during the pandemic, especially for precious metal and energy commodities.

Our study contributes to the literature in two ways. First, we are the first study that brings firm-level equity returns and geographical dispersions together into consideration of the localized impact of COVID-19 in the Chinese equity market. We quantified the influence of regional COVID-19 outbreaks in 31 provinces in China on the stock returns of local listed firms. Second, we are the first study that uncovers the microlevel V-shaped return trajectory for stocks in COVID-19 affected provinces. We show that the adverse effects of COVID-19 on firm values are only temporary in a maximum 20-trading-day window. We show that our method and empirical findings are of great importance in terms of academic and practical applications. By involving location information, it is easy to isolate the impact of COVID-19 without interference from other factors. Our empirical findings provide direct guidance on stock selection and market timing in the optimal portfolio construction. These findings are also meaningful for policymakers to understand firm evaluations in pandemic periods and formulate policies to stabilize the market.

This study is structured as follows: Section 2 introduces the data, date of event day for each province and descriptive statistics of the stock groups; in Section 3, we propose the DID model and spline regression model and the estimation results. Section 4 concludes.

2. Data and summary statistics

We retrieve daily returns with cash dividend reinvested, market values of tradable stocks and registration locations from December 2, 2019 to February 23, 2021 of all Chinese A-shares through the China Stock Market & Accounting
Fig. 2. Daily increases of confirmed cases by provinces. Note: This figure plots the time series of daily increases of confirmed cases by province. The sample period is from Dec 2nd, 2019 to Feb 23rd, 2021.

We also obtained the firms’ financial statement data from CSMAR which includes Total Asset, Current Ratio, Return on Asset (ROA), Operating Profit Margin, Net Operating Profit Margin, for the fiscal year 2019.

The Chinese A-share market is categorized under the following three headings: the Main Board Market, which includes large and mature companies that have a substantial business running across the entire country, the Small and Medium Enterprise Board (SME), which are small and medium firms that generally concentrate their business within provinces or cities, and the Growth Enterprise Market (GEM), which generally includes start-up technology firms that also operate regionally. In this study, we group SME and GEM stocks together since both of them are generally running their business with provinces. After discarding firms that have less than 60 days of trading records during the sample period, our sample consists of 2,696 firms in the Main Board market and 882 firms in the Small and Medium Enterprise Board (SME) and Growth Enterprise Market. We have 796,598 day-firm observations in the Main Board market and 258,949 day-firm observations in SME/GEM market. Firms are also categorized into the following 6 industries: Finance, Utility, Property, Conglomerate, Industry and Commerce.

The dataset of daily confirmed cases of COVID-19 for 31 provinces is obtained from the National Health Commission of China through Wind terminal over the same period. Fig. 2 illustrates the time series of daily increases in confirmed cases by province. In most regions, especially for provinces with severe epidemics such as Hubei, Guangdong and Hunan, the daily increases of confirmed cases have a unimodal pattern, which indicates the effectiveness of the infection prevention measures once the daily increases reach the highest. Few exceptions include Beijing, Hebei, Liaoning and Heilongjiang, which have a second wave of high increase in confirmed cases.

Table 2 shows the number of listed firms, the date of the event day, the number of confirmed cases on the event day, whether there were lockdown restrictions and the lockdown periods for each province. There is great heterogeneity for firm distributions across provinces. Guangdong has the most listed firms of 396 in the Main Board market and 201 in the SME/GEM market. Qinghai, Ningxia and Tibet have the fewest listed firms, which are less than 20. The contagious disease spread over 30 provinces and most of provinces are economically well-developed. As the origin of the pandemic, Hubei has the largest single-day increase of 13,797 confirmed cases on 12 Feb 2020, which greatly exceeded the second of 202 cases of Shandong. There were roughly four major epidemic outbreaks according to the time of the event day. The first and most serious outbreak of the pandemic occurred in the southern provinces that were geographically located around Hubei provinces between February 3 to February. As the COVID-19 spread throughout the entire country between March 6 and April 13, 2020, the second outbreak occurred in most provinces of northern China. The third occurred outbreak in Liaoning and Xinjiang at the end of July 2020. The fourth occurred in Hebei from January 4 to January 29, 2021. The last two outbreaks have no great nationwide influence and are generally restricted within provinces or cities. Twenty-five provinces officially announced full or partial lockdown prevention. The Chinese government has implemented the

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1 We do not include special treatment (ST) stocks in the sample.
2 Note that some provinces do not officially announce the termination date of the lockdowns.
Table 2
Number of stocks and date of event day by province.

| Provinces       | # of firms in main-board market | # of firms in SME and GEM market | Event day     | Increase of confirmed cases on event day | Lockdown | Lockdown start date | Lockdown ending date |
|-----------------|---------------------------------|----------------------------------|---------------|------------------------------------------|----------|---------------------|----------------------|
| Beijing         | 221                             | 117                              | 13-Jun-20     | 32                                       | Yes      | 10-Feb-20           | N/A                  |
| Tianjin         | 42                              | 10                               | 3-Feb-20      | 15                                       | Yes      | N/A                 |                       |
| Hebei           | 43                              | 10                               | 12-Jan-21     | 90                                       | Yes      | 08-Jan-21           | 27-Jan-21            |
| Shanxi          | 28                              | 3                                | 7-Apr-20      | 25                                       | No       | N/A                 |                       |
| Inner Mongolia  | 19                              | 3                                | 12-Apr-20     | 27                                       | Yes      | 21-Nov-20           | N/A                  |
| Liaoning        | 54                              | 14                               | 31-Jan-20     | 11                                       | Yes      | 05-Feb-20           | 20-Feb-20            |
| Jilin           | 32                              | 4                                | 24-Jan-21     | 46                                       | Yes      | 09-May-20           | 09-Jun-20            |
| Heilongjiang    | 29                              | 3                                | 13-Apr-20     | 79                                       | Yes      | 13-Dec-20           | 10-Jan-20            |
| Shanghai        | 228                             | 63                               | 11-Apr-20     | 25                                       | Yes      | 10-Feb-20           | N/A                  |
| Jiangsu         | 342                             | 100                              | 29-Jan-20     | 105                                      | Yes      | 02-Feb-20           | 08-Feb-20            |
| Anhui           | 87                              | 18                               | 6-Feb-20      | 74                                       | Yes      | 05-Feb-20           | 08-Feb-20            |
| Fujian          | 102                             | 31                               | 26-Jan-20     | 15                                       | No       | N/A                 |                       |
| Jiangxi         | 31                              | 12                               | 3-Feb-20      | 85                                       | Yes      | 04-Feb-20           | 06-Feb-20            |
| Shandong        | 163                             | 39                               | 20-Feb-20     | 202                                      | Yes      | 03-Feb-20           | 09-Feb-20            |
| Henan           | 60                              | 14                               | 3-Feb-20      | 109                                      | Yes      | 04-Feb-20           | N/A                  |
| Hubei           | 75                              | 25                               | 12-Feb-20     | 13797                                    | Yes      | 23-Jan-20           | 08-Apr-20            |
| Hunan           | 75                              | 28                               | 28-Jan-20     | 72                                       | No       | N/A                 |                       |
| Guangdong       | 396                             | 201                              | 31-Jan-20     | 114                                      | Yes      | 06-Feb-20           | N/A                  |
| Guangxi         | 30                              | 1                                | 29-Jan-20     | 18                                       | Yes      | 02-Feb-20           | 08-Feb-20            |
| Hainan          | 20                              | 3                                | 27-Jan-20     | 12                                       | No       | N/A                 |                       |
| Chongqing       | 45                              | 5                                | 2-Feb-20      | 37                                       | Yes      | 31-Jan-20           | N/A                  |
| Sichuan         | 90                              | 31                               | 30-Jan-20     | 28                                       | Yes      | 07-Feb-20           | N/A                  |
| Guizhou         | 27                              | 1                                | 31-Jan-20     | 13                                       | Yes      | 07-Feb-20           | N/A                  |
| Yunnan          | 29                              | 4                                | 28-Jan-20     | 8                                        | Yes      | 14-Sept-20          | 21-Sept-20           |
| Tibet           | 15                              | 3                                | N/A           | 9                                        | No       | N/A                 |                       |
| Shaanxi         | 37                              | 13                               | 31-Jan-20     | 23                                       | Yes      | 09-Feb-20           | N/A                  |
| Gansu           | 27                              | 3                                | 6-Mar-20      | 17                                       | Yes      | 07-Feb-20           | N/A                  |
| Qinghai         | 9                               | 0                                | 2-Feb-20      | 2                                        | No       | N/A                 |                       |
| Ningxia         | 11                              | 0                                | 5-Feb-20      | 6                                        | Yes      | 31-Jan-20           | N/A                  |
| Xinjiang        | 44                              | 5                                | 30-Jul-20     | 112                                      | Yes      | 24-Aug-20           | 01-Sept-20           |

Note: This table reports the geographical distribution of stocks, the date of event day, the number of confirmed cases of COVID-19 on that date, whether there is a lock down announced by the government and the lock down periods if it is available for 31 provinces. ‘N/A’ means the information is not available. Note that the event day for a province is defined as the day when there are most confirmed cases of COVID-19 in the sample period between Dec 2nd, 2019 and Feb. 23rd 2021.

strictest infection prevention measures. For example, during the lockdown period of Zhumadian City in Henan, only one person from each family was allowed to go out for purchasing necessities.

Table 3 reports the descriptive statistics of five firm fundamentals: Total Asset, Current Ratio, Return on Asset, Profit Margin and Net Profit Margin, stock groups by market type (Main Board and SME/GEM) and industry classifications (Finance, Utility, Property, Conglomerate, Industry and Commerce). Data are obtained from the financial statement of fiscal year 2019. We report the cross-sectional mean, standard deviation, minimum, median and maximum of firm fundamentals for each stock group. There are distinct differences in the firm total assets between the Main Board and SME/GEM. Firms trading in the Main Board market have an average of 102.49 billion RMB in total assets and firms in the SME/GEM have an average of 3.57 billion in total assets. In the industry classifications, finance firms have the greatest average total assets of 341.95 billion RMB and conglomerate firms have the lowest average total assets of 10.35 billion RMB.

3. Empirical analysis

To investigate how the firm-level equity returns are affected as the pandemic unfolded across provinces, we follow Bretschger et al. (2020) who devised a natural experiment for firms in the U.S. by using the date on which the first confirmed case was reported in a given county as the event day, to identify the return differences for firms under the treatment of COVID-19. In this study, to obtain the whole picture of the causal effects of COVID-19 in the entire process, especially during the phase when the pandemic is under control and daily confirmed cases are decreasing, we use the day that has the largest confirmed cases as the event day, which could proxy for the most difficult period of the pandemic in each province. Since the patterns of confirmed cases over time are unimodal as shown in Fig. 2, the event day in this study serves as the dividing crest for the local severity of the pandemic.

3.1. Baseline difference-in-difference analysis

Our Difference-in-Difference (DID) model is designed to capture the treatment effect of regional recovery from the pandemic on firm-level equity returns. Tibet, as the only province that has not been infected by COVID-19, also serves as
part of the control group. The different timing of the event day enables us to compare the cross-sectional returns of firms located in epidemic and non-epidemic provinces.

Our baseline model is designed to investigate the cross-sectional return differences on the event day as shown in Eq. (1)

\[ r_{it} = \alpha + \beta \times \text{COVID}_{ij,t} + \gamma \times \text{PostCOVID}_{ij,t} + X_{it} + \phi_i + \rho_j + \epsilon_{it} \]  

Where \( \alpha \) is the regression intercept and \( \epsilon_{it} \) is the residual term; \( r_{ijt} \) denotes the daily returns with cash dividend reinvested of firm \( i \) at time \( t \); \( \text{COVID}_{ij,t} \) is the event dummy for firm \( i \) which equals 1 if its registered province \( j \) has the highest confirmed cases on day \( t \). \( \text{PostCOVID}_{ij} \) is the post-treatment dummy variable which equals 1 during the 10 days post-event window for firm \( i \) in province \( j \). We also include industry fixed effects \( \phi_i \) and province fixed effects \( \rho_j \) to absorb unobserved heterogeneity across industries and provinces. Firm-specific heterogeneity is controlled by variable \( X_{it} \) which consists of the logarithm of total assets, current ratio, return on total assets (ROA), operating profit margin and net operating profit margin reported in fiscal year 2019.

In Eq. (2), we add the pre-event dummy variable \( \text{PreCOVID}_{ij} \) in Eq. (1) as a robustness check. We evaluate whether there were distinct effects pre- or posttreatment. The dummy variable \( \text{PreCOVID}_{ij} \) equals 1 during the 10-day pre-event window for firm \( i \) in province \( j \).

\[ r_{ij} = \alpha + \delta \times \text{PreCOVID}_{ij} + \beta \times \text{COVID}_{ij,t} + \gamma \times \text{PostCOVID}_{ij,t} + X_{ij} + \phi_i + \rho_j + \epsilon_{ij} \]  

In this model, the treated groups are firms registered in the epidemic provinces on the event day. Firm returns that were not on the event day or firms registered in non-epidemic provinces are in the control group. Coefficients \( \delta \), \( \beta \) and \( \gamma \) are of particular interests. \( \delta \) and \( \gamma \) are meant to capture the daily average return difference before and after the event day. \( \beta \) is meant to capture the return difference on the event day.

Table 4 reports the regression coefficient estimates, standard errors, t-statistics, and adjusted R-squares for two stock groups of Main Board and SME/GEM, based on Eqs. (1) and (2). Standard errors are grouped at the province level. The upper panel represents the sample of firms in the Main Board market. Coefficient estimates for \( \beta \)s are negative and significant in

Table 3
Descriptive statistics for stock groups.

| Market type       | Main Board (2696 firms) | SME/GEM (882 firms) |
|-------------------|-------------------------|----------------------|
|                   | Mean        | Std.Dev   | Min   | Median | Max       | Mean    | Std.Dev   | Min   | Median | Max       |
| Total Asset       | 102.49      | 1107.66   | 0.09  | 5.68   | 30109.44 | 3.57    | 6.87     | 0.18  | 1.99   | 101.35   |
| Current Ratio (%) | 55.67       | 20.56     | 3.51  | 57.60  | 99.74    | 63.04   | 17.96    | 11.07 | 63.06  | 99.28    |
| ROA (%)           | 3.58        | 8.20      | -150.18 | 3.46  | 52.62    | 2.18    | 14.79    | -191.91 | 4.64  | 39.87    |
| Profit Margin (%) | 11.78       | 66.43     | -572.59 | 8.24  | 2330.08  | -164.37 | 4931.20  | -146269.71 | 10.52 | 144.93  |
| Net Profit Margin (%) | 11.43 | 146.34     | -579.61 | 6.89  | 7019.96  | -167.91 | 4925.60  | -146088.83 | 9.45  | 123.90  |

Industry classification

| Finance (116 firms) | Utility (630) | Property (182 firms) | Conglomerate (75 firms) | Industry (2419 firms) | Commerce (156 firms) |
|---------------------|---------------|----------------------|------------------------|-----------------------|----------------------|
| Mean                | Mean           | Mean                 | Mean                   | Mean                  | Mean                 |
| Std.Dev             | Std.Dev        | Std.Dev              | Std.Dev                | Std.Dev               | Std.Dev              |
| Min                 | Median | Max                 | Mean                   | Std.Dev               | Min                 | Median | Max     |
| Total Asset (billion) | 341.95 | 2373.03 0.49       | 6.13 | 24878.29 | 96.83  | 12487.44 0.15 | 4.87 | 30109.44 |
| Current Ratio (%)  | 55.32 | 17.61    5.46       | 56.56 | 90.68   | 54.85  | 22.07    3.72  | 55.81 | 98.73   |
| ROA (%)            | 1.71   | 7.00     -39.51      | 1.86 | 11.85   | 2.42   | 10.99    -150.18 | 3.46 | 29.67   |
| Profit Margin (%)  | 47.52  | 238.77   -342.31     | 14.31 | 2330.08 | 8.69   | 69.20    -542.02 | 8.69 | 1404.26 |
| Net Profit Margin (%) | 93.06 | 675.80   -406.33     | 12.06 | 7019.96 | 5.91   | 65.49    -579.61 | 7.09 | 1208.05 |
| Total Asset (billion) | 143.96 | 976.67   0.25       | 5.71 | 102167.16 | 10.35  | 20.12    0.46  | 4.20 | 144.49  |
| Current Ratio (%)  | 65.43 | 19.69    14.70       | 67.94 | 98.44   | 58.75  | 23.02    11.42 | 58.54 | 99.74   |
| ROA (%)            | 3.57   | 5.78     -42.70      | 3.08 | 14.92   | 3.70   | 10.76    -29.22 | 2.04 | 52.62   |
| Profit Margin (%)  | 11.22  | 22.65    -111.18     | 10.29 | 144.93  | 10.45  | 48.94    -184.75 | 6.38 | 361.00  |
| Net Profit Margin (%) | 8.65  | 19.42    -112.07     | 7.95 | 123.90  | 9.56   | 47.63    -171.14 | 4.84 | 356.39  |

| Market type       | Main Board (2696 firms) | SME/GEM (882 firms) |
|-------------------|-------------------------|----------------------|
| ROA (%)           | 3.48        | 10.51     -191.91   | 3.97 | 39.87   | 3.17   | 8.36     -37.31 | 4.04 | 22.93   |
| Profit Margin (%)  | -52.21      | 2975.62   -146269.71 | 9.02 | 707.37  | -3.40  | 103.42   -1249.19 | 6.13 | 54.62   |
| Net Profit Margin (%) | -55.04 | 2972.24   -146088.83 | 7.70 | 523.88  | -4.60  | 100.06   -1208.22 | 4.90 | 51.53   |

Note: This table reports the mean, standard deviation, minimum, median and maximum of five firms’ financial statement information: Natural logarithm of total assets, Current Ratio, Return on Assets, Profit Margin and Net Profit Margin, in the market type stock groups (Main Board and SME/GEM) and industry classification groups (Finance, Utility, Property, Conglomerate, Industry and Commerce). The financial statement information is from the fiscal year of 2019.
Table 4
COVID-19 and cross-sectional stock returns.

|            | Main Board |           |           | SME/GEM |           |           |
|------------|------------|-----------|-----------|----------|-----------|-----------|
| Mdl1       |            | Mdl2      |           | Mdl1     |            | Mdl2      |
|            | Coef.      | SE        | t-Stat    | Coef.    | SE        | t-Stat    |
|            | (×100)     | (×100)    | (×100)    | (×100)   | (×100)    | (×100)    |
| \(\delta\) (PreCOVID\(_{ij}\)) | -0.54     | 0.12      | -4.38     | -0.28    | 0.16      | -1.77     |
| \(\beta\) (COVID\(_{ij}\))   | -5.15     | 1.18      | -4.37     | -5.91    | 1.21      | -4.91     |
| \(\gamma\) (PostCOVID\(_{ij}\)) | 0.78      | 0.08      | 9.31      | 1.13     | 0.18      | 6.43      |
| Control Variables | Yes      | Yes       | Yes       | Yes      | Yes       | Yes       |
| Industry Fixed Effect | Yes      | Yes       | Yes       | Yes      | Yes       | Yes       |
| Province Fixed Effect | Yes      | Yes       | Yes       | Yes      | Yes       | Yes       |
| Adj. R-square (%) | 1.33      |           |           | 0.91     |           |           |

Note: This table reports the baseline DID regression results of the coefficient estimates, standard errors (SE), t-statistics (t-stat) and adjusted R-square. Standard errors are grouped at the province level. The regression specification is shown in Eq. (1) and Eq. (2). We use the daily return series of 2,696 firms in the Main Board and 882 firms in SME/GEM as the dependent variable, respectively. There are 796,598 day-firm observations in Main Board sample and 258,949 day-firm observations in SME/GEM sample. The sample period is from Dec. 2nd, 2019 to Feb. 23rd, 2021.

3.2. Spline regression analysis

To discover the detailed return pattern, we proposed the spline regression model around the event day. We assign individual dummies to each of the days in the 10-day pre- and post-event window. The model specification is as follow in Eq. (3).

\[
r_{it} = \alpha + \sum_{k=1}^{10} \Phi_k \times \text{COVID}(-k)_{it} + \beta \times \text{COVID}_{it} + \sum_{k=1}^{10} \Psi_k \times \text{PostCOVID}_{it} + \phi_k + \rho_j + \varepsilon_{it}
\]

By introducing the spline regression, we narrow down the return difference identification from the full sample to a 21-day window. To do this, we show that the return differences are mainly generated around the event day. We assign individual dummies \(\Phi_k\) and \(\Psi_k\) in the pre- and post-10-day windows, respectively. \(\text{COVID}(-k)_{it}\) is a dummy variable that...
equals 1 if there are \( k \) days leading up to the event day. Similarly, \( COVID(-k)_{it} \) is a dummy variable that equals 1 if there are \( k \) days after to the event day.

Table 5 shows the spline regression results. The left panel represents the sample of firms in the Main Board market. Seven out of ten pre-event coefficients \( \phi_k \) are negative and five of them are significantly negative at the 1% level. Among the three positive estimates of pre-event coefficients (\( \phi_1, \phi_3, \phi_7 \)), only one (\( \phi_7 \)) is significant at the 1% level. Thus, one could argue that, during the phase of rapid spreads of the virus in a province, the local listed firms experience lower returns compared with firms in the control group. The largest return difference still occurs on the event day and the coefficient estimate for \( \beta \) is analogous to that in Eq. (1). Eight out of ten postevent coefficients \( \psi_k \) are positive. Five of them are significant at the 1% level, and another one (\( \psi_5 \)) is significant at the 5% level. Only two out of ten postevent coefficients (\( \psi_6 \) and \( \psi_8 \)) are negative but none of them are significant. Therefore, during the phase in which COVID-19 is gradually under control, firms within the 10-day post-event window could regain from previous large losses by earning higher returns than firms in the control group.

The right panel represents the sample of firms in SME/GEM. Two of them (\( \phi_{10} \) and \( \phi_4 \)) are significantly negative at the 10% level. Only one of the pre-event coefficients (\( \phi_9 \)) is significantly positive. The rest of \( \phi_{5,8} \) are insignificant but most of them have a negative sign (seven out of ten). Similarly, the coefficient estimate for \( \beta \) is analogous to that in Eq. (1). For the postevent coefficients \( \psi_k \), six out of ten (\( \psi_1, \psi_2, \psi_3, \psi_4, \psi_7 \) and \( \psi_{10} \)) are significantly positive at the 1% level. We show that firms in SME/GEM demonstrate less unified coefficient estimates in the 10-day pre- and post-event window than firms in the Main Board.

3.3. V-shaped return trajectory

We proposed a hypothesis for this V-shaped return trajectory of the treated firms. In the initial downturn stage of the V-shaped pattern, investors tend to overreact to bad news. Investors are worried about the negative influences of lockdowns on firms’ supply chains, deliver of goods, and services and workforces. Borgards et al. (2021) find evidence of investor overreactions on the commodity market. The following recovery periods in the V-shaped pattern could be price corrections from previous overreactions. Nevertheless, our empirical results also show that there is a strong price recovery once the daily confirmed cases decrease after the event date. The decrease in confirmed cases is a positive signal for the evaluations of treated firms. Therefore, one could reasonably argue that strict infection prevention measures such
Table 6
COVID-19 and cross-sectional stock returns without Hubei Province.

|                  | Main Board |                     | SME/GEM   |                     |
|------------------|------------|---------------------|-----------|---------------------|
|                  |            | Coef. (×100)        | SE (×100) | t-Stat              | Coef. (×100) | SE (×100) | t-Stat |
| Mdl1             |            | δ (PreCOVIDt−1,j)  | −0.54     | 0.13                | −0.26       | 0.16      | −1.63  |
|                  |            | β (COVIDt−1,i,j)   | 0.78      | 0.09                | 1.15        | 0.18      | 6.36   |
|                  |            | γ (PostCOVIDt,j)   | 0.76      | 0.08                | 1.14        | 0.18      | 6.20   |
| Control Variables| Yes        | Yes                 | 1.45      | 1.52                |             |           |        |
| Industry Fixed Effect | Yes | Yes                |           |                      |             |           |        |
| Province Fixed Effect | Yes | Yes                |           |                      |             |           |        |
| Adj. R-square (%) |            |                     | 1.45      | 1.52                |             |           |        |

Note: This table reports the baseline DID regression results of the coefficient estimates, standard errors (SE), t-statistics (t-stat) and adjusted R-square. Standard errors are grouped at the province level. The regression specification is shown in Eq. (1) and Eq. (2). We use the daily return series of Main Board firms and SME/GEM firms registered in provinces other than Hubei Province. The sample period is from Dec. 2nd, 2019 to Feb. 23rd, 2021.

as lockdowns have positive effects on investors’ confidence about the future. Zhang et al. (2021) show that human mobility is largely decreased after lockdowns, which effectively block the transmission of COVID-19. Lau et al. (2020) find that a significant decrease in the growth rate of confirmed cases is observed after the lockdowns in Wuhan.

3.4. Robustness check

We first consider a subsample that excludes Hubei Province who are most affected by the COVID-19. It has a much larger single-day increase of 13,797 confirmed cases compared with the second of 202 cases in Shandong. There are also a considerable number of listed firms in Hubei. Thus, we exclude Hubei to stress the possibility that the V-shaped pattern has been mainly driven by treated firms in the most epidemic province.

Tables 6 and 7 show that the exclusion of firms in Hubei does not change the empirical results considerably. There was only a slight change in the coefficient estimates and statistical inferences. Thus, we show that our results are not driven by firms in Hubei Province only.

We also perform a robustness check by splitting the sample by North China provinces and South China provinces. The North China provinces consist of Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shandong, Henan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang. The South China provinces are Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Hainan, Chongqing, Sichuan, Guizhou and Yunnan. The virus transmission is different in these two areas. It was initiated with a concentrated outbreak of COVID-19 in Wuhan and rapidly spread to most of the South China provinces. Thus, the event days in South China are mainly around Feb. 2020. However, the event days in North China provinces are dispersive throughout the whole year because epidemic outbreaks infrequently occur at a relative mild scale within local areas in North China. Tables 8 and 9 report coefficient estimates for the main regression. Tables 10 and 11 are the spline regression estimates.

We find that the main regression results are still robust for these two subsamples with significant coefficients and expected signs. However, the V-shaped pattern tends to stronger for the South China sample, as their coefficient estimates are higher in absolute value compared with the full sample and the North China sample.

4. Conclusion

In this study, we try to quantify the influence of regional COVID-19 outbreaks in 31 provinces in China on the stock returns of local listed firms. We show that the impact of the pandemic creates a significant cross-sectional return difference in terms of firm geographical location and COVID-19 outbreak timings. By utilizing the day that has the largest increases in confirmed cases as the dividing crest, we could recognize the different impacts of COVID-19 on local listed firms in the outbreak and alleviation stages. Compared with firms in control groups, firms experience a V-shaped return
Table 7
Spline regression around the event day without Hubei Province.

|            | Main Board | SME/GEM |
|------------|------------|---------|
|            | Coef. (×100) | SE (×100) | t-Stat | Coef. (×100) | SE (×100) | t-Stat |
| $\Phi_1$   | -2.56      | 0.75     | -3.44  | -2.69      | 0.75     | -3.58  |
| $\Phi_2$   | -0.40      | 0.37     | -1.08  | 0.47       | 0.48     | 0.98   |
| $\Phi_3$   | 1.18       | 0.42     | -2.81  | -0.70      | 0.50     | -1.41  |
| $\Phi_4$   | 0.13       | 0.30     | 0.42   | 0.56       | 0.38     | 1.47   |
| $\Phi_5$   | -0.77      | 0.30     | -2.58  | -0.39      | 0.92     | -0.43  |
| $\Phi_6$   | -0.43      | 0.16     | -2.68  | 0.00       | 0.22     | 0.00   |
| $\Phi_7$   | -0.59      | 0.14     | -4.11  | -0.48      | 0.22     | -2.21  |
| $\Phi_8$   | 0.13       | 0.21     | 0.62   | -0.03      | 0.31     | -0.11  |
| $\Phi_9$   | 0.70       | 0.19     | 3.67   | 1.33       | 0.34     | 3.89   |
| $\Phi_{10}$| -0.44      | 0.38     | -1.15  | -0.71      | 0.67     | -1.06  |
| $\beta$ (COVID$_it$) | -5.34 | 1.18 | -4.54 | -6.22 | 1.18 | -5.29 |
| $\psi_1$  | 0.14       | 0.34     | 0.42   | 0.95       | 0.39     | 2.45   |
| $\psi_2$  | 2.04       | 0.16     | 12.48  | 2.78       | 0.20     | 14.14  |
| $\psi_3$  | 1.23       | 0.39     | 3.15   | 1.91       | 0.64     | 2.99   |
| $\psi_4$  | 0.56       | 0.18     | 3.06   | 1.05       | 0.46     | 2.27   |
| $\psi_5$  | 0.76       | 0.33     | 2.31   | 0.08       | 0.70     | 0.12   |
| $\psi_6$  | -0.54      | 0.31     | -1.74  | -0.85      | 0.40     | -2.14  |
| $\psi_7$  | 1.11       | 0.33     | 3.42   | 1.73       | 0.46     | 3.78   |
| $\psi_8$  | -0.38      | 0.29     | -1.33  | 0.06       | 0.65     | 0.09   |
| $\psi_9$  | 0.41       | 0.28     | 1.45   | 0.15       | 0.40     | 0.36   |
| $\psi_{10}$| 2.28      | 0.24     | 9.44   | 3.44       | 0.29     | 11.76  |
| Industry Fixed Effect | Yes | Yes |
| Province Fixed Effect | Yes | Yes |
| Adj. R-square (%) | 2.10 | 1.45 |

Note: This table reports the spline regression results of the coefficient estimates, standard errors (SE), t-statistics (t-stat) and adjusted R-square. Standard errors are grouped at the province level. The regression specification is shown in Eq. (3). We use the daily return series of Main Board firms and SME/GEM firms registered in provinces other than Hubei province. The sample period is between Dec. 2th, 2019 and Feb 23rd, 2020.

Table 8
COVID-19 and cross-sectional stock returns in North China.

|            | Main Board | SME/GEM |
|------------|------------|---------|
|            | Mdl1       | Mdl2    |
|            | Coef. (×100) | SE (×100) | t-Stat | Coef. (×100) | SE (×100) | t-Stat |
| $\delta$ (PreCOVID$_it$) | -1.59 | 0.10 | -5.69 | -1.60 | 0.10 | -5.81 |
| $\beta$ (COVID$_it$) | -0.32 | 0.03 | -9.90 | -0.32 | 0.03 | 9.75  |
| $\gamma$ (PostCOVID$_it$) | 0.33 | 0.03 | 10.10 | 0.32 | 0.03 | 9.75  |
| Control Variables | Yes | Yes |
| Industry Fixed Effect | Yes | Yes |
| Province Fixed Effect | Yes | Yes |
| Adj. R-square (%) | 0.17 | 0.21 |

|            | Mdl1       | Mdl2    |
|------------|------------|---------|
|            | Coef. (×100) | SE (×100) | t-Stat | Coef. (×100) | SE (×100) | t-Stat |
| $\delta$ (PreCOVID$_it$) | -3.24 | 0.27 | -11.99 | -3.27 | 0.27 | -12.07 |
| $\beta$ (COVID$_it$) | 0.31 | 0.09 | 3.52  | 0.31 | 0.09 | 3.52  |
| $\gamma$ (PostCOVID$_it$) | 0.37 | 0.42 | 3.89  | 0.37 | 0.42 | 3.89  |
| Industry Fixed Effect | Yes | Yes |
| Province Fixed Effect | Yes | Yes |
| Adj. R-square (%) | 0.37 | 0.42 |

Note: This table reports the baseline DID regression results of the coefficient estimates, standard errors (SE), t-statistics (t-stat) and adjusted R-square. Standard errors are grouped at the province level. The regression specification is shown in Eq. (1) and Eq. (2). We use the daily return series of Main Board firms and SME/GEM firms in the North China provinces as the dependent variable. The sample period is from Dec. 2nd, 2019 to Feb. 23rd, 2021.

pattern around the event day. We also find that firms operating within provinces have an even sharper V-shaped return pattern.
Table 9
COVID-19 and cross-sectional stock returns in South China.

|                          | Main Board |                      |                      | SME/GEM |
|--------------------------|------------|----------------------|----------------------|---------|
|                          | Mdl1       | Mdl2                 |                      |         |
|                          | Coef. (×100) | SE (×100) | t-Stat | Coef. (×100) | SE (×100) | t-Stat |
| $\delta$ (PreCOVID$_{ij}$)  | −0.65 0.12  | −5.27 |        | −0.15 0.09  | −1.64 |        |
| $\beta$ (COVID$_{ijt}$)  | −6.74 1.28 | −5.28 |        | −6.94 1.40 | −4.95 |        |
| $\gamma$ (PostCOVID$_{ij}$) | 0.98 0.04 | 26.55 |        | 1.43 0.09 | 16.32 |        |
| Control Variables | Yes | Yes | | Yes | Yes |         |
| Industry Fixed Effect | Yes | Yes | | Yes | Yes |         |
| Province Fixed Effect | Yes | Yes | | Yes | Yes |         |
| Adj. R-square (%)  | 2.23 | | | 1.22 | | |

Note: This table reports the baseline DID regression results of the coefficient estimates, standard errors (SE), t-statistics (t-stat) and adjusted R-square. Standard errors are grouped at the province level. The regression specification is shown in Eq. (1) and Eq. (2). We use the daily return series of Main Board firms and SME/GEM firms in the South China provinces as the dependent variable. The sample period is from Dec. 2nd, 2019 to Feb. 23rd, 2021.

Table 10
Spline regression around the event day for North China Provinces.

|                          | Main Board |                      | SME/GEM |
|--------------------------|------------|----------------------|---------|
|                          | Coef. (×100) | SE (×100) | t-Stat | Coef. (×100) | SE (×100) |
| $\Phi_10$ | −0.09 0.59 | −0.15 | | −0.30 0.94 | −0.32 |
| $\Phi_9$ | −0.14 0.53 | −0.27 | | 0.53 0.93 | 0.57 |
| $\Phi_8$ | −0.22 0.81 | −0.27 | | −0.99 0.81 | −1.22 |
| $\Phi_7$ | −0.28 0.32 | −0.86 | | −0.12 0.94 | −0.13 |
| $\Phi_6$ | −1.62 0.62 | −2.61 | | −3.27 0.38 | −8.63 |
| $\Phi_5$ | −0.06 0.40 | −0.15 | | −0.04 0.27 | −0.16 |
| $\Phi_4$ | −0.77 0.35 | −2.24 | | −0.87 0.26 | −3.32 |
| $\Phi_3$ | 0.51 0.62 | 0.82 | | −0.56 0.17 | −3.34 |
| $\Phi_2$ | 0.71 0.44 | 1.61 | | 2.03 0.83 | 2.46 |
| $\Phi_1$ | −1.20 0.50 | −2.43 | | −2.42 0.24 | −10.10 |
| $\beta$ (COVID$_{it}$) | −1.60 0.41 | −3.94 | | −3.27 0.69 | −4.71 |
| $\psi_1$ | 0.65 0.41 | 1.58 | | 1.34 0.38 | 3.48 |
| $\psi_2$ | 1.53 0.31 | 4.92 | | 2.03 0.69 | 2.92 |
| $\psi_3$ | −0.33 0.41 | −0.82 | | −0.61 0.59 | −1.04 |
| $\psi_4$ | −0.33 0.26 | −1.27 | | −0.93 0.27 | −3.47 |
| $\psi_5$ | −0.10 0.54 | −0.19 | | −1.58 0.46 | −3.45 |
| $\psi_6$ | −1.26 0.77 | −1.65 | | −1.71 0.27 | −6.36 |
| $\psi_7$ | 0.96 0.76 | 1.25 | | 0.67 0.66 | 1.01 |
| $\psi_8$ | 0.34 0.50 | 0.69 | | 2.13 0.27 | 7.90 |
| $\psi_9$ | 0.07 0.38 | 0.18 | | −0.81 0.38 | −2.11 |
| $\psi_{10}$ | 1.48 0.46 | 3.23 | | 2.33 0.69 | 3.36 |
| Industry Fixed Effect | Yes | | | Yes | | |
| Province Fixed Effect | Yes | | | Yes | | |
| Adj. R-square (%)  | 0.67 | | | 1.25 | | |

Note: This table reports the spline regression results of the coefficient estimates, standard errors (SE), t-statistics (t-stat) and adjusted R-square. Standard errors are grouped at the province level. The regression specification is shown in Eq. (3). We use the daily return series of Main Board firms and SME/GEM firms in the North China provinces as the dependent variable. The sample period is between Dec. 2th, 2019 and Feb. 23rd, 2020.

The findings of this paper have implications for both investors and policymakers. The significant V-shaped pattern around the event day could help equity investors in risk management and investment performance. For policymakers,
Table 11
Spline regression around the event day for South China Provinces.

|        | Main Board |            |        | SME/GEM |            |
|--------|------------|------------|--------|---------|------------|
|        | Coef. (×100) | SE (×100) | t-Stat | Coef. (×100) | SE (×100) | t-Stat |
| Φ₁₀    | -3.60      | 0.74       | -4.84  | -3.51    | 0.81       | -4.33  |
| Φ₉     | -0.44      | 0.47       | -0.96  | 0.50     | 0.56       | 0.89   |
| Φ₈     | 1.52       | 0.46       | -3.30  | -0.47    | 0.59       | -0.79  |
| Φ₇     | 0.43       | 0.38       | 1.12   | 0.90     | 0.44       | 2.05   |
| Φ₆     | -0.26      | 0.19       | -1.42  | 0.86     | 0.75       | 1.14   |
| Φ₅     | -0.64      | 0.16       | -4.01  | -0.07    | 0.20       | -0.35  |
| Φ₄     | -0.81      | 0.35       | -2.31  | -0.70    | 0.43       | -1.62  |
| Φ₃     | -0.19      | 0.16       | -1.20  | 0.01     | 0.33       | 0.04   |
| Φ₂     | 0.66       | 0.20       | 3.31   | 1.02     | 0.21       | 4.80   |
| φ₁     | -0.11      | 0.16       | -0.73  | -0.08    | 0.26       | -0.31  |
| β (COVIDₙ) | -6.77     | 1.27       | -5.31  | -6.94    | 1.40       | -4.95  |
| Ψ₁     | -0.11      | 0.40       | -0.29  | 0.73     | 0.41       | 1.79   |
| Ψ₂     | 2.19       | 0.16       | 13.33  | 2.99     | 0.21       | 14.58  |
| Ψ₃     | 2.01       | 0.25       | 8.08   | 2.90     | 0.18       | 16.00  |
| Ψ₄     | 0.98       | 0.08       | 12.46  | 1.88     | 0.15       | 12.81  |
| Ψ₅     | 1.10       | 0.29       | 3.75   | 0.68     | 0.39       | 1.73   |
| Ψ₆     | -0.13      | 0.22       | -0.61  | -0.40    | 0.47       | -0.84  |
| Ψ₇     | 1.18       | 0.31       | 3.79   | 2.08     | 0.35       | 6.03   |
| Ψ₈     | -0.63      | 0.24       | -2.60  | -0.70    | 0.28       | -2.50  |
| Ψ₉     | 0.55       | 0.36       | 1.53   | 0.48     | 0.42       | 1.12   |
| Ψ₁₀    | 2.47       | 0.31       | 7.84   | 3.63     | 0.34       | 10.71  |

Industry Fixed Effect | Yes | Yes |
Province Fixed Effect | Yes | Yes |
Adj. R-square (%) | 3.32 | 1.85 |

Note: This table reports the spline regression results of the coefficient estimates, standard errors (SE), t-statistics (t-stat) and adjusted R-square. Standard errors are grouped at the province level. The regression specification is shown in Eq. (3). We use the daily return series of Main Board firms and SME/GEM firms in the South China provinces as the dependent variable. The sample period is between Dec. 2th, 2019 and Feb 23rd, 2020.

the empirical result suggests that governments should anticipate such return patterns on the equity market when there are COVID-19 outbreaks in a province. The negative effects of COVID-19 outbreaks are an exogenous shock for firms and will recover in later periods when the epidemic is under control. Thus, corresponding policies, such as, short-term financial aid for affected firms, should be made to stabilize the market.

We recognize that we do not provide an explicit explanation for the V-shaped return pattern. Future research should investigate the specific effect of infection prevention measures, investor overreactions, and economic policies during a pandemic period.

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