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The impact of operating flexibility on firms’ performance during the COVID-19 outbreak: Evidence from China

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ABSTRACT

This paper investigates the effect of firm-level operating flexibility on stock performance during the COVID-19 outbreak in China. We find that firm-level operating flexibility is significantly positively correlated with the cumulative abnormal stock returns that occurred during the event window, and this positive relation is more pronounced in firms in the provinces most affected by the epidemic. This positive relation is also more obvious in firms that have relatively fewer fixed assets. Therefore, our results provide direct empirical evidence that the real options embedded in operating flexibility played an important role during the COVID-19 outbreak.

1. Introduction

In recent months, the novel coronavirus (COVID-19) has spread fear and anxiety among people and has had a severe impact on world economic activities. The initial impact on global financial markets, a loss in market value of greater than 30%, was as near to collapse as the markets were during the financial crisis of 2008 (GFC) (Georgieva, 2020; Sharif et al., 2020; Shehzad et al., 2020). The financial volatility index (VIX), known as the ‘fear gauge,’ moved to the uppermost level, even higher than it was during the GFC era (Leduc and Liu, 2020). According to scholars, although the long-lasting and exact effects of COVID-19 on economic wealth are not yet clear (Goodell, 2020; McKibbin and Fernando, 2020), financial markets have already responded with dramatic movements\textsuperscript{1}.

Due to the transmission patterns and mortality rate of COVID-19, future economic outcomes are highly uncertain (Baker et al., 2020; Leduc and Liu, 2020), making projections of the future cash flows of corporations highly unpredictable. Thus, a sudden shift in investment and consumption patterns has emerged. However, certain industry groups, especially those associated with more operating flexibility, have reported fewer impacts than those of others that have less operating flexibility. Some industry groups have virtually stopped operating (e.g., transportation, hotels and restaurants, retailing, and entertainment), while others have been using existing capacity to achieve transformation while they operate to meet basic needs (e.g., essential consumption goods, medical devices and pharma, and online services).

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\textsuperscript{1} Some studies map the markets’ reactions to coronavirus news (Cepoi, 2020; Zaremba et al., 2020), and the general patterns of both country-specific and systemic risks in the financial markets (Zhang et al., 2020). Other studies have explored financial contagion effects and their implications for portfolio design (Akhtaruzzaman et al., 2020; Okorie and Lin, 2020) and the probable elevated systemic risk of vulnerabilities in financial systems (Rizwan et al., 2020).

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This information intimates at the importance of considering firm characteristics when exploring COVID-19’s impact on financial markets. Is the difference in impact attributable to the operational flexibility of some firms, or does it have something to do with adjusting costs on the production line? To the best of the authors’ knowledge, firm-level evidence that considers differences in firm characteristics during epidemic diseases is very limited. One exception is the work of Corbet et al. (2020), who indicate that companies whose names or products include the term “corona” have suffered more severely. This research sets out to establish how this flexibility is manifested. Recently, a growing body of empirical and theoretical studies has focused on understanding the role of inflexibility as a determinant of firms’ risks and expected returns (Gu et al., 2018; Kim and Kung, 2017). Recent widespread pandemics are unfortunate but unique natural experiments and offer a rare opportunity to assess the reaction dynamics of firms’ performance relative to inflexibility.

This study contributes to the literature in at least two important ways. First, unlike existing studies focusing on an aggregate-level sample in one country or a country-level sample globally, we contribute to the recently emerging literature by investigating the stock market’s reaction to coronavirus news at the firm level in China, which is where the virus was first detected. By employing event analysis, we show that stock markets exhibit asymmetric dependencies with COVID-19-related information. Specifically, fake news exerts a positive influence on firms that possess operating flexibility, and the effect is more pronounced in firms with relatively fewer fixed assets and in areas where the impacts on firms have been more severe. Second, we contribute to the studies on the value of flexibility in response to extreme disasters and crises. Despite substantial theoretical literature on flexibility or redeployability, relatively little attention has been paid to testing important cross-sectional behaviors during market extremes. Our paper is also related to the work of Gu et al. (2018) and Kim and Kung (2017), who examine the average relation between uncertainty and corporate performance under varying degrees of asset redeployability. We complement their studies by examining firms’ performance in response to the COVID-19 pandemic across a range of operating flexibility.

2. Data and methodology

We use all the Chinese A-share listed companies on the Shanghai and Shenzhen stock exchanges as initial samples. Following standard sample screening procedures, we exclude some firms: i) firms in the financial industry; ii) firms in the pharmaceutical manufacturing industry, since firms in this industry experience positive market reactions to COVID-19 news; iii) firms with negative book value of equity and firms with missing values for control variables; iv) firms that have traded for fewer than 210 days prior to the event day. We winsorize all variables at the 1% and 99% tails of the distributions and finally obtain 3,412 observations. All data and variables are obtained from the China Stock Market & Accounting Research database. Since the annual reports of 2019 had not yet been disclosed on the event day, the relevant financial data are calculated using the reports for the third quarter of 2019.

The choice of event day is very important for our research. We choose the day when the city of Wuhan was locked down, that is, January 23, 2020. The reasons for choosing this time point are summarized as follows. First, the lockdown of a city, which has severe negative consequences for people’s lives and economic activities, is rare in the history of New China. Before the lockdown of Wuhan, only one similar event had been recorded in Chinese history, the closure of Wenchuan in 2008 in response to the Wenchuan earthquake. Based on that recent episode, the economic slowdown and extreme panic were well anticipated. Second, Wuhan is one of the largest and most important cities in China. Its population, more than 11 million people, ranks fourth in China. It is the central city in the middle area of China, which has the transportation systems of a world-class megacity. The high-speed rail network radiates over half of China, and 53 overseas routes fly directly to four continents. It is also the largest waterway and air transportation hub in inland China with its shipping center in the middle reaches of the Yangtze River. The lockdown, beyond all doubt, has caused a significant shock to public and economic activities. Third, January 23, 2020, was exactly one day before the most celebrated Chinese holiday, the Lunar New Year, which includes many events and celebrations that provide spiritual support for people yearning for the eternal promises of happiness and best wishes in life. Consequently, the Chinese stock market was severely hit by the lockdown of Wuhan. On February 3, 2020, the first trading day after the lockdown of Wuhan, the Shanghai Composite Index fell by 7.72%, which is the greatest crash since the second half of 2008. Although the lockdown of a city is an aggressive policy, the spread of COVID-19 was quickly brought under control in China. Since then, China’s economy has made a vigorous recovery. Therefore, we believe that Wuhan’s lockdown is a truly significant shock to the public and should necessarily carry meaningful economic implications for the Chinese stock market. January 23, 2020, is the start of the key event window for the stock market as it faced the lockdown caused by the COVID-19 pandemic, and it is important for researchers to understand the consequences of the market reactions in a reasonable way, which offers a powerful opportunity to measure possible links between operating flexibility and stock returns in a direct and convincing manner.

To investigate stock market reactions to the announcement of the lockdown, we follow the standard literature and calculate the abnormal return of each stock based on the market model,

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2 See for example, Azimli (2020), Goodell and Huynh (2020), Mazur et al. (2020), etc.
3 See for example, Akhtaruzzaman et al. (2020), Ashraf (2020), Okorie and Lin (2020), Zaremba et al. (2020), Zhang et al. (2020), etc.
4 The Chinese stock market was closed from January 24 to February 2, 2020, the dates of the Chinese New Year.
5 Though there are some comparatively important dates worldwide related to the COVID-19 pandemic (https://fraser.stlouisfed.org/timeline/covid-19-pandemic), they have little impact on China’s stock market. The biggest drop in the Shanghai Composite Index since Wuhan’s lockdown is still less than half that of the first trading day after the lockdown of Wuhan. Therefore, we do not include these datasets when measuring possible links between operating flexibility and stock returns.
\[ AR_{it} = R_{it} - \bar{a}_i - \hat{\beta}_i R_{M,t} \]  
(1)

where \( R_{it} \) represents the return of stock \( i \) in day \( t \). \( R_{M,t} \) represents the market return, which is equal to the value-weighted average of all stocks in day \( t \). Moreover, alpha (\( \bar{a}_i \)) and beta (\( \hat{\beta}_i \)) are estimated by a total of 200 trading days from March 20, 2019, to January 9, 2020. After calculating the abnormal returns, we calculate the cumulative abnormal returns (CAR[-1,0]) from 1 day prior to the event day as the measure of the change in stock prices.

Following Gu et al. (2018), the standardized firm-level inflexibility, \( \text{INFLEX} \), is defined as a firm’s historical range of operating costs over sales scaled by the volatility of the logarithm of changes in sales over assets. Specifically, the computation for firm \( i \) in year \( t \) is as follows:

\[
\text{INFLEX}_{it} = \frac{\text{max}_0^t \left( \frac{\text{OPC}}{\text{Sales}} \right) - \text{min}_0^t \left( \frac{\text{OPC}}{\text{Sales}} \right)}{\text{std}_0^t \left( \Delta \log \left( \frac{\text{Sales}}{\text{Assets}} \right) \right)}
\]
(2)

\[
\text{max}_0^t \left( \frac{\text{OPC}}{\text{Sales}} \right) - \text{min}_0^t \left( \frac{\text{OPC}}{\text{Sales}} \right) \text{ is the range of a firm's quarterly operating costs over sales for the period from year 0 to year } t, \text{ and std}_0^t \left( \Delta \log \left( \frac{\text{Sales}}{\text{Assets}} \right) \right) \text{ is the standard deviation of the quarterly growth rate of sales over total assets for the period from year 0 to year } t. \text{ Year 0 is the firm’s beginning year, that is, 2002, when it releases its quarterly financial report in China. We take the opposite of } \text{INFLEX} \text{ and obtain the corporate operating flexibility, } \text{FLEX}.
\]

To test the impact of \( \text{FLEX} \) on corporate market values, we employ the following OLS regression:

\[
\text{CAR}[-1,0]_i = \beta_0 + \beta_1 \text{FLEX}_i + \beta_2 \text{Size}_i + \beta_3 \text{BM}_i + \beta_4 \text{INV}_i + \beta_5 \text{ROA}_i + \beta_6 \text{Lev}_i + \beta_7 \text{Ivol}_i + \sum \text{Industry} + \epsilon_i
\]
(3)

Eqn 3 where \( \text{CAR}[-1,0] \) is the cumulative abnormal return. \( \text{Size} \) is firm size, which is defined as the logarithm of the market value of equity, \( \text{BM} \) is the book-to-market ratio, which is defined as the logarithm of the book value of equity scaled by the market value of equity. \( \text{INV} \) indicates the ratio of investments to assets, which is defined as the change in gross property, plant, and equipment plus the change in inventories divided by lagged total assets. \( \text{ROA} \) is return on assets, expressed as net profits divided by total assets. \( \text{Lev} \) is financial leverage adjusted by cash holdings, which is defined as total liabilities minus corporate cash holdings and then divided by total assets. \( \text{Ivol} \) is the idiosyncratic return volatility, which is defined as the standard deviation of the residual estimated from the Fama–French three-factor model by regressing daily return data. Huo and Qiu (2020) find that the pandemic lockdown of \( \text{Wuhan} \) affected various industries differently. Therefore, we add industry fixed effects to control for industry differences.

3. Empirical results

3.1. Univariate portfolio analysis results

First, we conduct a univariate portfolio analysis on the relationship between operating flexibility and cumulative abnormal stock returns (CAR[-1,0]). We sort the whole sample into two groups based on the median of the corporate operating flexibility of all firms: a high-operating-flexibility group that contains firms with higher-than-median operating flexibility, and a low-operating-flexibility group that contains firms with lower-than-median operating flexibility. Table 1 presents the mean value of the cumulative abnormal returns for these two groups. The cumulative abnormal return for the high-operating-flexibility group is significantly higher than that for the low-operating-flexibility group. The return for the high–low hedge portfolio is 0.24% per day and 12.48% per annum, with a \( t \)-statistic of 2.026. This result confirms that firms with high operating flexibility experience a more positive market response when facing the impact of COVID-19.

3.2. Regression results

Table 2 further shows the regression results based on Equation (3). Column (1) does not control for industry effect and the other firm-level determinants. Column (2) controls for industry effect but does not control for the other firm-level determinants. Column (3) controls for both the industry effect and the other firm-level determinants. From Columns (1) to (3), we can see that operating flexibility has a significantly positive effect on cumulative abnormal stock returns. These results are consistent with the results of portfolio analysis.

Considering that the impact of epidemic shocks in different provinces is not the same, operating flexibility may be more valuable in regions with severe shock. We use the number of people who moved from \( \text{Wuhan} \) to the province 10 days before the closure of the city to measure the degree of infection in the province and divide the provinces into two groups according to the number of moved from \( \text{Wuhan} \). Specifically, the companies located in the Hubei, Henan, Hunan, Anhui, Jiangxi, Guangdong, Jiangsu, Sichuan, Chongqing and Shandong provinces\(^6\) would be classified as the severe-shock group; others are classified as the light-shock group. Comparing Columns
(4) and (5), we can see that the positive effect of operating flexibility on cumulative abnormal returns appears only in provinces with severe shock, which confirms the important role of operational flexibility when companies face negative shocks.

Companies with relatively fewer fixed assets (light assets) can respond to shocks easily with small adjustment costs. Companies with relatively more fixed assets (heavy assets) may encounter higher adjustment costs. As a result, the value of operating flexibility may be offset by the high adjustment costs associated with more fixed assets in a firm’s asset composition. Therefore, we divide the samples into two groups according to the median of the fixed asset ratio (net fixed assets scaled by total assets). We define companies whose fixed asset ratio is more than the median as the "heavy assets" group, while others are defined as the "light assets" group.

Comparing Columns (6) and (7), we can see that the positive effect of operating flexibility on cumulative abnormal returns exists only for firms with "light assets," which supports the hypothesis.

### 3.3. Robust tests

Before Wuhan’s lockdown, there was another important news item about COVID-19. On January 20, 2020, Professor Nanshan Zhong, one of the most respected scientists in China and well known for his discovery of SARS in 2003, announced that the new coronavirus has human-to-human characteristics. Since Professor Zhong is the leader of the high-level expert group of the National Health Commission of China, the announcement could constitute a significant public news shock because his statement represents official speech. Therefore, the capital markets may have begun to react on January 21, 2020. To address this problem, we also calculate cumulative abnormal stock returns from January 21, 2020, to the event day, which is the day that Wuhan was locked down. The results are shown in Table 3. It can be seen that all the results are robust.

### 4. Conclusion

The sudden outbreak of COVID-19 has seriously affected the normal production and operating activities of firms and has induced a massive shock on financial markets. This paper finds that firms with high operating flexibility have better stock performance than those with lower operating flexibility because of the risk hedge value of contraction options embedded in firm operating flexibility. Further results show that the hedge value is more pronounced for firms in provinces experiencing severe shock and in firms with fewer fixed assets. Our paper emphasizes the important role of firm-level operating flexibility in facing major negative shocks.

### CRediT authorship contribution statement

**Hao Liu:** Software, Validation, Data curation, Methodology, Formal analysis, Writing - original draft. **Xingjian Yi:** Supervision,
Project administration, Funding acquisition. Libo Yin: Conceptualization, Investigation, Resources, Writing - review & editing.

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Supplementary materials

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Table 3
Robustness checks using CAR[-2, 0] as an independent variable.

| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|-----|-----|-----|-----|-----|-----|-----|
| **FLEX** | 0.009*** | 0.006* | 0.008** | 0.012** | 0.004 | 0.010* | 0.007 |
| | (2.779) | (1.684) | (2.174) | (2.015) | (0.915) | (1.904) | (1.403) |
| **Size** | 0.001 | 0.002 | 0.000 | 0.000 | 0.001 | 0.001 |
| | (1.228) | (1.314) | (0.144) | (0.740) | (0.652) |
| **BM** | -0.004*** | -0.005** | -0.004** | -0.005*** | -0.005** | -0.003 |
| | (-3.169) | (-2.311) | (-1.985) | (-2.625) | (-1.612) |
| **ROA** | -0.052*** | -0.056** | -0.049*** | -0.013 | -0.095*** |
| | (-3.690) | (-2.565) | (-2.694) | (-0.618) | (-4.882) |
| **INV** | 0.016 | 0.054 | -0.024 | 0.065 | -0.022 |
| | (0.531) | (1.237) | (-0.578) | (1.298) | (-0.586) |
| **Lev** | -0.000 | -0.002 | 0.001 | -0.001 | 0.000 |
| | (-0.416) | (-1.586) | (0.835) | (0.688) | (0.030) |
| **Ivol** | -0.355*** | -0.242 | -0.429*** | -0.485*** | -0.185 |
| | (-3.098) | (-1.464) | (-2.720) | (-1.611) | (-1.073) |
| **Industry effect** | NO | YES | YES | YES | YES |
| | 0.003** | -0.035*** | -0.052*** | -0.088*** | -0.046* |
| | (2.296) | (-5.352) | (-2.589) | (-2.675) | (-1.969) |
| **Constant** | 3,201 | 3,201 | 3,201 | 1,624 | 1,577 | 1,593 | 1,608 |