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Firms’ COVID-19 Pandemic Exposure and Corporate Cash Policy: Evidence from China

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Abstract

The COVID-19 pandemic adversely impacted economic activity, decreased corporate revenues, and magnified cash flow fluctuations. We study how Chinese listed firms’ COVID exposure influences their cash holdings. A firm’s COVID exposure is measured by its excess stock return responses to globally newly infected cases while controlling for market return. Firms increase (decrease) cash balances when their stock returns fall (increase) with COVID severity due to precautionary motives. Firms cannot predict the evolution of the pandemic, which impacts demand and supply and the cash conversion cycle. The deteriorating business condition also increases external financing costs with non-state-owned, low-growth, small, and firms without overseas businesses facing higher financial frictions. Furthermore, firms with good corporate governance tend to pre-empt operational uncertainty by increasing cash holdings. The increased cash holdings translate to more R&D expenditure but lesser capital investment. Our results remain robust to placebo tests, using excess cash and alternative COVID exposure measures.

1. Introduction

The COVID-19 pandemic has triggered a worldwide crisis that significantly curtailed global economic activity (Bernanke, 2020) and caused massive stock price movements (Ding et al., 2021), resulting in an acute increase in market risk aversion that matches the global financial crisis. In addition, countries worldwide have adopted disease containment measures that destabilised the world’s supply chain, impacting industries’ demand and supply. Facing this unprecedented shock, firms’ corporate revenues have been adversely affected, and their cash flow fluctuations magnified. To this end, this paper investigates how firms manage their corporate cash holding when exposed to the pandemic.

Firms’ exposure to the pandemic can have two opposing effects on cash holding. On the one hand, the precautionary motive of cash holding predicts that firms will likely increase cash holding when exposed to the pandemic. As epidemic diseases are unpredictable, managers cannot predict the evolution, severity, and duration they last. As a result, firms’ exposure to the pandemic could negatively impact the supply of intermediate goods and the demands for final goods, affecting the duration...
of the cash conversion cycle. In response, firms might increase their cash balances to hedge against cash flow fluctuations.

On the other hand, the stock market turmoil caused by the pandemic and the deteriorating market conditions could heighten uncertainty and increase financial frictions for corporate managers. Uncertainty increases the real option values of investment, making firms more cautious when investing (Bloom et al., 2007); thus, firms may not hold as much cash for investment. However, firms envisage that external financing costs in future states will rise, leading to inefficient investment caused by insufficient liquidity. Therefore, in anticipation, firms may increase their cash holding when exposed to the pandemic. The overall effect of firms’ exposure to the pandemic on their cash holding stemming from precautionary motives, uncertainty and financial frictions is hard to predict theoretically; hence this is addressed empirically.

For two reasons, we study a large sample of 3924 listed firms in China for 2020Q1-2021Q1. First, the coronavirus outbreak started in Wuhan, China, in December 2019, followed by a lockdown of Wuhan in January 2020. The initial COVID-19 lockdown threatened Chinese enterprises in the first quarter of 2020; tens of millions of small and medium-sized enterprises (SMEs) were shut down (Dai et al., 2021). China’s economy has been steadily recovering through economic recovery policies and pandemic-related restrictions. As the world’s second-largest economy, China presents an interesting case study to empirically test the overall effect of firms’ exposure to the pandemic on their cash holding. Secondly, China has continued to enforce the COVID-Zero policy with draconian lockdowns and strict quarantine measures (Fang et al., 2020). Travel bans and lockdown measures have impacted the tourism and hospitality industries the most. In addition, the retail sector has also been adversely affected, with many shopping malls subject to COVID-19-related restrictions, including a reduction in store operating hours, temporary closures, and cancellation of events. Under China’s COVID-Zero policy, these measures may continuously impact firms’ operations and cash holding policies.

Recognising that not all firms are exposed to the pandemic equally and negatively, we measure the firms’ exposure to the pandemic (i.e., COVID exposure, henceforth) by the slope coefficient of a linear regression of the firm’s risk-free adjusted stock returns on the pandemic severity measure while controlling for market returns. For firms that are negatively (positively) impacted by the pandemic, the slope coefficient is negative (positive) and statistically significant. We then perform the baseline regression of firms’ cash holding on firms’ COVID exposure with various control variables as previously suggested in cash holding determinants literature. The results reveal a negative association between the firms’ COVID exposure and cash holding. Firms whose stock returns respond negatively to pandemic severity increase corporate cash holding. However, firms whose stock returns respond positively to pandemic severity decrease their cash holding. Our results remain robust after controlling for firm and quarterly time-fixed effects. The results support precautionary motives and financial frictions that increase cash holding amongst firms with a harmful COVID exposure.

To understand how firms’ COVID exposure influences their cash holding, we examine their financial frictions and corporate governance. Specifically, firms’ financial frictions are captured through the firms’ state ownership status, growth, size and overseas business diversification. We find that their cash holding increases when the pandemic severity adversely impacts their stock returns for non-state-owned firms, low-growth and small firms, and firms without overseas business. These results also suggest that firms increase cash holding for precautionary motives, especially when financial frictions peak. In addition, we find that firms’ COVID exposure significantly influences their cash holding when firms exhibit good corporate governance (i.e., firms have high board independence, no CEO-Chairman duality and low institutional ownership). These results suggest that the link between firms’ COVID exposure and cash holding could stem from operational uncertainty during the pandemic, leading firms with good corporate governance to take pre-emptive measures by retaining cash to hedge against the effects of pandemic shocks on cash flows.

Finally, we shed light on how firms use cash holding in the pandemic. We investigate whether the increased cash holding translates to increased investment for firms whose stock returns are negatively impacted by the pandemic. The high cash holdings during the pandemic are associated with less capital investment consistent with the prediction of the real option value of an investment in times of high uncertainty. Instead, the higher cash holding is associated with more R&D expenditure.

The baseline regression results remain robust when performing a battery of robustness tests. Should firms’ COVID exposure stems from unobserved firm characteristics associated with high cash holding in the pre-pandemic period, our results may be subject to endogeneity bias. Therefore, we conduct a placebo test examining the link between firms’ COVID exposure and pre-pandemic cash holding. We do not find a significant association between them, suggesting that firms’ cash holding policy is based on their COVID-19 pandemic exposure. Second, we study firms’ COVID exposure and excess cash to study the level of cash holding adjustment in the pandemic period. Using the predicted value of cash holding in the most recent pre-pandemic quarter (i.e., 2019Q4), we define a firm’s excess cash as the difference between its real cash holding and the benchmark. Firms whose stock returns fall (increase) with pandemic severity hold higher (lower) excess cash, corroborating our baseline results.

Next, we obtain a more stringent measure of firms’ COVID exposure by incorporating the Fama-French three-factor model, the Carhart four-factor model, and the Fama-French five-factor model, in addition to the market model. Based on this stringent firms’ COVID exposure measure, we re-estimate the baseline regression and find the results remain qualitatively unchanged. Finally, to alleviate concerns that firms’ COVID exposure is not endogenously determined by firms’ pre-pandemic financial conditions, we undertook t-tests for equality of firms’ COVID exposure between high and low firms’ pre-pandemic characteristics and corporate governance, comprising cash holding, return on equity (ROE), return on assets (ROA), financial constraint, institutional ownership, board independence, and CEO-chairman duality. Firms’ COVID exposures are not significantly different from each other between any pair of high and low firms’ characteristics, indicating that firms’ COVID exposure is unlikely to stem from pre-pandemic financial conditions and corporate governance measures.

This study contributes to the literature in the following ways. First, we advance our understanding of the drivers of corporate cash policies. Prior studies document that firms with more considerable aggregate risk tend to hold more cash (Acharya et al., 2013), and non-operational cash protects against future negative cash flow shocks in recessions (Lins et al., 2010). We show that firms’ exposure to the COVID-19 pandemic has predictive power on corporate cash holding during the pandemic crisis. This study also sheds new light on how firms’ COVID exposure may influence corporate cash policies.

Second, like many studies on the ongoing COVID-19 pandemic, our study has shown significant policy relevance. Firms’ COVID exposure will likely influence their refinancing frictions, ultimately influencing
corporate strategy. The Chinese government can learn about the companies’ concerns and design appropriate policies to ease the firms’ refinancing costs. For instance, the government could formulate preferential policies for bank loans, tax cuts, and fee reductions according to firms’ pandemic exposure to help them maintain sufficient cash holding for business operations and overcome increased financial frictions. In addition, government subsidies or bailouts should be granted to firms adversely affected by the COVID-19 pandemic. The conclusions drawn from this research are also relevant and applicable to many economies facing stringent restrictions and travel bans to control the disease spread, which in turn affect corporate cash flows.

Third, our contribution lies in constructing a firm-level pandemic exposure based on individual firms’ stock price responses to the severity of the pandemic spread. Hassan et al. (2021) use a new word pattern-based method to measure U.S. firms’ primary concerns over epidemic diseases spread communicated in their quarterly earnings conference calls. In the absence of data on firms’ quarterly earnings conference calls, our method is sufficiently general to appropriately capture the extent of a firm’s exposure to the COVID-19 pandemic over time. This approach, as we show in this paper, yields a robust COVID exposure measure that enables the study of corporate policy responses during the pandemic.

The rest of the paper is structured as follows. Section 2 describes the data, sample, and variables. Section 3 shows our baseline findings together with robustness tests. Section 4 explores how firms’ pandemic exposure influences corporate cash holding. Section 5 provides evidence on the link between pandemic period cash holding and investments. Finally, we conclude the paper in Section 6.

2. Data, sample, and variable construction

2.1. Data and sample

We use the China Stock Market and Accounting Research (CSMAR) database to retrieve stock price and firm characteristics data. In addition, we utilise the pandemic data from the Center for Systems Science and Engineering at Johns Hopkins University to obtain global and country-level daily new confirmed COVID-19 cases. Our initial sample includes all firms listed on the Shanghai and Shenzhen Stock Exchanges from 2020 to 2021. After excluding firms in financial sectors and special treatment (ST) firms and winnowing all continuous variables at the 1% and 99% levels, in our final sample, we have 3,924 firms with 18,058 firm-quarter observations.

2.2. Variable construction

Our key variable of interest is the firms’ pandemic exposure, which measures the sensitivity of a firm’s daily stock return to the COVID-19 pandemic spread. The spread of the COVID-19 pandemic is defined as the increased newly confirmed global COVID-19 cases. For each day from January 22, 2020 to March 31, 2021, we use the country-level COVID-19 daily reported new confirmed cases and aggregate the number from each country to obtain the global number. Motivated by the literature that measures exchange rate exposure (Jorion, 1990), we calculate a firm’s COVID-19 exposure using the regression shown in Eq. (1). In each quarter, we use the daily data to run the following regression:

\[ R_t = \alpha + \beta COVID_t \times COVID + \gamma_{Mt} + \delta_t + \tau_t + \epsilon_{it} \]  

where \( R_t \) is a firm’s daily stock return (over the risk-free rate), \( COVID_t \) is the increased number of confirmed global COVID-19 cases, and \( \gamma_{Mt} \) is the daily value-weighted market return. The coefficient \( \beta COVID_t \) is the firm’s \( COVID \) Exposure captured by the firm’s stock return response to the evolving pandemic severity after controlling for market return. A positive (negative) \( COVID \) Exposure, denoted by \( \beta COVID_t > 0 \) (<0), represents the firm’s stock returns respond (un)favorably to the pandemic severity in terms of increased confirmed cases. For a typical firm, \( COVID \) Exposure is predicted to be harmful because of deteriorating market conditions due to the pandemic and as the stock market reacts adversely to the increasing number of COVID-19 cases. However, for firms that operate in pharmaceutical or vaccine development industries, their \( COVID \) Exposure (i.e., \( \beta COVID_t > 0 \)) could be positive, indicating that firms are rewarded based on business activities that alleviate pandemic uncertainty.

2.3. Summary statistics

The descriptive statistics for our main variables are presented in Table 1a. Panel A reports the summary statistics for our dependent variable of interest, i.e., cash holding (ratio of cash to total assets). Panel B presents the summary statistics for our primary explanatory variable, \( COVID \) Exposure. Panels C and D present the descriptive statistics of the control variables. Panel A shows that our sample firms’ median value of cash holding is 11.2%. The 90th and 10th percentiles of cash holding are 3.3% and 29.6%, respectively, indicating significant differences in cash holding across our sample firms. The results in panel B show that the 10th and 25th percentiles of \( COVID \) Exposure are negative, while the 75th and 90th percentiles are positive, suggesting that there is significant heterogeneity in the firms’ stock returns responses to the daily new confirmed COVID-19 cases worldwide. The correlation matrix of the main variables is reported in Table 1b. It shows that none of the correlations between explanatory variables is high enough to cause collinearity concerns for our multivariate analysis.

3. Main findings

3.1. The baseline regression

We estimate the following baseline model in Eq. (2) to examine the relation between COVID exposure and corporate cash holding:

\[ Cash_{it} = \alpha + \beta COVID Exposure_{it} + \sum_{n=1}^{N} \gamma_n X_{it} + \delta_t + \tau_t + \epsilon_{it} \]  

where \( Cash_{it} \) is the cash holding (cash scaled by total assets) of firm \( i \) in quarter \( t \). The key explanatory variable, \( COVID Exposure_{it} \), is the measure of firms’ \( COVID \) pandemic exposure. \( X_{it} \) represents a group of control variables. Following Gao et al. (2013) and Liu et al. (2015), we control for firm characteristics that influence a firm’s cash holding. These control variables comprise firm size, age, leverage, return on assets (ROA), sales growth, Tobin’s \( Q \), cash flow, total risk, board independence, CEO duality and institutional ownership. Definitions of all the variables are provided in Appendix A. Firm and time fixed effects are also included to control for the influence of time-invariant firm characteristics and business cycles.

Table 2 reports the results of our baseline regression. We observe that a lower \( COVID \) exposure is associated with higher cash holding. Specifically, in column (1), we regress cash holding on \( COVID \) exposure with quarterly time and firm fixed effects. In column (2), we incorporate a set of control variables in the regression as documented in cash holding literature. The coefficients on \( COVID \) Exposure are negative and statistically significant at the 1% level in both specifications. For firms with

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Footnote: 8 This method is also employed by PásTor and Veronesi (2013), who consider the political uncertainty as a risk factor that impacts the market systematically. In the robustness analyses, we include \( R_{Mt} \), \( SMB_t \), \( HML_t \), and \( UMD_t \) in the model to estimate \( \text{ThreeFactor}_t \) \( COVID_t \) Exposure; We include \( R_{Mt} \), \( SMB_t \), \( HML_t \), and \( UMD_t \) in the model to estimate \( \text{FourFactor}_t \) \( COVID_t \) Exposure; We include \( R_{Mt} \), \( SMB_t \), \( HML_t \), \( RMW_t \), and \( CMA_t \) in the model to estimate \( \text{FiveFactor}_t \) \( COVID_t \) Exposure.
positive (negative) COVID exposure (i.e., their stock returns respond positively (negatively) to the pandemic severity), they reduce (increase) their cash holdings. In terms of economic magnitude, the coefficient on COVID Exposure is –0.10 in column (1), suggesting that a 1% increase in positive (negative) COVID Exposure would lead to a 0.1% decline (increase) in the cash holding ratio. The coefficient on COVID Exposure is approximately 0.07% in column (2) after controlling for firm characteristics. Given our sample’s average firm size of 4.791 billion yuan, the 0.1% change in cash holding ratio is equivalent to an average increase or decrease of 4.791 million yuan in cash holding depending on the sign of the COVID Exposure.9

The consistently significant coefficients on COVID Exposure in both regressions underline the importance of firm-specific COVID-driven uncertainty in shaping corporate cash policies. In addition, we also observe the sign of the coefficient estimates on control variables are consistent with the literature. Large firms and firms with greater sales growth, stock return volatility, and cash flow hold more cash during the pandemic, while firms with higher leverage, ROA, and Tobin’s Q hold lower cash during the same period.

The results in Table 2 show that a firm’s COVID Exposure significantly negatively affects its cash holding during the pandemic. Next, we conduct four groups of tests to address the endogeneity concern: the placebo test, excess cash holding analysis, COVID exposure measures with alternative factor models, and difference test for COVID exposure in firms with various pre-pandemic conditions.

3.2. Robustness tests

3.2.1. Placebo test for endogeneity bias

The results presented in the previous section may be fraught with endogeneity concerns as firms’ COVID exposure may stem from

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9 To exclude the impact from industry wide characteristics, in untabulated tables, we replace firm fixed effect with industry fixed effect and find our baseline results remain unchanged.
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Table 2
COVID exposure and corporate cash holdings.

| Dep. Variable – Cash holdings | (1) | (2) |
|-------------------------------|-----|-----|
| **Covid Exposure**            | -0.100*** | -0.073*** |
| (0.000)                       | (0.005) |
| **Firm size**                 | 0.038*** | (0.000) |
| **Leverage**                  | -0.131*** | (0.000) |
| **ROA**                       | -0.106*** | (0.000) |
| **TobinQ**                    | -0.005*** | (0.000) |
| **Sales growth**              | 0.001**  | (0.015) |
| **Firm age**                  | 0.019    | (0.451) |
| **Sigma_ret**                 | 0.116*   | (0.052) |
| **CF**                        | 0.303*** | (0.000) |

Quarter FE Y Y Y Y
Firm FE Y Y Y Y
Observations 18,058 17,590
Adj R² 0.033 0.097

Notes: This table shows the estimated results of regressing cash holdings on COVID exposure and firms' characteristics. Each regression contains firm fixed effects and quarterly time fixed effects. Standard errors are clustered by firm, and the p values are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 3
COVID exposure and corporate cash holdings (placebo test).

| Dep. Variable – Cash holdings in 2018 | Cash holdings in 2019 |
|---------------------------------------|-----------------------|
| (1)                                   | (2)                   |
| COVID Exposure                       | 0.043                 | -0.040|
| (0.171)                               | (0.111)               |
| Firm size                             | 0.004                 | 0.010|
| (0.737)                               | (0.403)               |
| Leverage                              | -0.070***             | -0.029|
| (0.007)                               | (0.345)               |
| ROA                                   | -0.082***             | -0.100***|
| (0.005)                               | (0.001)               |
| Tobin’s Q                             | 0.002                 | 0.002|
| (0.445)                               | (0.403)               |
| Sales growth                          | 0.002*                | 0.001|
| (0.086)                               | (0.319)               |
| Firm age                              | 0.013                 | 0.033|
| (0.631)                               | (0.218)               |
| Total risk                            | 0.003                 | -0.134*|
| (0.968)                               | (0.099)               |
| Cash Flow                             | 0.407***              | 0.389***|
| (0.000)                               | (0.000)               |
| Quarter FE                            | Y                     | Y     |
| Firm FE                               | Y                     | Y     |
| Observations                          | 12,691                | 12,469|
|                                      | 13,450                | 13,212|
| Adj R²                                | 0.026                 | 0.106|
|                                      | 0.031                 | 0.107|

Notes: This table shows the results of the placebo test using corporate cash holdings in 2018 and 2019. Quarterly time and firm fixed effects are considered in all regressions. Standard errors are clustered by firm, and the p values are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 4
COVID exposure and corporate excess cash holdings.

| Dep. Variable – Excess cash holdings | (1) | (2) |
|-------------------------------------|-----|-----|
| COVID Exposure                      | -0.047** | -0.043** |
| (0.042)                             | (0.005) |
| Firm size                           | 0.030*** | (0.000) |
| Leverage                            | -0.083*** | (0.000) |
| ROA                                 | -0.037*** | (0.000) |
| Tobin’s Q                           | -0.003**  | (0.027) |
| Sales growth                        | -0.006*** | (0.000) |
| Firm age                            | 0.008     | (0.748) |
| Total risk                          | 0.062     | (0.285) |
| Cash Flow                           | 0.223***  | (0.000) |
| Quarter FE                          | Y         | Y     |
| Firm FE                             | Y         | Y     |
| Observations                        | 16,574    | 16,514|
|                                      | 16,514    | 16,514|
| Adj R²                              | 0.030     | 0.092|

Notes: This table shows regression results of excess cash holdings on firms’ COVID exposure and firm characteristics. Quarterly time and firm fixed effects are considered in all regressions. Standard errors are clustered by firm, and the p values are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

3.2.2. Excess cash
In this section, we concentrate on firms' excess cash holding rather than their cash holding. Following Gao et al. (2013), we define excess cash as the difference between a firm’s actual cash holding and its predicted cash holding before the pandemic. We adopt the cash holding in the last quarter of 2019 as our pre-pandemic benchmark. Next, we estimate how firms in a pandemic would act regarding cash holding policy if the COVID-19 pandemic did not occur. In particular, excess cash also reflects firms' cash holding adjustment during the pandemic period.

Table 4 presents the estimation results with excess cash. Again, we observe consistent evidence that firms with negative (positive) COVID exposure is significantly related to lower (higher) excess cash holding. Specifically, the estimated coefficient on COVID Exposure is -0.047 (-0.043) under the simple (multivariate) regression, suggesting that a 1% decline in COVID Exposure leads to a 0.047% increase in excess cash holding. More importantly, this effect is statistically significant, although smaller than our baseline regression, where a 1% decline in COVID Exposure likely stems from unobserved firm characteristics.

3.2.3. COVID exposure with alternative factor models
We test to determine that the negative association between firms’ COVID exposure and corporate cash holding is not sensitive to the factor model used to estimate firms’ COVID Exposure. We re-estimate the corporate cash policies before the pandemic. In particular, the coefficient on COVID Exposure is positive in 2018, while it becomes negative with the sample in 2019. However, both cases result in an insignificant coefficient on COVID Exposure, independent of controlling for a host of firm-specific variables. In brief, firms with negative COVID exposure hold more cash during the pandemic. This relationship indicates that COVID exposure unlikely stems from unobserved firm characteristics that lead to changes in cash holding. The placebo test also implies that managers will likely alter their cash holding strategy based on the new information embedded in firms’ COVID exposure.
baseline regression by replacing the COVID Exposure of the market model with COVID Exposure based on the Fama-French three-factor, the Carhart four-factor, and the Fama-French five-factor models.

Table 5 presents the estimation results with COVID Exposure obtained using alternative factor models. We find that COVID Exposure continues to be negatively and significantly associated with firms’ cash holding. In particular, a 1% decline in firms’ COVID exposure leads to a 0.046% rise in its cash holding under the Fama-French three-factor model scenario while controlling for a host of control variables. In comparison, this effect becomes 0.038% and 0.042% under the Carhart four-factor model and the Fama-French five-factor model, respectively. These results indicate that the model to estimate firms’ COVID exposure is unlikely to be the dominant force behind the vital link between COVID exposure and corporate cash holding. In brief, our baseline results remain unchanged with the COVID exposure definition using alternative factor models.

3.2.4. The t-test for equality of COVID exposure across firms

Although the COVID-19 pandemic outbreak is an exogenous shock for the real economy and stock market, one may still be concerned that firms’ COVID exposure may be endogenously linked to firm characteristics. These characteristics are related to firms’ pre-pandemic financial conditions, such as financial constraints and profitability, or influenced directly by firms’ pre-pandemic cash holding. For example, Ding et al. (2021) find that the decline in the stock market during the COVID-19 pandemic is milder among firms with better pre-pandemic financial conditions.

To alleviate this concern, in this section, we first divide firms into high and low groups according to the median of firms’ pre-pandemic financial conditions and corporate governance measures. Specifically,

Table 5

| Dep. Variable = | Cash holdings |
|----------------|---------------|
|                | (1)           | (2)          | (3)          |
| ThreeFactor_COVID Exposure | -0.046** (0.037) |              |              |
| FourFactor_COVID Exposure   | -0.038+ (0.075) | -0.042* (0.058) |              |
| FiveFactor_COVID Exposure   |              |              |              |
| Firm size               | 0.030*** (0.003) | 0.030*** (0.003) | 0.030*** (0.003) |
| Leverage                | -0.083*** (0.000) | -0.083*** (0.000) | -0.083*** (0.000) |
| ROA                     | -0.037** (0.030) | -0.037** (0.030) | -0.037** (0.030) |
| Tobin’s Q               | -0.003*** (0.008) | -0.003*** (0.008) | -0.003*** (0.008) |
| Sales growth            | -0.000*** (0.000) | -0.000*** (0.000) | -0.000*** (0.000) |
| Firm age                | 0.016 (0.559)   | 0.016 (0.564)   | 0.016 (0.563)   |
| Total risk              | 0.12** (0.055)  | 0.12** (0.052)  | 0.12** (0.054)  |
| Cash Flow               | 0.231*** (0.000) | 0.231*** (0.000) | 0.231*** (0.000) |
| Quarter FE              | Y              | Y              | Y              |
| Firm FE                 | Y              | Y              | Y              |
| Observations            | 17,590         | 17,590         | 17,590         |
| Adj R²                  | 0.091          | 0.091          | 0.091          |

Notes: This shows the regression results of cash holdings on alternative firms’ COVID exposure (i.e., ThreeFactor_COVID Exposure, FourFactor_COVID Exposure, and FiveFactor_COVID Exposure) and firm characteristics. The alternative COVID exposure measures are estimated based on the Fama-French three-factor model, the Carhart four-factor model, and the Fama-French five-factor model. Quarterly time and firm fixed effects are considered in all regressions. Standard errors are clustered by firm, and the p-values are reported in parentheses. * *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

we use the median of the following variables in 2019 for the high and low group division: cash holding, ROE, ROA, KZ-index (a measure of financial constraint)\(^{10}\), institutional ownership, board independence, and CEO-chairman duality. Next, we conducted t-tests for mean equality of firms’ COVID exposure between the high and low groups. By doing so, we seek to determine whether COVID exposure is significantly different for firms with different pre-pandemic characteristics.

Table 6 provides the t-statistics and their associated p-values for firms’ COVID exposure equality between the two groups. In column (1), the t-test results are insignificant for all COVID exposure measures (i.e., COVID Exposure, ThreeFactor_COVID Exposure, FourFactor_COVID Exposure and FiveFactor_COVID Exposure) between the two groups of firms classified according to their pre-pandemic cash holding. The results indicate that the means of COVID exposure measures are not significantly different between firms with high versus low pre-pandemic cash holding. In columns (2) to (7), we divide firms based on other pre-pandemic characteristics and find similar results. Specifically, our results show that the means of COVID exposure measures are not significantly different between high versus low ROE firms, high versus low ROA firms, high versus low financial constraint firms, high versus low institutional ownership firms, high versus low board independence firms, and firms with versus without CEO-chairman duality.

Overall, the empirical results from a set of t-tests indicate that firms’ COVID exposure measures are unlikely to be influenced by their pre-pandemic financial conditions or corporate governance measures.

4. Channels through which firms’ COVID exposure influences cash holding

We attempt to understand how firms’ COVID exposure influences corporate cash holding policies by conducting two groups of tests. Specifically, we explore firms’ financial frictions or agency conflicts as channels for COVID exposure to affect firms’ cash holding. Accordingly, we first investigate firms’ financial frictions as important mechanisms in subsection 4.1; then, we test the agency conflict mechanism by considering a set of corporate governance measures in subsection 4.2.

4.1. Financial frictions

Financial frictions might force firms to abandon profitable investment opportunities, especially companies with much information that is asymmetric to external providers of capital. To evaluate firms’ financial frictions as a mechanism for COVID exposure to affect corporate cash holding, we examine how our main results vary according to firms’ state ownership status, growth, firm size and overseas business diversification.

We present in Table 7 the regression results for different groups of firms. Specifically, we report in columns (1) and (2) the results using state-owned and non-state-owned firms, respectively. We find that firms’ cash holding are only statistically negatively associated with their COVID exposure in non-state-owned firms. Similarly, we find that only low-growth and small firms are significantly affected by COVID exposure on their cash holding (columns 3–6). Finally, we analyse the variation of our baseline results by considering firms with and without overseas business. The effect of COVID exposure on cash holding for firms without overseas business is approximately three times larger than that for firms with overseas business, with COVID Exposure coefficients of –0.077 and –0.026, respectively (columns 7–8). Moreover, the effect is only significant in the former case, suggesting that overseas business diversification can mitigate the impact of firms’ COVID exposure on cash holding. In brief, corporate cash holding are significantly negatively

\(^{10}\) We follow Kaplan and Zingales (1997) and use the KZ-index to measure financial constraints. It is calculated based on firms’ cash flow, dividends, cash holding, leverage as well as Tobin’s Q.
Table 6

t-tests for equality of COVID exposure between groups sorted by pre-pandemic firm characteristics.

| t-test for equality of COVID exposure between two groups sorted by pre-pandemic firm characteristics | Cash Holding | ROA | ROE | Financial Constraint | Institutional Ownership | Board Independence | CEO-chairman Duality |
|---|---|---|---|---|---|---|---|
| COVID Exposure | −0.8608 (0.3894) | −1.1806 (0.2378) | −0.1919 (0.8478) | 0.9513 (0.3415) | −0.6379 (0.5236) | 0.5719 (0.5674) | 0.6795 (0.4969) |
| ThreeFactor COVID Exposure | −0.2371 (0.8125) | −0.3135 (0.7539) | 0.9035 (0.3663) | 0.6413 (0.5213) | −1.0435 (0.2967) | −0.0269 (0.9785) | 0.9830 (0.3256) |
| FourFactor COVID Exposure | −0.5501 (0.5823) | −0.2918 (0.7704) | 1.1798 (0.2881) | −0.0610 (0.9514) | −0.3662 (0.7142) | −0.3014 (0.7631) | 0.6263 (0.5311) |
| FiveFactor COVID Exposure | −0.2847 (0.7759) | −0.5179 (0.6045) | 0.6976 (0.3791) | −0.4494 (0.6532) | −0.8457 (0.3977) | −0.1313 (0.8956) | 1.0756 (0.2821) |
| # of Observations of High Group | 7,476 | 7,230 | 7,239 | 7,776 | 7,771 | 8,246 | 10,916 |
| # of Observations of Low Group | 8,134 | 8,380 | 8,371 | 7,834 | 7,839 | 7,364 | 4,694 |

Notes: This table shows the results of regressions investigating how firms' COVID exposure affects corporate cash holdings. The results suggest that COVID exposure only significantly affects cash holding in firms with high financial frictions. In that case, we expect the association between firms' COVID exposure and cash holding to be pronounced in poor corporate governance firms. On the other hand, we conjecture that good corporate governance would strengthen the firms' COVID exposure and cash holding association if the firms' harmful COVID exposure represents more operational uncertainty that motivates them to hold more cash. Accordingly, we adopt three proxy measures of corporate governance: board independence, CEO duality, and institutional ownership.

Table 7

COVID exposure, corporate financial frictions and cash holdings.

| Dep. Variable | Cash holdings | SOE | Non-SOE | High growth | Low growth | Large firm | Small firm | Overseas business | Non overseas business |
|---|---|---|---|---|---|---|---|---|---|
| COVID Exposure | −0.062 (0.133) | −0.072** (0.024) | −0.070 (0.112) | −0.092** (0.034) | −0.049 (0.105) | −0.092** (0.024) | −0.026 (0.662) | −0.077*** (0.009) |
| Firm size | 0.036*** (0.004) | 0.039*** (0.000) | 0.041*** (0.001) | 0.030*** (0.002) | 0.064*** (0.000) | 0.039*** (0.007) | 0.091*** (0.002) | 0.031*** (0.000) |
| Leverage | −0.149*** (0.001) | −0.127*** (0.000) | −0.152*** (0.001) | −0.102*** (0.000) | −0.166*** (0.000) | −0.099*** (0.001) | −0.240*** (0.000) | −0.116*** (0.000) |
| ROA | −0.103*** (0.018) | −0.105*** (0.000) | −0.125*** (0.000) | −0.083*** (0.008) | −0.137*** (0.000) | −0.078*** (0.002) | −0.376*** (0.000) | −0.062*** (0.009) |
| Tobin’s Q | −0.001 (0.692) | −0.006*** (0.000) | −0.005*** (0.000) | −0.007*** (0.001) | −0.003 (0.132) | −0.006* (0.056) | −0.005** (0.049) | −0.004** (0.016) |
| Sales growth | 0.002** (0.024) | 0.001 (0.130) | 0.001 (0.417) | −0.009* (0.059) | 0.002** (0.024) | 0.001 (0.340) | −0.001 (0.568) | 0.002*** (0.008) |
| Firm age | 0.020 (0.646) | 0.019 (0.544) | 0.087** (0.028) | −0.000 (0.992) | 0.016 (0.607) | −0.002 (0.962) | −0.042 (0.402) | 0.030 (0.329) |
| Total risk | 0.008 (0.935) | 0.153** (0.042) | 0.159* (0.054) | −0.005 (0.957) | 0.051 (0.460) | 0.097 (0.327) | −0.002 (0.986) | 0.130 (0.065) |
| Cash Flow | 0.327*** (0.000) | 0.293*** (0.000) | 0.338*** (0.000) | 0.275*** (0.000) | 0.290*** (0.000) | 0.325*** (0.000) | 0.466*** (0.000) | 0.289*** (0.000) |
| Quarter FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Firm FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 5,208 | 12,278 | 8,794 | 8,796 | 8,897 | 8,693 | 3,325 | 14,265 |
| Adj R² | 0.115 | 0.092 | 0.114 | 0.075 | 0.122 | 0.101 | 0.185 | 0.090 |

Notes: This table shows the results of regressions investigating how firms’ COVID exposure affects corporate cash holdings through different financial friction channels. SOE and non-SOE, High and Low, Large and Small, and Overseas and non overseas represent the subgroups of state-owned and non-state-owned enterprises, high-growth and low-growth firms, large and small firms, and firms with and without overseas business, respectively. Standard errors are clustered by firm, and the p values are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
values reported in parentheses are based on standard errors clustered by firms. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

vestments: capital expenditure, R&D expenditure. Specifically, we adopt four proxy measures of firms

5. Pandemic period cash holding and investment

Having established how firms’ cash holding are affected by their COVID exposure, we further explore how firms allocate the change in their cash holding or excess cash in capital investment and R&D expenditures. Specifically, we adopt four proxy measures of firms’ investments: capital expenditure, R&D expenditure, acquisition expenditure, and their sum. We run the regression of each investment proxy on firms’ cash holding or excess cash, together with the same control variables in our baseline regression. The results are reported in Table 9.

The results in Table 9 indicate that with increasing cash holding, firms are likely to decrease rather than increase capital and acquisition investments. However, the impact on acquisition expenditure is insignificant. However, increasing cash holding is followed by higher R&D investments. These results suggest that firms have inadequate investment opportunities due to more uncertainty during the pandemic and that R&D has become a vital cash outlet. Taken together, increasing cash holding is related to a decline in total investment, even though the effect is not statistically significant. A similar pattern emerges when we replace cash holding with excess cash holding. In brief, these results suggest that firms use the increased cash holding driven by their COVID exposure mainly for R&D expenditure. In further analyses not reported here for brevity but are available from the authors upon request, we observe that the decrease in capital investment resulting from increased cash holding largely occurs in firms with negative COVID exposure.

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6. Conclusion

The COVID-19 pandemic has enormously impacted economies and the stock market. In turn, the operational uncertainty embedded in firms’ stock prices reveals essential information for managers to quickly respond and adjust their cash holding policy. In this study, we construct firms’ COVID exposure by regressing firms’ daily stock returns on increased COVID-19 infection cases while controlling for market returns. In addition, we examine the link between firms’ COVID exposure and corporate cash holding for a large sample of listed firms in China.

We provide robust evidence to show that firms’ COVID exposure is significantly and negatively associated with cash holding. Firms whose stock returns are negatively (positively) impacted by the COVID severity measure tend to increase (decrease) their cash holding. Placebo tests exclude the concerns that the COVID exposure stems from unobserved firm characteristics that lead to high cash holding in the pre-pandemic period. Confirming evidence of the significant link is supported by robustness tests that consider excess cash and employ different models to measure firms’ COVID exposure.

We also explore how firms’ COVID exposure influences their cash holding. We show that operational considerations are the main drivers of cash policies during the pandemic. The empirical evidence shows that the relationship between firms’ COVID exposure and cash holding only exists in firms with high financial frictions (i.e., non-state-owned, low-growth, and small firms) and firms without global business for diversification. We also consider the channel of agency conflicts. Our empirical results do not support the agency conflicts channel. Instead, the more pronounced negative link between firms’ COVID exposure and cash holding shows up in firms with good corporate governance. The results indicate that the change in cash holding policy stems from precautionary motives under operational considerations, particularly for firms with good corporate governance that seek to benefit shareholders.

In a set of additional analyses, we examine how firms react to cash or excess cash holding by investigating their investment policies. We

| Dep. Variable | Cash holdings |
|---------------|---------------|
|               | High board independence | Low board independence | Duality chairman | Non-duality chairman | Low institutional ownership | High institutional ownership |
|               | (1) | (2) | (3) | (4) | (5) | (6) |
| COVID Exposure | -0.169*** | 0.036 | -0.023 | -0.097*** | -0.079** | -0.058 |
|               | (0.000) | (0.383) | (0.686) | (0.005) | (0.027) | (0.121) |
| Firm size | 0.068*** | 0.040*** | 0.059*** | 0.047*** | 0.030*** | 0.062*** |
|               | (0.003) | (0.001) | (0.009) | (0.001) | (0.017) | (0.000) |
| Leverage | -0.135*** | -0.132*** | -0.167*** | -0.120*** | -0.110*** | -0.121*** |
|               | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ROA | -0.179*** | -0.206*** | -0.249*** | -0.158*** | -0.106*** | -0.124*** |
|               | (0.001) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Tobin’s Q | -0.008*** | -0.001 | -0.006** | -0.004** | -0.005** | -0.005** |
|               | (0.000) | (0.454) | (0.019) | (0.017) | (0.013) | (0.006) |
| Sales growth | -0.000 | 0.002** | 0.002 | 0.001 | 0.001 | 0.002** |
|               | (0.754) | (0.035) | (0.208) | (0.429) | (0.183) | (0.025) |
| Firm age | 0.002 | -0.011 | 0.015 | -0.012 | -0.015 | 0.007 |
|               | (0.952) | (0.776) | (0.769) | (0.705) | (0.672) | (0.853) |
| Total risk | 0.154* | -0.032 | 0.043 | 0.077 | 0.037 | 0.233*** |
|               | (0.084) | (0.717) | (0.712) | (0.303) | (0.658) | (0.005) |
| Cash Flow | 0.410*** | 0.374*** | 0.380*** | 0.397*** | 0.316*** | 0.303*** |
|               | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Quarter FE | Y | Y | Y | Y | Y | Y |
| Firm FE | Y | Y | Y | Y | Y | Y |
| Observations | 7,271 | 6,479 | 4,140 | 9,710 | 8,728 | 8,704 |
| Adj R² | 0.140 | 0.117 | 0.108 | 0.136 | 0.094 | 0.107 |

Note: This table shows the results of regressions investigating how firms’ COVID exposure affects corporate cash holdings through different corporate governance channels. High board and low board, duality and non-duality, and high institutional and low institutional represent the subgroups of low-board-independence firms and high-board-independence firms, CEO duality and non-duality firms, and high institutional ownership firms and low institutional ownership firms, respectively. The p-values reported in parentheses are based on standard errors clustered by firms. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

11 Since the investment measures (capital expenditure, R&D expenditure and acquisition expenditure) in Table 8 are only available at annual level, we use as dependent variables the 2020 year-end investment measures instead of quarterly measures and control industry fixed effect instead of firm fixed effect.
Appendix A. Variable definitions

| Variables | Definition |
|-----------|------------|
| Panel A: Dependent variables | |
| Cash holdings | The ratio of cash and equivalent assets to total assets. |
| Excess cash holdings | The difference between a firm’s actual cash holdings and its predicted cash holdings before the pandemic period scaled by total assets. |
| Capital Expenditure | Total capital expenditure scaled by total assets. |
| R&D Expenditure | Total R&D expenditure scaled by total assets. |
| Acquisition Expenditure | Total acquisition expenditure scaled by total assets. |
| Total Investments | Total investment expenditure scaled by total assets. |
| Panel B: COVID sensitivities | |
| COVID Exposure | \( COVID \text{ Exposure} \) is a coefficient that captures the sensitivity of a firm’s stock returns to the daily new confirmed COVID-19 cases worldwide. It is estimated by the regression model which regresses stock returns on the pandemic and market factors within each quarter. |
| ThreeFactor_COVID Exposure | \( \text{ThreeFactor\_COVID Exposure} \) is an alternative measure that captures the sensitivity of a firm’s stock returns to the daily new confirmed COVID-19 cases worldwide. It is estimated by the regression model, which regresses stock returns on the pandemic factor and the Fama-French three factors within each quarter. |

Note: This table shows the results of regressions investigating the impact of firm cash holdings (excess cash holdings) on their investment expenditures, including capital expenditure (Capital Expenditure), R&D expenditure (R&D), acquisition expenditure (Acquisition), and the sum of them (Total Investments). The p values reported in parentheses are based on standard errors clustered by firms. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 9

| Dep. Variable | Capital Expenditure | R&D Expenditure | Acquisition Expenditure | Total Investments |
|--------------|---------------------|-----------------|-------------------------|------------------|
| Cash         | –0.020*** (0.005)   | 0.013*** (0.001) | 0.005 (0.870)           | 0.021 (0.598)    |
| Excess cash  | –0.020*** (0.002)   | 0.002 (0.475)   | 0.033** (0.042)         | –0.016 (0.627)   |
| Firm size    | 0.001* (0.082)      | –0.000 (0.638)  | –0.029*** (0.000)       | –0.028*** (0.000) |
| Leverage     | 0.095 (0.276)       | –0.003 (0.034)  | (0.995) (0.805)         | 0.019 (0.422)    |
| ROA          | 0.101*** (0.000)    | 0.019** (0.008) | (0.018) (0.015)         | –0.217*** –0.219** –0.178 –0.172 |
| Tobin’s Q    | 0.003*** (0.000)    | 0.003*** (0.000) | 0.055*** (0.000)        | 0.045*** 0.048*** 0.048*** |
| Sales growth | –0.001** (0.015)    | 0.000 (0.873)   | 0.004* (0.082)          | 0.002 (0.410)    |
| Firm age     | –0.021*** (0.000)   | –0.005*** (0.000) | –0.005*** –0.018 –0.018 –0.055*** –0.056*** |
| Total risk   | 0.132** (0.099)     | 0.106*** (0.000) | 0.097*** (0.226)        | 0.306 0.367 0.343 |
| Cash Flow    | 0.090*** (0.000)    | 0.091*** (0.000) | –0.012* –0.010 –0.086 –0.093 | 0.015 0.024 |
| Quarter FE   | Y Y Y Y Y Y Y     | Y Y Y Y Y Y Y Y | Y Y Y Y Y Y Y Y Y Y Y Y |
| Firm FE      | Y Y Y Y Y Y Y     | Y Y Y Y Y Y Y Y | Y Y Y Y Y Y Y Y Y Y Y Y |
| Observations | 13,131 13,118      | 11,895 11,886   | 13,202 13,186           | 9,629 9,820     |
| Adj R²       | 0.118 0.120        | 0.295 0.292     | 0.169 0.170             | 0.211 0.211     |

Note: This table shows the results of regressions investigating the impact of firm cash holdings (excess cash holdings) on their investment expenditures, including capital expenditure (Capital Expenditure), R&D expenditure (R&D), acquisition expenditure (Acquisition), and the sum of them (Total Investments). The p values reported in parentheses are based on standard errors clustered by firms. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
Variables | Definition
--- | ---
FourFactor\_COVID\_Exposure | FourFactor\_COVID\_Exposure is an alternative measure that captures the sensitivity of a firm’s stock returns to the daily new confirmed COVID-19 cases worldwide. It is estimated by the regression model, which regresses stock returns on the pandemic factor and the Carhart four factors within each quarter.

FiveFactor\_COVID\_Exposure | FiveFactor\_COVID\_Exposure is an alternative measure that captures the sensitivity of a firm’s stock returns to the daily new confirmed COVID-19 cases worldwide. It is estimated by the regression model, which regresses stock returns on the pandemic factor and the Fama-French five factors within each quarter.

**Panel C: Firm characteristics variables**

- **Firm size**: The natural logarithm of the book value of total assets.
- **Leverage**: Total debt divided by total assets.
- **ROA**: Operating cash flow divided by total assets.
- **Tobin’s Q**: Market value/replacement value.
- **Sales growth**: (Operating income of the current quarter - Operating income of the last quarter) / Operating income of the previous quarter.
- **Firm age**: The natural logarithm of the number of years since a firm’s incorporation.
- **Total risk**: The standard deviation of daily stock returns over the current quarter.
- **Cash Flow**: Operating cash flow scaled by total assets.
- **SOE**: SOE takes a value of one if the ultimate controller is the state and zero otherwise.

**Panel D: Corporate governance variables**

- **Board independence**: Independent board of directors to total board of directors.
- **CEO duality**: Dummy variable which equals one if the chairman and CEO are the same person, 0 otherwise.
- **Institutional ownership**: Shares owned by institutions scaled by total shares outstanding.

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