The COVID-19 pandemic and firm value: the mediating effect of FinTech applications

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Abstract
This study investigates the impact of the COVID-19 pandemic on firm value and the mediating effect of financial technology (FinTech) applications. Examining the U.S.-listed domestic and foreign firms, we find the negative association between the severity of the virus pandemic and firm value. However, we also show the evidence that FinTech applications alleviate the negative impact of the COVID-19 pandemic on firm value. These findings provide important implications for global regulators, investors, and managers.

Keywords Virus pandemic · Firm value · FinTech · COVID-19

1 Introduction

The outbreak of COVID-19 has had a devastating impact on humanity. On March 11, 2020, the World Health Organization (2020) declared COVID-19 a global pandemic. As of November 30, 2020, approximately 62.2 million COVID-19 cases were reported worldwide, with over 1.4 million deaths, and the death toll was continuing to rise. In the United States, during the same week, the pandemic caused the Standard & Poor’s 500 to lose more than $5 trillion in market value. In another unprecedented event in 2020, market circuit breakers were triggered four times in trading sessions on March 9, 12, 16, and 18 (Osipovich and Lim 2020). In response to the COVID-19 pandemic, this study aims to investigate how a global virus pandemic impairs firm value.
Currently, the regulator in each country must diagnose the impact of a pandemic on firms’ organizational processes and respond in a timely basis to the challenges faced by company managers in different sectors. Financial technology (FinTech) thus plays a vital role in this scenario. Since the outbreak of COVID-19, the use of FinTech applications has increased by 72%; registrations for online banking services have increased and, with more people than ever working remotely, there has been a surge in demand for video conferencing such as Google Hangouts, Skype, FaceTime, and Zoom (Forbes 2020). When the U.S. government proposed a COVID-19 assistance program, FinTech giants such as PayPal, Intuit, and Square were eager to participate in government lending programs designed to help small and medium-sized enterprises cope with the growing pandemic (Cacioli 2020). In terms of personal finance, individuals were also able to use FinTech P2P lending platforms to acquire fast and efficient emergency relief loans, avoiding the lengthy credit approval processes of traditional banks (Najaf et al. 2022). FinTech applications can decrease the chance of viral transmission and group infection by reducing face-to-face business transactions. In addition, the application of big data analytics helps healthcare organizations (Wang et al. 2018; Khanra, Dhir Islam, Mäntymäki 2020), where the timely acquisition of infection status and FinTech machine learning can help capture the footprints of infected people and predict cluster infections. All these applications can assist a country with controlling the expansion of the virus and further stabilize investor confidence. Hence, this study is aimed secondly at exploring whether FinTech applications can reduce the negative impact of a virus pandemic on firm value.

In this study, we investigate the association between the severity of the COVID-19 pandemic and firm value. Using a sample of 4,024 U.S.-listed domestic and foreign firm observations in March 2020, we find that firm value is significantly and negatively associated with the COVID-19 pandemic severity, measured by the case fatality rate, the mortality rate, the confirmed rate, the number of deaths, and the number of confirmed cases by country. We further examine whether FinTech applications mediate the negative association between the severity of the virus pandemic and firm value. Our results show that firms in countries with better FinTech applications experience a less negative impact of the COVID-19 pandemic on firm value. We conduct several additional and robustness analyses. First, because the uncertainty surrounding the COVID-19 pandemic provides new opportunities for FinTech firms (Deloitte 2020), we split our sample into FinTech and non-FinTech firms and find that FinTech firms benefit from better FinTech applications in the countries. Secondly, due to the different impacts of the COVID-19 pandemic on industries (Gryta and Maloney 2020), we break the sample into severely affected industries (SAIs) and non-severely affected industries (non-SAIs) and re-estimate the regressions. The results suggest that firms in SAIs experience the alleviating effect of better FinTech applications on firm value. For robustness, we first delete the retail industry firms to ease the concern that our findings are driven by the effect of the retail industry. In addition, we verify the validity of our FinTech application definition by focusing on the firms in countries of the top and bottom 5% based on FinTech rankings. Finally, we conduct the change analysis to deal with the potential endogeneity issues. Our results for these robustness analyses are generally consistent with our main findings, suggesting that FinTech applications alleviate the negative impact of the COVID-19 pandemic on firm value.

The remainder of this paper is organized as follows. Section 2 reviews the extant literature and develops the research hypotheses. Section 3 discusses the data collection processes.
2 Literature review and hypothesis development

2.1 The COVID-19 pandemic and firm value

As COVID-19 spread globally in 2020, it led to a decline in product demand, increased uncertainty, and disruptions of the supply chain. Due to strict quarantine policies in most countries, many economic activities have been severely restricted (Goodell 2020; Zhang et al. 2020). Previous literature indicates that a virus pandemic results in country-wide reductions in gross domestic product (GDP) levels (Keogh-Brown, Wren-Lewis, Edmunds, Beutels, and Smith 2010), economic losses of up to $30 billion to $100 billion (Keogh-Brown and Smith 2008), affecting changes in both labor market demand and supply (Lee and Warner 2005), and negative capital returns (Karlsson et al. 2014). Due to intensive news coverage of a pandemic and resulting global panic, such a catastrophic event can result in a negative market response (Ichev and Marinč 2018).

Since a virus pandemic restricts economic activities, resulting in manufacturing shortages, reduced consumer demand, business failures, and increased unemployment, countries suffering from more severe issues from a virus pandemic are likely to experience a stronger negative influence on their capital market. Hence, we propose the first hypothesis as follows.

\[ H_1: \text{Firm value is negatively associated with the severity of the virus pandemic in a country.} \]

2.2 FinTech applications, the virus pandemic, and firm value

A global virus pandemic increases the risk of broken supply chains, industry stagnation, and negative impacts on a country’s imports and exports. Although during such times governments in various countries enact policies to stimulate the economy or consumption on the part of companies and individuals, group infections are unavoidably increased. FinTech applications could then be an appropriate solution for reducing the chances of viral transmission.

The core of FinTech is artificial intelligence, blockchain and big data analysis, cloud computing, data mining and data analytics, and mobile payments and machine learning (also known as ABCDM), which can be applied in firms in various industries. Digital technologies have changed our ways of life, work, and communication (Anthony 2021). Leading FinTech countries are better able to make good use of their artificial intelligence or big data analysis capabilities to help industries implement changes in the global supply chain and enhance international competitiveness among firms. More importantly, the pandemic presents a new opportunity for FinTech, where contactless payment provides a safer and more convenient alternative to potentially contaminated cash and where company and personal loans can be applied for online, without having to physically visit banks.

Because quarantine concerns and fear of infection keep customers away from bank branches, virus-free, branchless banking services are not only a safer and more cost-effec-
tive alternative, but also more accessible to people in remote areas (Patel 2020). FinTech is leading the path forward to a new life: banking everywhere, but never at a bank. In addition, it assists in the integration of online and offline business models to respond to changes in international trade or domestic economic conditions during outbreaks. Similarly, FinTech can increase a company’s overseas revenue creation, market value, and cross-border market development capabilities through the promotion of electronic commerce and mobile payments (Gomber, Kauffman Parker, Weber 2018). Therefore, it is inferred that countries with better development and applications of FinTech solutions will be more capable of creating the favorable economic climate necessary to cope with industry shocks caused by the pandemic and to stabilize the performance of capital markets, compared to countries with poorer FinTech rankings.

However, the adoption of FinTech might not necessarily have a positive impact on the association between the COVID-19 pandemic and firm value. Surveying 1,428 FinTech firms, a report released by the Cambridge Centre for Alternative Finance (CCAF), World Bank, and World Economic Forum (2020) indicates that these companies still face challenges in the pandemic period. More than 40% of the survey respondents indicate a negative impact on firm valuation. In addition, 34% note a negative impact on future fundraising. In addition, the survey firms report an increase in liquidity risks and cybersecurity risks. They have also been experiencing an increase in operational complexity and costs. Furthermore, downward revisions of revenue targets of profitability are also reported by digital lending firms. Based on these FinTech firms’ challenges, it is still unclear whether FinTech applications necessarily have a mediating effect on the negative impact of the COVID-19 pandemic on firm value. We propose our second hypothesis as follows:

\[ H_2: \text{In countries with better applications of FinTech solutions, a virus pandemic is likely to have a smaller negative impact on firm value.} \]

3 Data and method

Since March 2020 is the most dramatic stock market crash since the outbreak of COVID-19 in the United States (Mazur, Dang, and Vega 2021), our sample is composed of U.S.-listed domestic and foreign firms in March 2020. The data on global COVID-19 cases by country are obtained from the Center for Systems Science and Engineering at Johns Hopkins University, and the global FinTech rankings data are collected from the Institute for Financial Services Zug (IFZ). Financial and market data are from Compustat and CRSP. After removing observations with missing values, the final sample comprises 4,024 firm observations (approximately 84% domestic firms and 16% foreign firms) from 16 countries.

To examine whether firm value is impacted by the COVID-19 virus pandemic, we adopt the balance sheet valuation model of Matsumura et al. (2014):

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1 See https://github.com/CSSEGISandData/COVID-19.
2 The IFZ of the Lucerne University of Applied Sciences and Arts uses factors related to driving entrepreneurship and innovation and PEST (politics, economics, society, and technology) analysis to analyze the overall indicators of each country to identify those regions with the most robust FinTech ecosystems. We use the IFZ’s 2020 country rankings.
MKT = β₀ + β₁COVID₁₉ + β₂ASSET + β₃LIAB + β₄OPINC + β₅GDP + β₆HCI + β₇IDI + CountryD + IndustryD + ε  

(1)

where MKT is the market value of common equity (in millions of U.S. dollars), calculated as the number of shares outstanding multiplied by the price per share of the firm’s common stock at the end of March 2020. Our independent variable of interest, COVID₁₉, is measured using the following five variables: (1) CASE FATALITY RATE, calculated as the number of deaths divided by the number of confirmed cases; (2) MORTALITY RATE, which denotes the percentage of deaths in the total population; (3) CONFIRMED RATE, which denotes the percentage of confirmed cases in the total global population; (4) DEATH, which denotes the natural logarithm of the number of deaths by country; and (5) CONFIRMED, which denotes the natural logarithm of the number of confirmed cases by country. Consistent with H₁, which posits a negative association between the severity of the virus pandemic and MKT, we expect a negative coefficient for COVID₁₉.

Following Matsumura et al. (2014), we include in the balance sheet valuation model firms’ total assets (ASSET), total liabilities (LIAB), and total operating income (OPINC). Also consistent with Matsumura et al. (2014), we expect ASSET and OPINC (LIAB) to be positively (negatively) associated with MKT. Furthermore, we use three variables to control for the impacts of the country’s economic activity indicators and FinTech-related drivers on firm value. First, the World Bank’s GDP growth rate (GDP) is included, to control for a country’s aggregate economic outcomes. In addition, we use CEOWorld Magazine’s Health Care Index (HCI), which reflects the overall quality of a country’s healthcare system. Finally, the difference in the development of information and communication technology is considered by including the International Telecommunication Union’s ICT Development Index (IDI) in our model. We also control for country and industry fixed effects and cluster standard errors by firm. All variable definitions are reported in the Appendix.

To examine H₂, that is, whether the negative impact of a virus pandemic on firm value is alleviated by FinTech applications, we employ the following ordinary least squares regression:

MKT = β₀ + β₁COVID₁₉ + β₂FINTECH_D + β₃COVID₁₉ × FINTECH_D + β₄ASSET + β₅LIAB + β₆OPINC + β₇GDP + β₈HCI + β₉IDI + CountryD + IndustryD + ε  

(2)

where FINTECH_D is a dummy variable equal to one if a country ranks above (better than) the median ranking of all countries in terms of the IFZ’s FINTECH_Rank, and zero otherwise. The variable FINTECH_Rank measures global FinTech hub rankings, where countries that are not listed are regarded as ranking last (i.e., with the poorest ratings). Our variable of interest is the interaction COVID₁₉ × FINTECH_D. The positive coefficient on the interaction suggests that FinTech applications alleviate the negative impact of the COVID-19 pandemic on firm value, suggesting that H₁ holds.
4 Results

Table 1 presents the descriptive statistics. The mean (median) \( MKT \) of our sample firms is $1,690 million ($299 million). The raw values of average \( CASE\ FATALITY\ RATE,\ MORTALITY\ RATE,\ CONFIRMED\ RATE,\ DEATH, \) and \( CONFIRMED\ ) are 2.791\%, 0.002\%, 0.054\%, 4,665 and 165,603, respectively. Finally, the mean (median) value of \( FINTECH\_\text{Rank} \) for our sample firms is 7.592 (6.000), suggesting that most of our sample firm observations are in countries with higher FinTech rankings.

Table 2 presents the results for \( H_1 \). Our regressions are significant at the 1\% level, with adjusted \( R^2 \) values of about 55\%. In regression (1), we find that the coefficient on \( CASE\ FATALITY\ RATE \) is negative (-0.485) and significant (t-stat. = -2.26), suggesting that companies located in countries with higher case fatality rates have lower firm value. For regressions (2) to (4), we find consistent results when the interest variable is replaced with the other four alternative measures (\( MORTALITY\ RATE,\ CONFIRMED\ RATE,\ DEATH, \) and \( CONFIRMED\ )). The results indicate that the severity of the virus pandemic can lead to the stagnation of economic activities and hence negatively affect firm market value. Our results support \( H_1 \), in that the severity of a virus pandemic is negatively associated with firm value.

To investigate whether FinTech applications alleviate the negative association between the severity of a virus pandemic and firm value, we run model (2) and present the empirical results in Table 3. The variable of interest for \( H_2 \) is the interaction term between our pandemic severity proxies and firm value, \( COVID19 \times FINTECH\_D \). Using regression (1) as the example, we find that \( COVID19 \) is still negatively associated with \( MKT \) (coefficient = -0.620, t-stat. = -2.61), consistent with the findings in Table 2. However, we find \( COVID19 \times FINTECH\_D \) to have a positive and significant coefficient on \( MKT \) (coefficient = 1.006, t-stat. = 1.99). The results suggest that the negative impact of the virus pan-
The COVID-19 pandemic and firm value: the mediating effect of FinTech applications. The results hold for the other four measures of COVID19. These solid and consistent results could be explained by countries with better FinTech rankings making better use of big data analysis to disseminate critical pandemic information and to assist with the integration of online and offline business models. In addition, face-to-face transactions can be reduced through mobile payments, which could help countries stabilize and control the pandemic spread, thereby mitigating the negative impact of the virus pandemic on firm value.

5 Additional and robustness analyses

We conduct several additional analyses. First, given the uncertainty surrounding the COVID-19 pandemic, there could be new opportunities for FinTech firms (Deloitte 2020). The report issued by the CCAF, World Bank, and World Economic Forum (2020) also indicates that FinTech firms are more resilient in the pandemic crisis. Therefore, we split the entire sample into FinTech firms and non-FinTech firms, where FinTech firms are defined according to Dranev et al. (2019). The results are reported in Table 4. In regression (1), using the subsample of FinTech firms, we consistently find negative and positive coefficients on COVID19 (coefficient = -0.626, t-stat. = -1.82) and COVID19×FINTECH_D.
Y.-C. Yang et al. (coefficient = 1.522, t-stat. = 2.44), respectively. The results are consistent with the main findings and suggest that FinTech firms can cope with the uncertainty and use their unique assets and skills to better handle the COVID-19 crisis. However, in the subsample of non-FinTech firms, we find COVID19 × FINTECH_D is negative but insignificantly associated with MKT (coefficient = -1.072, t-stat. = -1.33), showing that non-FinTech firms do not experience the alleviating effect of better FinTech applications on firm value. In sum, the results reasonably suggest that only FinTech firms benefit from better FinTech applications in the country, given the difficult virus pandemic situation.

Additionally, due to the different impacts of the COVID-19 pandemic on industries (Gryta and Maloney 2020), we split the sample into severely affected industries (SAIs) and non-severely affected industries (non-SAIs), following Suneson (2020). Specifically, SAIs include the retail, oil and gas, construction, hotels, transportation, and movie theater industries. Table 5 reports the results. Similarly, we find COVID19 × FINTECH_D to have positive and significant coefficients on MKT for SAIs (coefficient = 1.984, t-stat. =

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Table 3: Regression Analyses of the Mediating Effect of FinTech Applications

| Variables                  | Predicted sign | Case Fatality Rate | Mortality Rate | Confirmed Rate | Death Confirmed |
|----------------------------|----------------|--------------------|----------------|----------------|-----------------|
| **COVID19**                | -              | -0.620***          | -1.196***      | -1.812***      | -0.575***       |
|                            | (-2.61)        | (-7.83)            | (-10.73)       | (-6.70)        | (-7.55)         |
| **FINTECH_D**              | ?              | 0.013              | 0.954**        | 0.719**        | 1.609***        |
|                            | (0.03)         | (2.50)             | (2.42)         | (4.16)         | (5.74)          |
| **COVID19 × FINTECH_D**    | ?              | 1.006**            | 1.011***       | 0.950***       | 0.601***        |
|                            | (1.99)         | (4.68)             | (2.94)         | (5.22)         | (2.65)          |
| **ASSET**                  | +              | 0.699***           | 0.666***       | 0.648***       | 0.684***        |
|                            | (37.97)        | (35.81)            | (34.69)        | (37.09)        | (36.92)         |
| **LIAB**                   | -              | -0.767***          | -0.732***      | -0.711***      | -0.751***       |
|                            | (-34.43)       | (-32.60)           | (-31.59)       | (-33.63)       | (-33.47)        |
| **OPINC**                  | +              | 4.442***           | 4.213***       | 4.161***       | 4.297***        |
|                            | (12.70)        | (12.18)            | (12.09)        | (12.31)        | (12.23)         |
| **GDP**                    | ?              | -0.224***          | 0.051          | 0.127**        | -0.112***       |
|                            | (-5.82)        | (0.81)             | (2.04)         | (-2.70)        | (-1.48)         |
| **HCI**                    | ?              | 0.053***           | 0.050**        | 0.020          | 0.080***        |
|                            | (2.59)         | (2.50)             | (0.97)         | (3.91)         | (4.10)          |
| **IDI**                    | ?              | -1.105***          | -0.672***      | 0.022          | -1.189***       |
|                            | (-7.41)        | (-3.08)            | (0.09)         | (-8.09)        | (-8.18)         |
| Constant                   |                | 6.380***           | 3.099**        | -0.525         | 4.682***        |
|                            | (7.11)         | (1.97)             | (-0.32)        | (5.12)         | (4.20)          |
| Country Controlled         |                | Controlled         | Controlled     | Controlled     | Controlled      |
| Industry Controlled        |                | Controlled         | Controlled     | Controlled     | Controlled      |
| N                          |                | 4.024              | 4.024          | 4.024          | 4.024           |
| Adjusted R²                |                | 0.543              | 0.555          | 0.560          | 0.548           |
| F                          |                | 282.389***         | 279.480***     | 301.675***     | 305.241***      |

*, **, and *** indicate significance levels of 10%, 5%, and 1% or less, respectively, based on two-tailed tests.
### Table 4 Regression Analyses of the Mediating Effect of FinTech Applications for FinTech and Non-FinTech firms

| Variables          | (1) CASE FATALITY RATE | (2) MORTALITY RATE | (3) CONFIRMED RATE | (4) DEATH | (5) CONFIRMED |
|--------------------|------------------------|--------------------|--------------------|-----------|---------------|
|                    | FinTech firms          | Non-FinTech firms  | FinTech firms      | Non-FinTech firms | FinTech firms | Non-FinTech firms | FinTech firms | Non-FinTech firms | FinTech firms | Non-FinTech firms | FinTech firms | Non-FinTech firms |
| COVID19            | -0.626*                | -0.919***          | -2.618***          | -3.108***   | -1.173***     | -0.443***     | -1.774***     | -0.524***     | (-1.82)               | (-3.31)             | (-12.85)       | (-4.25)          | (-9.98)        | (-3.88)             | (-12.02)        | (-3.34)             |
| FINTECH_D          | -0.422                 | 1.399***           | 2.107***           | 1.570***    | 2.775***      | 2.448***      | 4.346***      | 2.523***      | (3.00)                | (2.23)              | (3.15)         | (3.45)          | (5.40)         | (4.62)              | (7.77)          | (4.25)              |
| COVID19×FINTECH_D  | 1.522**               | -1.072             | 2.991***           | 2.651***    | 1.168***      | -0.442        | 1.679***      | -0.271        | (2.44)                | (-1.33)             | (6.15)         | (-2.30)       | (5.90)         | (-1.58)             | (7.32)          | (-0.85)             |
| ASSET              | 0.482***               | 0.610***           | 0.442***           | 0.444***    | 0.463***      | 0.455***      | 0.603***      | -0.595***     | (18.89)              | (21.78)             | (18.32)        | (21.24)       | (18.61)        | (21.11)             | (18.46)        | (22.20)             |
| LIAB               | -0.492***             | -0.595***          | -0.449***          | -0.455***   | -0.472***     | -0.583***     | -0.588***     | -0.435***     | (-16.11)              | (-15.88)            | (-15.72)       | (-15.07)      | (-15.85)       | (-15.52)            | (-15.70)        | (-15.61)            |
| OPINC              | 0.448                 | 11.382***          | 0.232              | -0.066      | 0.099         | 11.216***     | 11.123***     | 0.053         | (1.28)                | (18.59)             | (18.28)        | (18.00)       | (0.29)         | (18.38)             | (0.16)          | (18.17)             |
| GDP                | -0.347***             | -0.099*            | -0.242***          | 0.294***    | -0.258***     | -0.000        | -0.187***     | 0.014         | (-6.39)               | (-1.89)             | (-3.75)        | (0.12)         | (-3.72)        | (-0.80)             | (-0.00)         | (-3.52)             |
| HCI                | 0.080***              | 0.084***           | -0.048*            | 0.027       | 0.116***      | 0.083***      | 0.122***      | 0.079***      | (3.04)                | (3.08)              | (2.03)         | (1.94)         | (4.49)         | (2.96)              | (4.76)          | (2.75)              |
| IDI                | -1.805***             | -1.249***          | 0.238              | -1.337***   | -2.224***     | -1.091***     | -2.276***     | -1.045***     | (-8.41)               | (-5.95)             | (-1.29)        | (-0.77)       | (-10.48)       | (-5.79)             | (-10.87)       | (-5.56)             |
| Constant           | 10.913***             | 5.275***           | -0.969             | 9.945***    | 9.901***      | 3.688***      | 8.743***      | 3.433***      | (8.20)                | (4.06)              | (-0.61)        | (-0.44)       | (4.22)         | (-0.27)             | (7.72)          | (3.02)              |
| Country            | Controlled             | Controlled         | Controlled         | Controlled  | Controlled    | Controlled    | Controlled    | Controlled    | Controlled             | Controlled          | Controlled    | Controlled | Controlled | Controlled          | Controlled      | Controlled          |
| N                  | 1,984                 | 2,040              | 1,984              | 2,040       | 1,984         | 2,040         | 1,984         | 2,040         | 1,984                 | 2,040              | 1,984         | 2,040         | 1,984         | 2,040              | 1,984         | 2,040              |
| Adjusted $R^2$     | 0.572                 | 0.615              | 0.603              | 0.617       | 0.632         | 0.617         | 0.591         | 0.616         | 0.600                 | 0.615              |
| $F$                | 241.550***            | 296.783***         | 251.897***         | 253.988***  | 285.100***    | 274.341***    | 261.428***    | 298.723***    | 270.997***            | 297.000***          | 253.988***    | 253.988***  | 285.100***    | 274.341***            | 261.428***    | 298.723***          |

*, **, and *** indicate significance levels of 10%, 5%, and 1% or less, respectively, based on two-tailed tests.
Table 5  Regression Analyses of the Mediating Effect of FinTech Applications for SAIs and Non-SAIs

| Variables | (1) CASE FATALITY RATE | (2) MORTALITY RATE | (3) CONFIRMED RATE | (4) DEATH | (5) CONFIRMED |
|-----------|------------------------|--------------------|-------------------|-----------|---------------|
|           | SAIs                   | Non-SAIs           | SAIs              | Non-SAIs  | SAIs          | Non-SAIs  |
| COVID19   | -0.470                 | -0.726***          | -1.925***         | -0.616*** | -0.992***     | -0.473*** |
|           | (-1.15)                | (-2.81)            | (-8.20)           | (-3.44)   | (-4.86)       | (-3.10)   |
| FINTECH_D | 1.215**                | 0.263              | 3.189***          | 0.594     | 3.365***      | 1.153***  |
|           | (2.10)                 | (0.82)             | (3.87)            | (1.03)    | (4.66)        | (3.07)    |
| COVID19xFINTECH_D | 1.984**              | -0.763             | 2.432***          | 0.187     | 2.977***      | -1.218    |
|           | (2.53)                 | (-1.26)            | (5.24)            | (0.56)    | (4.46)        | (-1.64)   |
| ASSET     | 0.661***               | 0.703***           | 0.623***          | 0.681***  | 0.607***      | 0.677***  |
|           | (26.87)                | (19.09)            | (25.11)           | (18.43)   | (24.49)       | (18.37)   |
| LIAB      | -0.715***              | -0.724***          | -0.675***         | -0.705*** | -0.656***     | -0.705*** |
|           | (-24.25)               | (-13.88)           | (-22.75)          | (-13.52)  | (-22.13)      | (-13.57)  |
| OPINC     | 3.428***               | 8.470***           | 3.254***          | 7.962***  | 3.261***      | 7.801***  |
|           | (7.75)                 | (11.72)            | (7.47)            | (11.02)   | (7.55)        | (10.79)   |
| GDP       | -0.347***              | -0.091***          | -0.241***         | 0.176**   | -0.330***     | 0.206***  |
|           | (-5.32)                | (-2.05)            | (-3.44)           | (2.44)    | (-2.63)       | (2.84)    |
| HCI       | 0.112***               | 0.068***           | 0.066*            | 0.083***  | 0.018         | 0.076***  |
|           | (3.55)                 | (2.93)             | (1.92)            | (3.33)    | (0.53)        | (3.11)    |
| IDI       | -1.703***              | -0.940***          | -0.370            | -1.016*** | 0.802**       | -0.690**  |
|           | (-6.37)                | (-5.94)            | (-1.16)           | (-4.12)   | (2.04)        | (-2.47)   |
| Constant  | 6.909***               | 4.725***           | -3.199*           | 5.235***  | -11.267***    | 2.927     |
|           | (4.85)                 | (4.45)             | (-1.71)           | (2.95)    | (-3.84)       | (1.53)    |
| Country   | Controlled             | Controlled         | Controlled        | Controlled | Controlled    | Controlled |
| N         | 2,002                  | 2,022              | 2,002             | 2,022     | 2,002         | 2,022     |
| Adjusted $R^2$ | 0.573               | 0.494              | 0.587             | 0.500     | 0.593         | 0.503     |
| F         | 268.995***             | 180.158***         | 237.880***        | 156.475***| 243.580***    | 171.143***|
|           | (185.016***            | (156.475***        | (156.475***       | (171.143***| (185.016***   | (185.344***|

*, **, and *** indicate significance levels of 10%, 5%, and 1% or less, respectively, based on two-tailed tests.
2.53 in regression (1) for example), suggesting that better FinTech applications have a positive mediating effect on firms in such industries. However, we find an insignificant impact for firms in non-SAI s (coefficient = -0.763, t-stat. = 1.26). Since the COVID-19 crisis has changed consumption patterns, these SAIs are better positioned to benefit from the impact of FinTech when they have better FinTech systems that allow them to respond in a timely manner (Donthu and Gustafsson 2020).

The drastic changes caused by the COVID-19 pandemic have had various effects on the business of the retail industry. Severe cash flow problems have occurred due to supply chain disruptions, resulting in retail store closures (Chatterjee et al. 2021). To ease the concern that our results are driven by the retail industry, for robustness, we remove from our sample 108 firms in the retail industry that could have been extremely impacted and re-estimate the regressions. The results, presented in Table 6, hold and consistently support H2.

In our primary tests, FINTECH_D is coded one if the country’s FinTech ranking is higher than the median value. To demonstrate robustness, we limit our sample to firms at the top or bottom 5% based on FinTech rankings. The variable FINTECH_D is redefined as equal to one if the firm is located in a country ranked in the top 5%, and zero if in the bottom 5%. As shown in Table 7, the results remain consistent with our main findings.

We also apply change analysis to ease concerns about potential endogeneity. Specifically, we take the differences between 2019 and 2020 for all the variables except COVID19 and FINTECH_D. The differences for these two variables are not used because there were no COVID-19 cases in March 2019 and the value of FINTECH_D remains unchanged between the two years. The results in Table 8 are generally consistent with our main results and show FinTech applications to have an alleviating on firm value, given the severe virus pandemic.

6 Conclusion

This study finds that a virus pandemic has a significant negative impact on firm value. In addition, we find that FinTech applications alleviate the negative impact of the COVID-19 pandemic on firm value. These findings offer important implications for global regulators and contribute to the literature in several ways. First, this study offers empirical evidence showing that health-related emergencies have a negative impact on firm value. Second, our study provides implications for regulators by empirically documenting the remediating impact of FinTech on the COVID-19 shock. The World Bank (2020) suggests that FinTech firms report an urgent need for regulatory support such as licensing, faster authorization for new activities and service approvals, and less burdensome supervision. Thus, our evidence of the positive mediating effect of FinTech applications on firm value during the COVID-19 pandemic period could offer insights in consideration of further regulatory support. Finally, we echo the World Bank (2020) by offering empirical evidence. Using survey data, the World Bank (2020) has provided rapid assessment of the impact of the COVID-19 pandemic on FinTech firms but still calls for future research to provide more empirical evidence. Our results add to the prior literature on the COVID-19 pandemic and FinTech applications.
Table 6  Regression Analyses of the Mediating Effect of FinTech Applications with the Sample Excluding Retailers

| Variables                  | (1)       | (2)       | (3)       | (4)       | (5)       |
|----------------------------|-----------|-----------|-----------|-----------|-----------|
| CASE FATALITY RATE         | -0.578**  | -1.199*** | -1.806*** | -0.552*** | -0.823*** |
|                           | (-2.39)   | (-7.82)   | (-10.67)  | (-6.33)   | (-7.15)   |
| MORTALITY RATE             | -0.042    | 0.926**   | 0.694**   | 1.492***  | 2.385***  |
|                           | (-0.11)   | (2.42)    | (2.32)    | (3.80)    | (5.34)    |
| CON-FIRMED RATE            | 0.936*    | 1.001***  | 0.927***  | 0.572***  | 0.518**   |
|                           | (1.84)    | (4.61)    | (2.85)    | (4.91)    | (2.48)    |
| COVID19 × FINTECH_D        | -0.764*** | -0.729*** | -0.709*** | -0.748*** | -0.745*** |
|                           | (-34.21)  | (-32.42)  | (-31.43)  | (-33.45)  | (-33.29)  |
| ASSET                      | 0.697***  | 0.665***  | 0.647***  | 0.683***  | 0.680***  |
|                           | (37.79)   | (35.67)   | (34.57)   | (36.95)   | (36.78)   |
| LIAB                       | -0.202*** | 0.058     | 0.136**   | -0.096**  | -0.052    |
|                           | (-5.16)   | (0.93)    | (2.18)    | (-2.29)   | (-1.16)   |
| OPINC                      | 4.301***  | 4.081***  | 4.029***  | 4.163***  | 4.131***  |
|                           | (12.25)   | (11.75)   | (11.66)   | (11.88)   | (11.80)   |
| GDP                        | 0.054***  | 0.049**   | 0.019     | 0.079***  | 0.083***  |
|                           | (2.61)    | (2.40)    | (0.91)    | (3.85)    | (4.03)    |
| HCI                        | -1.031*** | -0.571*** | 0.110     | -1.111*** | -1.122*** |
|                           | (-6.86)   | (-2.61)   | (0.45)    | (-7.50)   | (-7.59)   |
| Constant                   | 5.883***  | 2.404     | -1.137    | 4.257***  | 3.584***  |
|                           | (6.47)    | (1.52)    | (-0.70)   | (4.59)    | (3.73)    |
| Country Controlled         |           |           |           |           |           |
| Industry Controlled        |           |           |           |           |           |
| N                          | 3,916     | 3,916     | 3,916     | 3,916     | 3,916     |
| Adjusted R²                | 0.546     | 0.557     | 0.562     | 0.550     | 0.552     |
| F                          | 277.764***| 274.551***| 296.367***| 299.841***| 284.311***|

*, **, and *** indicate significance levels of 10%, 5%, and 1% or less, respectively, based on two-tailed tests.
Table 7  Regression Analyses of the Mediating Effect of FinTech Applications with the Sample of the Top and Bottom 5% of FinTech Rankings

| Variables          | (1)                  | (2)                  | (3)                  | (4)                  | (5)                  |
|--------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                    | CASE                | MORTALITY RATE       | CONFORMED RATE       | DEATH                | CONFORMED            |
|                    | FATALITY RATE       |                      |                      |                      |                      |
| COVID19            | -1.491*             | -1.189**             | -1.480**             | -1.013**             | -1.348**             |
|                    | (-1.95)             | (-2.55)              | (-2.04)              | (-2.45)              | (-2.17)              |
| FINTECH_D          | 0.991               | 1.290                | 0.886                | 5.109**              | 8.045**              |
|                    | (0.73)              | (0.93)               | (0.63)               | (1.97)               | (2.04)               |
| COVID19×FINTECH_D  | 2.299**             | 1.506**              | 1.946*               | 1.270**              | 1.896*               |
|                    | (2.08)              | (2.50)               | (1.90)               | (1.98)               | (1.67)               |
| ASSET              | 0.761***            | 0.751***             | 0.755***             | 0.755***             | 0.762***             |
|                    | (11.70)             | (11.52)              | (11.54)              | (11.59)              | (11.66)              |
| LIAB               | -0.808***           | -0.796***            | -0.801***            | -0.800***            | -0.803***            |
|                    | (-9.90)             | (-9.75)              | (-9.77)              | (-9.80)              | (-9.80)              |
| OPINC              | 7.703***            | 7.572***             | 7.570***             | 7.546***             | 7.432***             |
|                    | (6.75)              | (6.66)               | (6.63)               | (6.61)               | (6.49)               |
| GDP                | -0.199*             | -0.180               | -0.245**             | 0.142                | 0.196                |
|                    | (-1.65)             | (-1.49)              | (-2.17)              | (0.69)               | (0.80)               |
| HCI                | 0.101               | 0.064                | 0.037                | 0.089                | 0.010                |
|                    | (1.24)              | (0.80)               | (0.46)               | (1.12)               | (0.13)               |
| IDI                | -1.271***           | -0.025               | 0.438                | -1.427***            | -1.388***            |
|                    | (-2.70)             | (-0.94)              | (0.49)               | (-2.96)              | (-3.09)              |
| Constant           | 4.049               | -4.175               | -6.462               | 3.922                | 6.578*               |
|                    | (1.10)              | (-0.83)              | (-0.99)              | (1.08)               | (1.80)               |
| Country Controlled | Controlled          | Controlled           | Controlled           | Controlled           | Controlled           |
| Industry Controlled| Controlled          | Controlled           | Controlled           | Controlled           | Controlled           |
| N                  | 406                 | 406                  | 406                  | 406                  | 406                  |
| Adjusted $R^2$     | 0.570               | 0.574                | 0.571                | 0.572                | 0.569                |
| F                  | 32.615***           | 33.065***            | 32.724***            | 32.851***            | 34.436***            |

*, **, and *** indicate significance levels of 10%, 5%, and 1% or less, respectively, based on two-tailed tests.
Table 8 Change Analysis of the Mediating Effect of FinTech Applications

| ΔMKT  | (1)                       | (2)                       | (3)                       | (4)                       | (5)                       |
|-------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| COVID19 | -0.064*** (2.90)         | -0.063*** (-4.86)         | -0.052*** (-3.67)         | -0.049*** (-4.38)         | -0.062*** (-4.03)         |
| FINTECH_D | 0.240*** (5.14)         | 0.255*** (5.82)          | 0.171*** (4.40)           | 0.439*** (5.84)           | 0.435*** (5.47)           |
| COVID19×FINTECH_D | 0.186*** (2.83)         | 0.086*** (3.02)          | 0.028                     | 0.080*** (4.11)           | 0.090*** (3.79)           |
| ΔASSET | 0.418*** (13.58)         | 0.422*** (13.77)         | 0.426*** (13.89)          | 0.421*** (13.72)          | 0.424*** (13.81)          |
| ΔLIAB  | -0.380*** (-9.79)        | -0.390*** (-10.10)       | -0.396*** (-10.22)        | -0.387*** (-10.02)        | -0.392*** (-10.14)        |
| ΔOPINC | -0.234* (-1.92)          | -0.176 (-1.45)           | -0.169                    | -0.212* (-1.75)           | -0.194 (-1.59)            |
| ΔGDP   | 0.039*** (4.31)          | 0.045*** (5.27)          | 0.058*** (6.70)           | 0.044*** (5.22)           | 0.054*** (6.54)           |
| ΔHCI   | 0.016*** (6.91)          | 0.017*** (7.25)          | 0.016*** (6.89)           | 0.019*** (7.73)           | 0.020*** (7.60)           |
| ΔIDI   | 0.413** (2.17)           | 0.067 (-0.39)            | -0.223                    | 0.876*** (3.53)           | 0.761*** (3.15)           |
| Constant | -0.798*** (-5.60)       | -0.801*** (-5.73)        | -0.582*** (-4.28)         | -1.168*** (-6.19)         | -1.108*** (-5.88)         |
| N      | 3,039                     | 3,039                     | 3,039                     | 3,039                     | 3,039                     |
| Adjusted $R^2$ | 0.122                      | 0.126                      | 0.123                      | 0.125                      | 0.124                      |
| F      | 48.031*** 49.775*** 48.426*** 49.230*** 48.828*** |

*, **, and *** indicate significance levels of 10%, 5%, and 1% or less, respectively, based on two-tailed tests

7 Appendix

Table 1 Variable Definitions

| Variable | Definition |
|----------|------------|
| MKT      | the market value of common equity (in millions of dollars), where the value is divided by 100 to avoid very large regression coefficients. |
| CASE FATALITY RATE | the natural logarithm of the case fatality rate, calculated as the number of deaths divided by the number of confirmed cases by country. |
| MORTALITY RATE | the natural logarithm of the mortality rate, calculated as the number of deaths divided by the total population of the country. |
| CONFIRMED RATE | the natural logarithm of the confirmed rate, calculated as the number of deaths divided by the total population of the country. |
| DEATH | the natural logarithm of the number of deaths by country. |
| CONFIRMED | the natural logarithm of the number of confirmed cases by country. |
| ASSET | the book value of the firm’s total assets. |
| LIAB | the book value of the firm’s total liabilities. |
| OPINC | firm operating income after depreciation. |
Table 1 Variable Definitions

| Variable       | Definition                                                                 |
|----------------|---------------------------------------------------------------------------|
| GDP            | the World Bank’s GDP growth rate.                                        |
| HCI            | CEOWorld Magazine’s Health Care Index.                                    |
| IDI            | International Telecommunication Union’s ICT Development Index.            |
| FINTECH_Rank   | IFZ’s global FinTech hub rankings, where unlisted countries are regarded as the lowest ranked. |
| FINTECH_D      | 1 if a country’s ranking is better than the median ranking of all countries in terms of FINTECH_Rank, and 0 otherwise. |

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Data Availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Conflict of interest No potential conflict of interest was reported by the authors.

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