International Review of Financial Analysis 82 (2022) 102186

Contents lists available at ScienceDirect

International Review of Financial Analysis

journal homepage: www.elsevier.com/locate/irfa

Effects of investor sentiment and country governance on unexpected conditional volatility during the COVID-19 pandemic: Evidence from global stock markets

Yu-Lin Hsu *, Leilei Tang

Department of Accounting and Finance, University of Strathclyde. Level 3, Stenhouse Wing, 199 Cathedral Street, Glasgow G4 0QU, UK

ARTICLE INFO

JEL codes:
G01
G1
G18

Keywords:
COVID-19
Country governance
Investor protection
Investor sentiment
Volatility

ABSTRACT

This paper first investigates the relationship between investor sentiment, captured by internet search behaviour, and the unexpected component of stock market volatility during the COVID-19 pandemic. According to data on 12 major stock markets, our research indicates a positive correlation between the Google search volume index on COVID-19 and the unexpected volatility of stock markets. The result suggests that greater COVID-19-related investor sentiment during this pandemic is associated with higher stock market uncertainty.

Our study further examines whether country-level governance plays a role in protecting stock markets during this pandemic and reveals that the unexpected conditional volatility is lower when a country's governance is more effective. The impact of investor sentiment and country governance on unexpected volatility after the initial shock of COVID-19 is also investigated. The findings demonstrate the importance of establishing good country-level governance that can effectively reduce stock market uncertainty in the context of this pandemic, and support continual policy development related to investor protection.

1. Introduction

COVID-19 has caused vast changes in society and economy. Studies have begun to investigate the effect of this pandemic on stock markets, such as its effect on liquidity, volatility, or stock returns (Baig, Butt, Haroon, & Rizvi, 2021; Mazur, Dang, & Vega, 2021). However, it is not clear which factors reduce the negative financial effects of the pandemic. Debate is ongoing regarding whether superior country-level governance contributed to stock market improvements during the 2007–2009 financial crisis (Paterson, Changwony, & Miller, 2019; Van Essen, Engelen, & Carney, 2013). Unlike the 2007–2009 financial crisis, the COVID-19 pandemic did not originate from dysfunctional economic conditions or imprudent financial policy; it was, arguably, completely unexpected. Goodell (2020) urges researchers to further investigate the role of government in protecting financial markets during this pandemic.

A few studies present early evidence on this topic. For example, Ashraf (2020a) demonstrates that governments' announcements of financial support during the pandemic are associated with higher stock returns. Zaremba, Kizys, Tzouvanas, Aharon, and Demir (2021) provide weak evidence that government effectiveness may help to improve stock market returns during the COVID-19 pandemic. However, Ashraf (2020b) contends that investor protection and regulatory quality are not associated with stock market returns. Because empirical evidence on the relationship between country-level governance and stock markets are inconsistent and limited, our research aims to expand the literature by investigating this relationship in the context of the COVID-19 pandemic. To our knowledge, our paper is the first to examine the association between investor protection and volatility during the COVID-19 pandemic.

This paper analyses whether investor sentiment increases the risks (measured in terms of volatility) associated with global stock markets during the COVID-19 pandemic, and it further investigates whether effective country governance reduces such risks. The internet represents a vital channel for people to obtain information, and this is particularly true during the COVID-19 pandemic, when many people are required to remain at home. Following previous literature (Da, Engelberg, & Gao, 2015; Gao, Ren, & Zhang, 2020), we use the index of COVID-19-related internet search volumes to gauge investor sentiment. Several papers provide early evidence on the relationship between investor sentiment—measured by internet search behaviour—and stock volatility during this pandemic (Smales, 2021; Tripathi & Pandey, 2021). However, these studies are broadly oriented around conditional volatility

* Corresponding author.
E-mail addresses: yulin.hsu@strath.ac.uk (Y.-L. Hsu), leilei.tang@strath.ac.uk (L. Tang).

https://doi.org/10.1016/j.irfa.2022.102186
Received 9 September 2021; Received in revised form 15 March 2022; Accepted 19 April 2022
Available online 22 April 2022
1057-5219/© 2022 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

data but not the unexpected component of volatility, which is a better measure of the financial shocks resulting from the pandemic (Kumar & Dhankar, 2010). Extending previous literature, in our study, we consider the relationship between investor sentiment and the unexpected conditional volatility of stock markets. Consistent with other authors, we consider overall investor protection, protection to minority shareholders, and government effectiveness in analysing the role of country-level governance in mitigating the pandemic's negative effects on stock markets (Ashraf, 2020b; Siekkinen, 2016; Zaremba et al., 2021). Data from 12 major stock markets with different levels of country governance are analysed in this study. Overall, our results indicate that stronger investor sentiment is associated with higher unexpected volatility and that effective country-level governance leads to lower unexpected volatility. We also use a different sample period to examine the impact of investor sentiment and country governance on unexpected volatility after the initial shock of COVID-19.

By exploring the influence of country-level governance on stock market volatility, this study expands on relevant discussions in the literature (see Ashraf, 2020b; Goodell, 2020; Zaremba et al., 2021) and helps to clarify the role of government in protecting financial markets during this pandemic. Our study also contributes to the debate over whether good governance is helpful during a crisis (Paterson et al., 2019; Van Essen et al., 2013). This study, using a better measure of stock market risk (i.e., unexpected conditional volatility) (Kumar & Dhankar, 2010), further clarifies whether internet-based investor sentiment affects stock market risk during this pandemic. The results can assist policy makers in understanding which aspects of effective country-level governance might reduce stock market risk during the COVID-19 pandemic. For example, our paper reveals that more robust investor protection reduces volatility during the pandemic. This result encourages ongoing policy development in increasing investor protection in a similar vein to the 2020 US Securities and Exchange Commission's Best Interest policy aimed at enhancing investor protection, the European Commission's 2020 review of *financial market regulatory framework* (viz., *MiFID II/MiFIR)* in 2020 and the China Securities Regulatory Commission's 2019 establishment of a task force aimed at strengthening investor protection. Our investigation into the post-pandemic period also helps to enhance our understanding of the impact of investor sentiment and country governance on stock markets at different stages of a crisis.

Our paper is structured as follows: Section 2 contains a review of the relevant literature, Section 3 explains our research method, Section 4 presents an analysis of the research results, and Section 5 concludes this study.

2. Literature review and hypothesis development

2.1. Investor sentiment and stock markets

Investor sentiment is proven to be a key factor affecting stock markets (Baker & Wurgler, 2006; Mian & Sankaraguruswamy, 2012). The internet is a critical information source. Consequently, a series of studies analyse the relationship between stock market performance and investor sentiment determined through internet search data (Da et al., 2015; Gao et al., 2020). For example, Khan, Hernandez, and Shahzad (2020) observe that investor sentiment gauged from Google search data is correlated with stock returns of certain US sectors, particularly the technology and consumer discretionary sectors. They suggest that this is both a short- and medium-term effect. Gao et al. (2020), using country-level data, also indicate that investor sentiment based on Google search activity can help to predict stock market returns.

Some of these authors focus on the relationship between internet search-derived investor sentiment and volatility, which is often used to measure the risk and uncertainty of stock markets. For example, Dimpfl and Jank (2016) reveal that a high volume of internet searches on Dow Jones is correlated with higher volatility in the Dow Jones stock market index. Da et al. (2015) also report that investors' fear of negative financial events (e.g., recession or bankruptcy) leads to higher volatility. These studies, which are based on noise trading theory (Black, 1986), suggest that noise trading resulting from investor sentiment variations causes a stock market to deviate from its normal state. Hence, unusual investor sentiment increases volatility (Brown, 1999; Da et al., 2015).

Following these studies, we expect that the shock from this COVID-19 pandemic would affect investor sentiment and that this effect could be captured by internet search behaviour. We hypothesise that increased searches of COVID-19-associated words would indicate stronger investor sentiment that would produce greater stock market volatility. Several papers provide early evidence on this topic. For example, Deb (2021) focuses on three US airlines and shows that internet-derived investor sentiment can help to predict these firms' volatility. Using stock market indexes, Smales (2021) and Tripathi and Pandey (2021) also show that stronger investor sentiment, captured by internet search activity, leads to greater stock market volatility. However, these researchers consider conditional volatility rather than the unexpected component of volatility that is analysed in this paper. The literature indicates the importance of distinguishing between the expected and unexpected components of volatility as they reflect the fundamentals and deviations of the stock markets, respectively (Kumar & Dhankar, 2010). Hence, the unexpected conditional volatility investigated in this paper is a better measure, than expected volatility, of uncertainty resulting from the current pandemic. In keeping with the research of Brown (1999), Da et al. (2015), and Smales (2021), we propose the following hypothesis in this study:

Hypothesis 1. Stronger investor sentiment owing to COVID-19, as measured by the index of COVID-19-related internet search volumes, is positively associated with unexpected stock market volatility.

2.2. Country governance

Governance is a crucial area of interest in accounting and finance, and it can be analysed at the firm or country level (Nguyen, Locke, & Reddy, 2015; Van Essen et al., 2013). Corporate governance, compared with country governance, attracts more attention in academic literature. Paterson et al. (2019) indicate a research gap related to country-level governance and suggest that future research should investigate the role of such governance in protecting stock markets by using country-level data. Therefore, our research focuses on country governance.

Unlike the 2007–2009 financial crisis, the COVID-19 crisis arose from a global health crisis. Both crises, however, critically affect global stock markets. Hence, reviewing the literature on financial crises may help to understand the current COVID-19-related financial crisis. Numerous studies investigate whether sound country-level governance helped mitigate the negative effects on stock markets or improve audit quality during the 2007–2009 financial crisis. Some researchers argue that countries with superior governance and investor protection suffered less severe consequences during that crisis. For example, Persakis and Iatridis (2016) discover that firms in countries with stronger investor protection record higher earnings quality. Enikolopov, Petrova, and Stepanov (2014) consider several components of country governance, including government effectiveness and legal protection to minority shareholders, and they demonstrate that firms in countries with efficient governance suffered less severe reductions in firm value during the 2007–2009 financial crisis due to greater transparency of information in those countries. However, discussion is ongoing as to whether good governance can effect positive change (e.g., reducing stock market risk) during financial crises (Paterson et al., 2019; Van Essen et al., 2013). Our research adds to this discussion.

Until now, studies on COVID-19 in accounting and finance principally discuss the pandemic's implications and document its negative effects on stock markets (Baig et al., 2021; Mazur et al., 2021; Smales, 2021). However, suggestions on how to assist various countries in minimising the detrimental effects of COVID-19 on their stock markets

Table 1
Descriptive statistics of key variables.

	Internet search (COVID-19) percentiles					Unexpected volatility percentiles				
Country	10%	25%	50%	75%	90%	10%	25%	50%	75%	90%
US	1	12	37	58	90	−0.00001	0.00006	0.00024	0.00108	0.00276
UK	1	13	42	53	78	−0.00002	0.00011	0.00024	0.00061	0.00143
Germany	2	13	41	51	59	0.00000	0.00022	0.00037	0.00078	0.00169
Japan	4	8	12	18	39	−0.00003	0.00000	0.00004	0.00033	0.00061
China	0	26	39	60	71	−0.00031	−0.00029	−0.00017	−0.00010	−0.00006
HK	14	23	36	50	62	−0.00001	0.00002	0.00014	0.00020	0.00035
Brazil	1	3	74	84	89	−0.00001	0.00018	0.00035	0.00159	0.00396
Russia	1	3	33	40	50	−0.00001	0.00006	0.00016	0.00051	0.00096
India	1	2	65	72	78	−0.00001	0.00009	0.00024	0.00085	0.00147
Sweden	2	17	32	48	66	0.00001	0.00018	0.00033	0.00057	0.00117
Spain	1	7	40	59	76	0.00001	0.00017	0.00028	0.00080	0.00222
Italy	1	16	52	62	71	−0.00002	0.00006	0.00023	0.00086	0.00240

are limited. A few COVID-19 studies analyse the relationship between country-level governance and stock market returns during the pandemic, but their results are inconsistent. For example, Zaremba et al. (2021) find a positive association between government effectiveness and stock market returns, but their findings are not sufficiently robust (at the 10% significance level). Furthermore, Ashraf (2020b) does not find a significant relationship between country-level governance (measured by investor protection levels and regulatory quality) and stock market returns. In discussing another health crisis, Lee (2009) indicates that government effectiveness in dealing with severe acute respiratory syndrome (SARS) markedly affected the confidence of the general public. When a government fails to respond to a crisis effectively, greater uncertainty arises.

Thus, the role of country-level governance in protecting stock markets during this COVID-19 pandemic remains unclear, and the literature emphasises the importance of investigating this issue (Goodell, 2020). Hence, our paper addresses this research gap by examining the relationship between country governance (including government effectiveness and investor protection) and stock market volatility (i.e., risk) during the COVID-19 pandemic. On the basis of agency theory and the work of Enikolopov et al. (2014), we expect that during the COVID-19 pandemic, the agency problem would be less severe and information more transparent in countries where investor protection is stronger. Additionally, effective governments make the general public, including investors, more confident in their government during a crisis (Lee, 2009). Consequently, stock market risk is lower in countries with better governance. However, Van Essen et al. (2013) contend that good national governance may not be helpful during a crisis such as the 2007–2009 one. Hence, our study also examines a second hypothesis as follows:

Hypothesis 2. The quality of country-level governance is associated with unexpected stock market volatility during the COVID-19 pandemic.

3. Sample and research methods

3.1. Sample and data

We obtain daily stock market index data from the Datastream database for the period from 4 January 2010 to 10 June 2020. We use a long sample duration to enhance the accuracy of estimations on expected and unexpected volatility, as suggested in prior studies (Christensen & Prabhala, 1998). For the analysis in Section 4, we focus on the period from 11 February 2020 to 10 June 2020. We name this period the "pandemic period" because the World Health Organisation (WHO) officially termed this disease "COVID-19" on 11 February 2020 (World Health Organization (WHO), 2020a). We consider 12 key stock markets (see Table 1 for complete list) with varying levels of country governance. In total, our sample data contain 1032 country-day observations.

As per the studies of Ashraf (2020b), Enikolopov et al. (2014), Siekkinen (2016), Van Essen et al. (2013), and Zaremba et al. (2021), we use three commonly used metrics for gauging country-level governance.[1] The first is the "anti-self-dealing index" conceived by Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008), which measures the legal protection of minority shareholders. This index is calculated by the hurdles that the controlling shareholder needs to overcome to get away with a stylized self-dealing transaction, to capture how the law deals with self-dealing (Djankov et al., 2008). A higher hurdle leads to a higher anti-self-dealing index, implying higher protection to minority shareholders. The second governance metric is the "government effectiveness index" developed by the World Bank (2020). This index is constructed based on survey responses, regarding the country governance, from experts, citizens, and companies. This index assesses the effectiveness of a government, including its "quality of policy formulation and implementation". The third metric we employ is the "strength of investor protection" ranking published by the World Economic Forum (2020). This ranking combines three investor protection related indices (i.e., "the extent of disclosure index, the extent of director liability index and the ease of shareholder suit index") published by the World Bank based on questionnaire responses from experts worldwide. Furthermore, we collect the data of the internet search volume index for the search terms "coronavirus" and "COVID-19" from Google Trends.

3.2. Empirical strategy

Our empirical strategy for estimating the association between internet searches using COVID-19-associated terms and stock market volatility as well as the role of effective country-level governance in mitigating that volatility worldwide consists of a two-stage regression approach. The first-stage regression generates unexpected conditional volatility for each market during the pandemic period. The unexpected conditional volatility is defined as the difference between the actual volatility and the expected volatility had the pandemic not happened. As mentioned in Section 2.1, distinct from the expected conditional volatility discussed in the literature (see Smales, 2021; Tripathi & Pandey, 2021), unexpected conditional volatility more precisely captures the financial shocks resulting from a crisis scenario (Kumar & Dhankar, 2010). To measure the unexpected volatility, we initially divide the sample period into two periods: the pre-pandemic period (4 January 2010 to 10 February 2020) and pandemic period (11 February 2020 to 10 June 2020). We then apply the GARCH(1,1), EGARCH(1,1), and GJR-GARCH(1,1) models to estimate the expected conditional volatility for the pre-pandemic period.

[1] The three governance variables remain unchanged within a particular country during the sample period. We use the most recent data for these three variables when the research was conducted. Specifically, the anti-self-dealing index, the government effectiveness index, and the ranking of investor protection were published in 2008, 2018 and 2017, respectively.

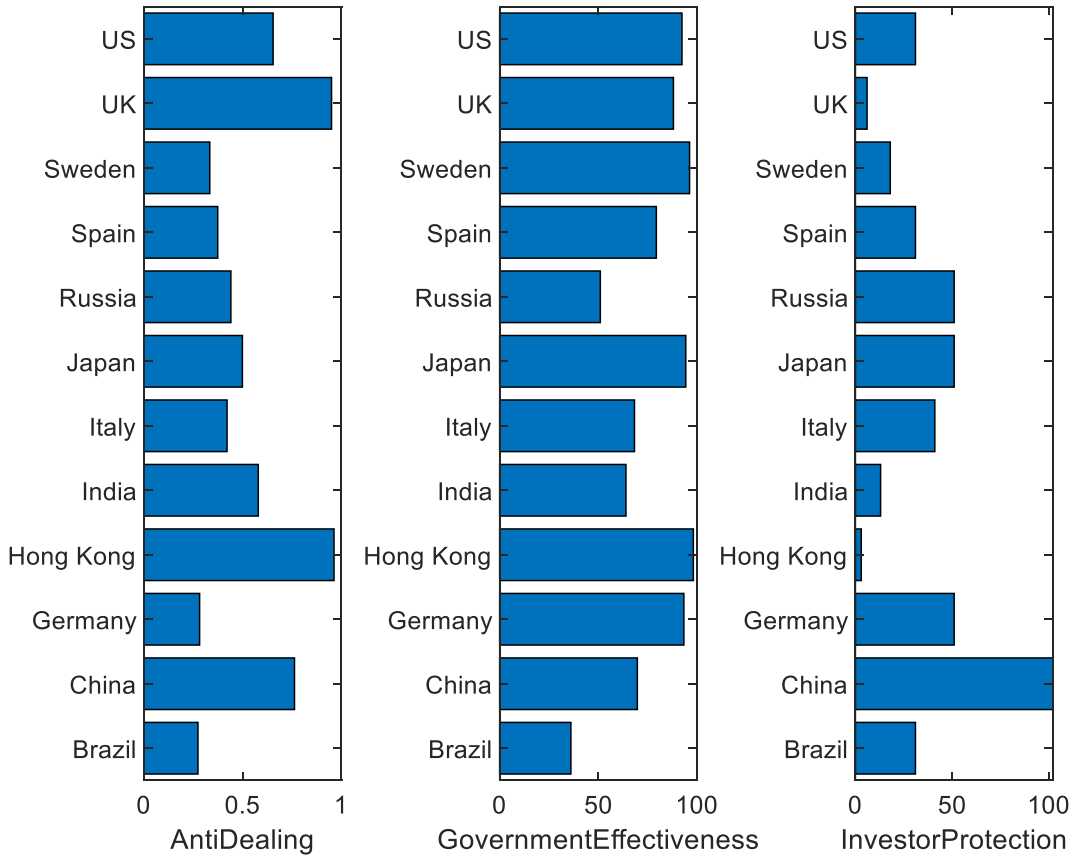

Fig. 1. Country-level governance variables.
Note: The left horizontal histogram presents the anti-self-dealing index (ranging from 0 to 1, where 1 indicates the highest protection to minority investors). The middle horizontal histogram shows the government effectiveness index (ranging from 0 to 100, where 100 indicates the highest effectiveness). The right horizontal histogram presents the overall investor protection ranking (ranging from 1 to 137, where 1 represents the highest investor protection).

Since the volatility of stock returns is often clustered and persistent, Engle (1982) first proposed the autoregressive conditional heteroscedasticity (ARCH) model to estimate the conditional volatility. To improve the model efficiency, Bollerslev (1986) generalized the ARCH model (i.e., became the GARCH model) to model the persistent movement in volatility without the need to estimate a large number of coefficients. Glosten, Jagannathan, and Runkle (1993) further generalized the GARCH model (i.e., became the GJR-GARCH model) to allow for the asymmetry effect of volatility (i.e., negative shocks tend to have larger impact on stock market volatility than positive shocks). When the leverage coefficient (i.e., γ which captures the asymmetric effect of volatility) equals zero, the GJR-GARCH model will reduce to the GARCH model. The asymmetric effect of volatility can also be estimated by the EGARCH model, proposed by Nelson (1991). The advantage of EGARCH model is that its specification ensures the conditional volatility is positive.

The GARCH, EGARCH, and GJR-GARCH models are widely used in estimating stock volatility. Both EGARCH and GJR-GARCH models can account for the asymmetry and leverage effect of stock volatility (i.e., positive and negative shocks would have different effects on conditional volatility), whereas the standard GARCH model is symmetric in the sense that positive and negative shocks have the same effect.[2] Using these three models, we can consider different situations in stock markets and ensure the robustness of our results. We assume that daily stock index returns for country i are defined as follows: $r_{it} = \mu_i + \varepsilon_{it}$ where $\varepsilon_{it} = \sigma_{it} z_{it}$ and $z_{it} \sim i.i.d(0,1)$. Thus, GARCH, EGARCH, and GJR-GARCH models are given as follows:.

$$\begin{aligned} GARCH(1,1): \quad & \sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \\ EGARCH(1,1): \quad & log\left(\sigma_t^2\right) = \varpi + \alpha\left(|z_{t-1}| - E(|z_{t-1}|)\right) + \gamma z_{t-1} + \beta log\left(\sigma_{t-1}^2\right) \end{aligned} \tag{1}$$

$$GJR-GARCH(1,1): \sigma_t^2 = \omega + (\alpha + \gamma I_{t-1})\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \text{ where } I_{t-1} = \begin{cases} 0 \text{ if } r_{t-1} \geq \mu \\ 1 \text{ if } r_{t-1} < \mu \end{cases}$$

After the estimation of the conditional volatility over the pre-pandemic period, we forecast the daily conditional volatility for the pandemic period in each country based on the estimation results from the pre-pandemic period. The forecast daily conditional volatility for the pandemic period τ is denoted by $\widetilde{\sigma_\tau^2}$. We treat $\widetilde{\sigma_\tau^2}$ as expected conditional volatility had the pandemic not happened. We repeat the conditional volatility estimations for both the pre-pandemic and pandemic periods to generate the actual conditional volatility for the pandemic period: $\overset{2}{\underset{\tau}{\sigma}}\wedge$. Therefore, the unexpected conditional volatility is the difference between the actual volatility and the expected volatility:

$$\sigma_\tau^2 = \overset{2}{\underset{\tau}{\sigma}}\wedge - \widetilde{\sigma_\tau^2} \tag{2}$$

In the second stage, we investigate the influence of internet searches using COVID-19-associated terms (and country-level governance) on the unexpected conditional volatility, σ_τ^2. Because our data are hierarchically structured (i.e., governance-related variables are at the country level and unexpected conditional volatility is nested within countries),

[2] Further details of these three GARCH-family models are provided by Hentschel (1995).

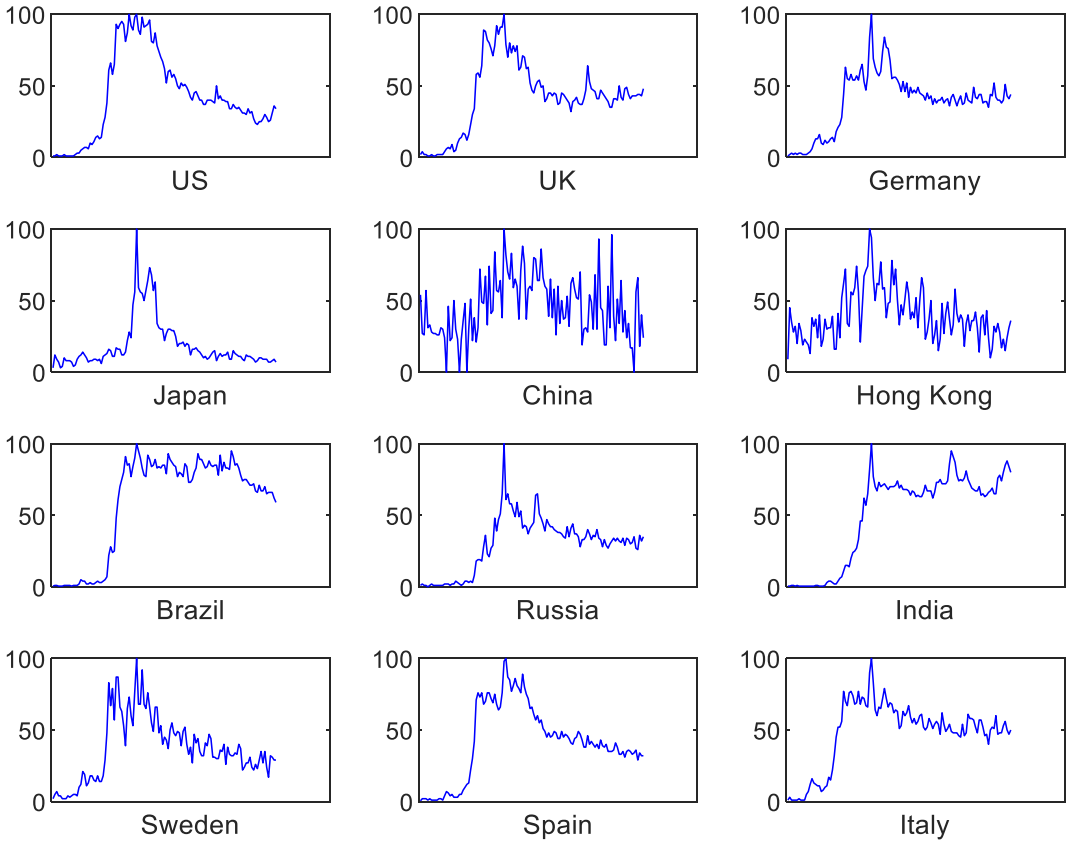

Fig. 2. Google search volume index on "COVID-19" during the pandemic period.

our model considers the nature of hierarchical data (Klein & Kozlowski, 2000). In our study, investors within a country are subject to the same country-level governance; this is called "hierarchical nesting" (Van Essen et al., 2013). A multilevel mixed effect model is superior to a standard ordinary least squares (OLS) regression model and more suitable in this case because OLS regressions too often reject the null hypothesis when a data set has a hierarchical structure. Hence, we estimate the effect of internet searches on the unexpected stock market volatility for each country in the pandemic period using a multilevel mixed effect model:

$$\begin{aligned} \sigma^2_{\tau i} &= \beta_{0i} + \beta_{1i} Google_{\tau i} + e_{\tau i} \\ \beta_{0i} &= \gamma_{00} + \gamma_{01} Gov_i \\ \beta_{1i} &= \gamma_{10} + \gamma_{11} Gov_i \end{aligned} \tag{3}$$

Where $\sigma^2_{\tau i}$ is the daily unexpected stock volatility for country i, $Google_{\tau i}$ denotes the daily Google search volume index for COVID-19 associated terms, and Gov_i refers to country-specific governance variables. As mentioned previously, three country-level governance metrics are investigated in this study: (1) the anti-self-dealing index (ranging from 0 to 1, where 1 indicates the highest protection to minority investors), (2) the government effectiveness index (ranging from 0 to 100, where 100 indicates the highest effectiveness), and (3) the investor protection ranking (ranging from 1 to 137, where 1 represents the highest overall investor protection).

4. Results and discussion

4.1. Descriptive statistics, and key observations related to markets and internet searches

We consider 12 key stock markets with varying levels of country governance, as determined using the three aforementioned metrics (see Fig. 1). The left horizontal histogram (based on the anti-self-dealing index) in Fig. 1 shows that the United Kingdom and Hong Kong have the best protection of minority shareholders, whereas Brazil and Germany provide the least protection to minority shareholders. The middle horizontal histogram (government effectiveness) in Fig. 1 shows that the governments of Hong Kong and Sweden—followed by the Japanese, German, and US governments—are the most effective, whereas the Brazilian and Russian governments are ranked as the least effective. Finally, the right horizontal histogram (based on investor protection rankings) illustrates that overall investor protection is highest in the United Kingdom and Hong Kong, whereas China has the lowest overall investor protection in our sample.

Table 1 presents descriptive statistics of the key variables in our study, namely the internet search volume index on COVID-19 (to gauge investor sentiment) and unexpected stock market volatility, for each country. The means of these two variables are different across different countries. Among the sampled countries, the mean value for daily internet search volume index on COVID-19 during the pandemic period (11 February 2020 to 10 June 2020) is highest in Japan and lowest in Brazil. Furthermore, unlike other countries, the mean of unexpected stock market volatility is negative in China. This may be explained by the findings of Wan, Cheng, and Yang (2014), who suggest that the individual investors who dominate the Chinese stock market tend to chase good news and respond less to bad news, resulting in a positive relationship between stock return and volatility. This phenomenon distinguishes China from most of the stock markets in the developed countries, where the main investors are institutional investors and a negative relationship between stock return and volatility is often observed. Hence, when the stock market performance is low (such as during the pandemic), a low stock volatility is observed in the Chinese market.

Figs. 2 and 3 further present the fluctuations of the internet search volume index on COVID-19 (as a measure of investor sentiment) and

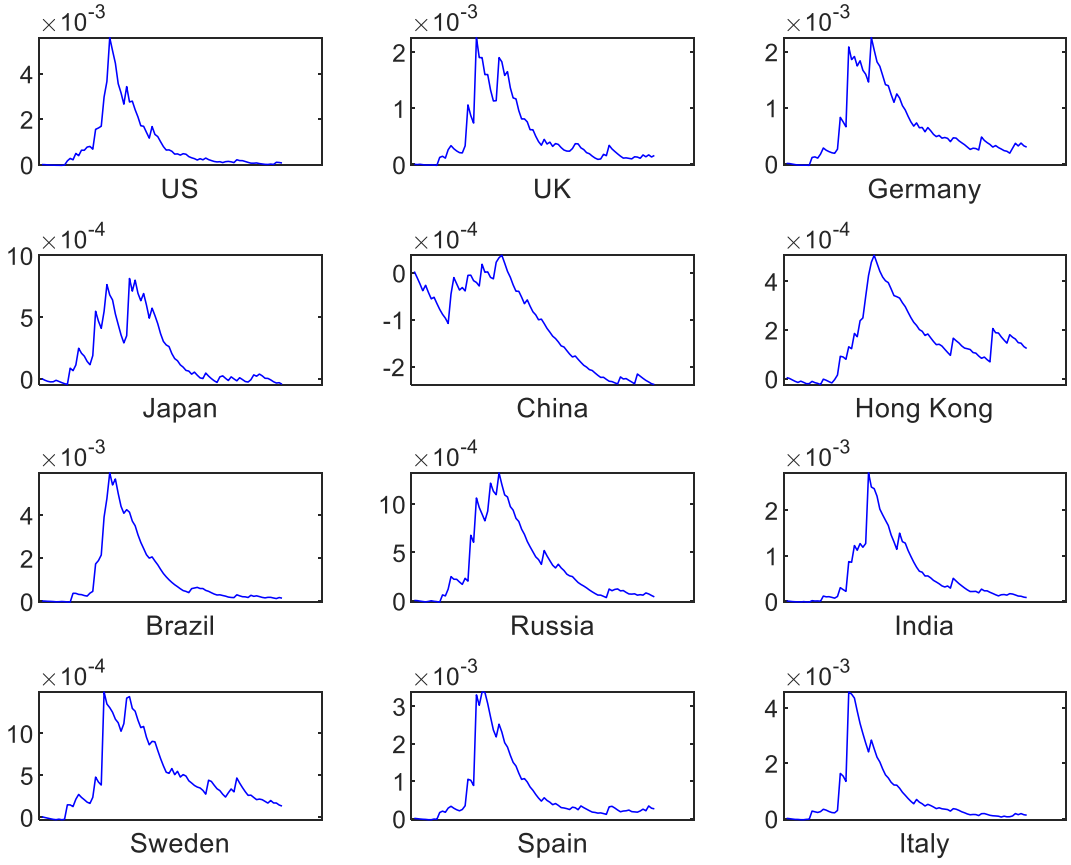

Fig. 3. Unexpected stock market volatilities during the pandemic period.

unexpected stock market volatility for each country during the pandemic period. Fig. 2 shows that the internet search volume index on COVID-19 rose sharply in most of the countries at the beginning of the pandemic, reached a peak at similar time (i.e., approximately 27 March 2020), and then started to decrease. Particularly large daily fluctuations in the internet search volume index on COVID-19 are observed in China and Hong Kong. The internet search volume index on COVID-19 in Brazil stayed at the peak level for a long period, whereas in Japan, the search volume index decreased quickly after the peak and generally remained low thereafter. The number of daily confirmed cases of COVID-19 in Japan started to decrease from the middle of April 2020, whereas in Brazil the cases continued to increase throughout the sample period (World Health Organization (WHO), 2020c). Variations in the COVID-19 outbreak severity and accompanying anti-infection measures in Japan and Brazil may explain the differences in investor sentiment (measured by internet search activity) in these two countries.

Furthermore, Fig. 3 indicates that the unexpected stock market volatilities for each country reached their peaks at a similar time (i.e., all

Table 2
Empirical results (COVID-19).

	GARCH			EGARCH			GJR_GARCH		
Variables	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Constant	0.0540	0.2751	−0.80***	0.1560	0.2240	−0.39***	0.1569	0.3891	−0.85***
	(0.21)	(0.31)	(0.11)	(0.14)	(0.21)	(0.08)	(0.27)	(0.03)	(0.15)
Internet Search Volume Index	0.2992***	0.2982***	0.2948***	0.1762***	0.1749***	0.1718***	0.3413***	0.3394***	0.3338***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Anti-Self-Dealing	−1.009***			−0.6886**			−1.230***		
	(0.45)			(0.28)			(0.55)		
Government Effectiveness		−0.994***			−0.5692*			−1.1604**	
		(0.44)			(0.29)			(0.53)	
Investor Protection			1.4027**			0.8328**			1.5674**
			(0.55)			(0.31)			(0.59)
LR test	93.29	130.7	128.2	50.21	83.66	128.2	62.05	89.95	89.41
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

There are 1032 country-day observations. The internet search volume index for "COVID-19" is used here. *Anti-Self-Dealing* refers to the anti-self-dealing index (ranging from 0 to 1, where 1 indicates the highest protection to minority investors). *Government Effectiveness* is the government effectiveness index (ranging from 0 to 100, where 100 indicates the highest effectiveness). *Investor Protection* is the overall investor protection ranking (ranging from 1 to 137, where 1 represents the highest investor protection).

Values in parentheses are estimated standard errors. Values in brackets are *p*-values. LR denotes the log-likelihood ratio test which follows the chi-square distribution with one degree of freedom. *, ** and *** denote the significance level at 10%, 5% and 1%, respectively.

Table 3
Empirical results (coronavirus).

	GARCH			EGARCH			GJR_GARCH		
Variables	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Constant	−0.685**	−0.4919	−1.97***	−0.575***	−0.525**	−1.48***	−1.038***	−0.841**	−2.66***
	(0.23)	(0.34)	(0.12)	(0.15)	(0.23)	(0.08)	(0.29)	(0.42)	(0.15)
Internet Search Volume Index	0.6277***	0.6269***	0.6242***	0.4740***	0.4732***	0.4707***	0.8407***	0.8383***	0.8349***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Anti-Self-Dealing	−1.3809**			−0.9588**			−1.7176**		
	(0.51)			(0.32)			(0.63)		
Government Effectiveness		−1.2147**			−0.7351**			−1.4542**	
		(0.49)			(0.33)			(0.61)	
Investor Protection			2.3381**			1.6472**			2.9596**
			(0.78)			(0.53)			(0.98)
LR test	148.7	232.4	259.2	91.89	176.5	192.5	106.7	177.5	201.3
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

There are 1032 country-day observations. The internet search volume index for "coronavirus" is used here. *Anti-Self-Dealing* refers to the anti-self-dealing index (ranging from 0 to 1, where 1 indicates the highest protection to minority investors). *Government Effectiveness* is the government effectiveness index (ranging from 0 to 100, where 100 indicates the highest effectiveness). *Investor Protection* is the overall investor protection ranking (ranging from 1 to 137, where 1 represents the highest investor protection).
Values in parentheses are estimated standard errors. Values in brackets are *p*-values. LR denotes the log-likelihood ratio test which follows the chi-square distribution with one degree of freedom. *, ** and *** denote the significance level at 10%, 5% and 1%, respectively.

Table 4
Empirical results (COVID-19 and coronavirus).

	GARCH			EGARCH			GJR_GARCH		
Variables	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Constant	−0.6227**	−0.4006	−1.60***	−0.3888	−0.3191	−1.02***	−0.7798**	−0.5453	−1.94***
	(0.22)	(0.32)	(0.13)	(0.15)	(0.21)	(0.10)	(0.28)	(0.40)	(0.18)
Internet Search Volume Index	0.4375***	0.4367***	0.4329***	0.2951***	0.2940***	0.2902***	0.5413***	0.5396***	0.5330***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.03)
Anti-Self-Dealing	−1.0961**			−0.7432**			−1.333***		
	(0.47)			(0.28)			(0.56)		
Government Effectiveness		−1.0563**			−0.6101**			−1.2355**	
		(0.45)			(0.30)			(0.55)	
Investor Protection			1.7225**			1.0617**			1.9822**
			(0.55)			(0.34)			(0.69)
LR test	109.7	159.4	162.2	59.11	104.7	103.1	72.34	110.6	113.7
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

There are 1032 country-day observations. The internet search volume index for "COVID-19" and "coronavirus" is used here. *Anti-Self-Dealing* refers to the anti-self-dealing index (ranging from 0 to 1, where 1 indicates the highest protection to minority investors). *Government Effectiveness* is the government effectiveness index (ranging from 0 to 100, where 100 indicates the highest effectiveness). *Investor Protection* is the overall investor protection ranking (ranging from 1 to 137, where 1 represents the highest investor protection).
Values in parentheses are estimated standard errors. Values in brackets are *p*-values. LR denotes the log-likelihood ratio test which follows the chi-square distribution with one degree of freedom. *, ** and *** denote the significance level at 10%, 5% and 1%, respectively.

peaks occurred between 13 March and 30 March 2020), similar to the situation seen in the internet search volume index on COVID-19. COVID-19 was officially declared a pandemic by World Health Organization (WHO) (2020b) on 11 March 2020, and many countries started their first lockdown or stay at home policy soon after that (e.g., Germany on 19 March, the United Kingdom on 23 March 2020, and India on 25 March 2020). Unexpected stock market volatilities (as well as the internet search volume index on COVID-19) reached a peak directly after these announcements. The findings here suggest that key (negative) announcements related to COVID-19 strongly affects investor sentiment and increases stock market uncertainty.

4.2. Analysis of results

This section details the regression analysis results for hypothesis testing. We examine whether investor sentiment (captured by the index of COVID-19-related internet search volumes) and the quality of country-level governance affect unexpected stock market volatility during the COVID-19 pandemic. Tables 2 and 3 show the results based on the search volume index for the terms "COVID-19" and "coronavirus", respectively. Table 4 illustrates the results based on the combined index of internet search volumes for these two terms. In the beginning of the pandemic, the term "coronavirus" is often used. However, later in the pandemic, the use of "COVID-19" becomes more common. Hence, Tables 2–4 using different search terms will help to confirm the robustness of our findings.

As presented in Table 2, the results derived from the GARCH, EGARCH and GJR-GARCH models are consistent. When the internet search volume index on COVID-19 is higher within a country, the unexpected volatility of that country's stock market is higher. Hence, during this pandemic, stronger COVID-19-driven investor sentiment increases the risk levels in stock markets. This result is consistent with the first of our hypotheses as well as the results of other studies indicating that shocks resulting from crisis events lead to higher stock market volatility (Brown, 1999; Da et al., 2015).

Furthermore, Table 2 shows that higher protection to minority investors (as in the anti-self-dealing index) lowers unexpected stock volatility. Similarly, when the ranking of overall investor protection (as measured by the investor protection rankings) is higher, the unexpected stock volatility is lower. These results suggest that during the COVID-19

Table 5
Empirical results (COVID-19 and coronavirus) for the post-pandemic period (11 June 2020–31 December 2020).

	GARCH			EGARCH			GJR_GARCH		
Variables	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Constant	−0.0305	−0.1043	−0.061***	−0.087**	−0.1561**	−0.112***	−0.0710*	−0.1043*	−0.061***
	(0.04)	(0.05)	(0.02)	(0.042)	(0.067)	(0.015)	(0.038)	(0.054)	(0.016)
Internet Search Volume Index	0.0247***	0.0252***	0.0249	0.0323***	0.0325***	0.0324***	0.0290***	0.0252***	0.0249***
	(0.001)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.04)	(0.003)
Anti-Self-Dealing	−0.1161			−0.0949			−0.0790		
	(0.09)			(0.09)			(0.08)		
Government Effectiveness		0.0132			−0.0212			0.0132	
		(0.08)			(0.100)			(0.07)	
Investor Protection			−0.0530			−0.0059			−0.0530
			(0.055)			(0.09)			(0.055)
LR test	635.8	590.7	285.2	1102.0	1038.7	483.2	541.35	590.7	286.1
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

There are 1740 country-day observations for the post-pandemic period. The internet search volume index for "COVID-19" and "coronavirus" is used here. *Anti-Self-Dealing* refers to the anti-self-dealing index (ranging from 0 to 1, where 1 indicates the highest protection to minority investors). *Government Effectiveness* is the government effectiveness index (ranging from 0 to 100, where 100 indicates the highest effectiveness). *Investor Protection* is the overall investor protection ranking (ranging from 1 to 137, where 1 represents the highest investor protection).
Values in parentheses are estimated standard errors. Values in brackets are ***p***-values. LR denotes the log-likelihood ratio test which follows the chi-square distribution with one degree of freedom. *, ** and *** denote the significance level at 10%, 5% and 1%, respectively.

pandemic, when more protection is given to investors, the risks to stock markets are lower. The results accord with agency theory as well as the work of Enikolopov et al. (2014), who indicate that stronger investor protection enhances information transparency and alleviates the agency problem during a crisis, thus lowering stock market risks.

Moreover, Table 2 illustrates that unexpected stock market volatility is lower when the presiding government is more effective (as per the government effectiveness index). Importantly, this suggests that governments' effectiveness in formulating and implementing relevant policies could reduce stock market risks during the current pandemic. The result is also consistent with those in the literature, indicating that government effectiveness can increase the confidence of the public, including investors, and reduce uncertainty during a crisis (Enikolopov et al., 2014; Lee, 2009). The findings support continual efforts from policy makers, in countries such as the United States and China, in improving investor protection and government effectiveness. Whether we consider investor sentiment derived from another single search term "coronavirus" (see Table 3), or from the combined internet search volume index on "COVID-19" and "coronavirus" (see Table 4), the same conclusions apply. The results suggest that different search terms can help to capture the investor sentiment towards COVID-19 and which search term is used is not crucial (as long as it is related to COVID-19) in determining the strength of investor sentiment.

4.3. Additional analysis: Post-pandemic period

To offer additional insights into the effect of investor sentiment and country-level governance, we further investigate how the internet searches and country-level governance impact unexpected stock market volatilities for the period from 11 June 2020 to 31 December 2020 when the initial shock of COVID-19 started to subside. We define this period as the "post-pandemic period". As can be seen in Fig. 3 reported earlier, the unexpected volatility began to diminish later in the pandemic period (i.e., 11 February 2020 to 10 June 2020). Hence, examining the situation in the post-pandemic period will help to further enhance our understanding of the role of investor sentiment and country-level governance. In Table 5, we re-examine the multilevel mixed effect model for the post-pandemic period, using the combined Google search volume index for "COVID-19" and "coronavirus". The estimation results show that investor sentiment (measured by the internet search volume index) still has a significant impact on unexpected stock market volatility. However, the magnitude of its impact (which can be seen from the coefficients of the internet search volume index) is much smaller than that seen in the pandemic period, suggesting the impact of COVID-19 associated investor sentiment on unexpected volatility decreased after the initial shock of COVID-19. This may be because the development of vaccines and the better understanding of COVID-19 later in this pandemic boost investors' confidence and reduce the uncertainty, hence weakening the effect of COVID-19 associated investor sentiment on stock markets.

Another interesting finding is that all country governance variables become statistically nonsignificant in the post-pandemic period. This finding suggests that country governance matters more during the period of crisis. Therefore, it is crucial for countries to establish good governance practice which is particularly helpful to reduce stock market uncertainty when a crisis is severe.

5. Conclusion

This study investigates whether investor sentiment and country-level governance affect stock markets in terms of unexpected conditional stock market volatility. Using data from 12 major stock markets, we demonstrate that higher investor sentiment (as captured by the index of COVID-19-related internet search volumes) would increase unexpected volatility during the COVID-19 pandemic. Furthermore, the legal protection to minority shareholders, the strength of overall investor protection, and government effectiveness significantly affect unexpected stock market volatility. When country governance—as measured by our three selected metrics—is more effective, unexpected stock market volatility (i.e., the risk) tends to be lower during the pandemic period.

Additionally, we examine how investor sentiment and country-level governance affect stock markets after the initial shock of COVID-19. The results show that higher investor sentiment still leads to higher unexpected stock market volatility, but the magnitude of the effect decreased in the post-pandemic period. Moreover, country governance variables are not significantly associated with unexpected volatility in the post-pandemic period, suggesting that country governance matters more when a crisis is severe.

Our findings indicate that a country must have robust investor protection and effective government to maintain investor confidence and reduce stock market volatility during large-scale and unpredictable events. Thus, our results support continual policy development to enhance country governance and investor protection. To our knowledge, this is the first study to investigate whether investor protection affects stock market volatility during the COVID-19 pandemic. This is also the first research to show that the impact of investor sentiment and country governance on unexpected stock market volatility changed after the

initial shock of COVID-19. Our study adds to the discussion on whether effective country governance improves stock market-related outcomes during a crisis (Ashraf, 2020b; Paterson et al., 2019; Van Essen et al., 2013) and extends current literature on the impact of investor sentiment on stock markets during the COVID-19 pandemic (Smales, 2021; Tripathi & Pandey, 2021).

CRediT authorship contribution statement

Yu-Lin Hsu: Conceptualization, Investigation, Writing – original draft, Writing – review & editing, Visualization, Project administration. **Leilei Tang:** Methodology, Software, Formal analysis, Investigation, Data curation, Writing – original draft, Visualization.

Declaration of Competing Interest

None.

This research did not receive any specific grant from funding agencies.

References

Ashraf, B. N. (2020a). Economic impact of government interventions during the COVID-19 pandemic: International evidence from financial markets. *Journal of Behavioral and Experimental Finance, 27*, 100371.
Ashraf, B. N. (2020b). Stock markets' reaction to COVID-19: Moderating role of national culture. *Finance Research Letters*, 101857.
Baig, A. S., Butt, H. A., Haroon, O., & Rizvi, S. A. R. (2021). Deaths, panic, lockdowns and US equity markets: The case of COVID-19 pandemic. *Finance Research Letters, 38*, 101701.
Baker, M., & Wurgler, J. (2006). Investor sentiment and the cross-section of stock returns. *The Journal of Finance, 61*(4), 1645–1680.
Black, F. (1986). Noise. *The Journal of Finance, 41*(3), 528–543.
Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics, 31*(3), 307–327.
Brown, G. W. (1999). Volatility, sentiment, and noise traders. *Financial Analysts Journal, 55*(2), 82–90.
Christensen, B. J., & Prabhala, N. R. (1998). The relation between implied and realized volatility. *Journal of Financial Economics, 50*(2), 125–150.
Da, Z., Engelberg, J., & Gao, P. (2015). The sum of all FEARS investor sentiment and asset prices. *The Review of Financial Studies, 28*(1), 1–32.
Deb, S. (2021). Analyzing airlines stock price volatility during COVID-19 pandemic through internet search data. *International Journal of Finance & Economics*. https://doi.org/10.1002/ijfe.2490
Dimpfl, T., & Jank, S. (2016). Can internet search queries help to predict stock market volatility? *European Financial Management, 22*(2), 171–192.
Djankov, S., La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2008). The law and economics of self-dealing. *Journal of Financial Economics, 88*(3), 430–465.
Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica, 50*(4), 987–1007.
Enikolopov, R., Petrova, M., & Stepanov, S. (2014). Firm value in crisis: Effects of firm-level transparency and country-level institutions. *Journal of Banking & Finance, 46*, 72–84.
Gao, Z., Ren, H., & Zhang, B. (2020). Googling investor sentiment around the world. *Journal of Financial and Quantitative Analysis, 55*(2), 549–580.
Glosten, L. R., Jagannathan, R., & Runkle, D. E. (1993). On the relation between the expected value and the volatility of the nominal excess return on stocks. *Journal of Finance, 48*(5), 1779–1801.
Goodell, J. W. (2020). COVID-19 and finance: Agendas for future research. *Finance Research Letters, 35*, 101512.
Hentschel, L. (1995). All in the family nesting symmetric and asymmetric garch models. *Journal of Financial Economics, 39*(1), 71–104.
Khan, M. A., Hernandez, J. A., & Shahzad, S. J. H. (2020). Time and frequency relationship between household investors' sentiment index and US industry stock returns. *Finance Research Letters, 36*, 101318.
Klein, K. J., & Kozlowski, S. W. J. (Eds.). (2000). *Multilevel theory, research, and methods in organizations: Foundations, extensions, and new directions*. Jossey-Bass.
Kumar, R., & Dhankar, R. S. (2010). Empirical analysis of conditional heteroskedasticity in time series of stock returns and asymmetric effect on volatility. *Global Business Review, 11*(1), 21–33.
Lee, K. (2009). How the Hong Kong government lost the public trust in SARS: Insights for government communication in a health crisis. *Public Relations Review, 35*(1), 74–76.
Mazur, M., Dang, M., & Vega, M. (2021). COVID-19 and the March 2020 stock market crash. Evidence from S&P1500. *Finance Research Letters, 38*, 101690.
Mian, G. M., & Sankaraguruswamy, S. (2012). Investor sentiment and stock market response to earnings news. *The Accounting Review, 87*(4), 1357–1384.
Nelson, D. B. (1991). Conditional heteroskedasticity in asset returns: A new approach. *Econometrica, 59*(2), 347–370.
Nguyen, T., Locke, S., & Reddy, K. (2015). Ownership concentration and corporate performance from a dynamic perspective: Does national governance quality matter? *International Review of Financial Analysis, 41*, 148–161.
Paterson, A. S., Changwony, F., & Miller, P. B. (2019). Accounting control, governance and anti-corruption initiatives in public sector organisations. *British Accounting Review, 51*(5), 100844.
Persakis, A., & Iatridis, G. E. (2016). Audit quality, investor protection and earnings management during the financial crisis of 2008: An international perspective. *Journal of International Financial Markets, Institutions and Money, 41*, 73–101.
Siekkinen, J. (2016). Value relevance of fair values in different investor protection environments. *Accounting Forum, 40*(1), 1–15.
Smales, L. A. (2021). Investor attention and global market returns during the COVID-19 crisis. *International Review of Financial Analysis, 73*, 101616.
Tripathi, A., & Pandey, A. (2021). Information dissemination across global markets during the spread of COVID-19 pandemic. *International Review of Economics & Finance, 74*, 103–115.
Van Essen, M., Engelen, P. J., & Carney, M. (2013). Does "good" corporate governance help in a crisis? The impact of country-and firm-level governance mechanisms in the European financial crisis. *Corporate Governance: An International Review, 21*(3), 201–224.
Wan, D., Cheng, K., & Yang, X. (2014). The reverse volatility asymmetry in Chinese financial market. *Applied Financial Economics, 24*(24), 1555–1575.
World Bank. (2020). *Worldwide governance indicators*. http://info.worldbank.org/governance/wgi/.
World Economic Forum. (2020). *Global competitiveness index*. http://reports.weforum.org/global-competitiveness-index-2017-2018/downloads/.
World Health Organization (WHO). (2020a). Naming the coronavirus disease (COVID-19) and the virus that causes it. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it.
World Health Organization (WHO). (2020b). WHO director-general's opening remarks at the media briefing on COVID-19 - 11 March 2020. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—11-march-2020.
World Health Organization (WHO). (2020c). WHO Coronavirus (COVID-19) dashboard. https://covid19.who.int/.
Zaremba, A., Kizys, R., Tzouvanas, P., Aharon, D. Y., & Demir, E. (2021). The quest for multidimensional financial immunity to the COVID-19 pandemic: Evidence from international stock markets. *Journal of International Financial Markets, Institutions and Money, 71*, 101284.