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Does investor attention increase stock market volatility during the COVID-19 pandemic?

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ABSTRACT

We decompose investor attention to the COVID-19 pandemic into expected and unexpected segments and investigate their effects on realized and fundamental stock market volatility. We show that expected investor attention can explain both types of volatility. However, unexpected investor attention can only explain realized volatility, though its realized volatility effect outweighs that of expected investor attention. Moreover, the relationship between expected investor attention and either type of volatility is unidirectional whereas the interaction between unexpected investor attention and realized volatility is bidirectional. These findings suggest that expected (unexpected) investor attention is informational (noisy and more harmful) to the stock market.

1. Introduction

In this paper, we examine the effect of investor attention to the COVID-19 pandemic on the U.S. and Chinese stock market volatility. Our hypothesis is that investor attention to the COVID-19 pandemic increases stock market volatility. The proposed relationship between investor attention and stock market volatility is motivated by the theory of investor sentiment first proposed by De Long et al. (1990) who explain the notion that investors in the stock market can be sentimental.

The core theoretical foundation of this study is built upon a well-known relationship between investor sentiment and the stock market, which is an essential concept in in behavioral finance. Such a relationship examines the effect of investor sentiment on the stock price changes. In fact, investor sentiment is a measure of market sentiment that sums investors' expectations for the general market (see Thorp, 2004). The sentiment theory helps to explain stock prices that are poorly correlated with fundamental analysis (see Brown and Cliff, 2005). Based on this foundation, this research relates the investor sentiment about the COVID-19 pandemic to stock market volatility.

To our knowledge, this study is the first to examine the impact of investor attention to the COVID-19 pandemic on stock market volatility. One strand of related literature (see Lee et al., 2002; Andrei and Hasler, 2015; Dzieliński et al., 2018; Brown, 2019; Audrino et al., 2020) documents evidence in favor of a significant relationship between investor attention/sentiment and stock market volatility but prior to the COVID-19 period. For example, Andrei and Hasler (2015) demonstrate that investor attention and uncertainty are key determinants of stock prices. Dzieliński et al. (2018) relate the asymmetry of stock market volatility to investor attention and belief

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dispersion. Audrino et al. (2020) associate investor sentiment and attention with stock market volatility. However, none of these studies examine the impact of investor attention on stock market volatility during the COVID-19 pandemic.

The second strand of literature closely related to our work examines the impact of the COVID-19 pandemic on the stock market performance (see Phan and Narayan, 2020; Mishra et al., 2020; Song et al., 2020; Liu et al., 2020; He et al., 2020; Shen et al., 2020; Xiong et al., 2020). Specifically, there is now evidence suggesting: (a) possible overreaction of stock markets during the early stages of the COVID-19 pandemic (see Phan and Narayan, 2020; Xiong et al., 2020); (b) a decline in stock returns and an increase in market volatility during the COVID-19 period (see Mishra et al., 2020; Prabheesh, 2020; Sharma, 2020; Salisu and Adediran, 2020; Chang et al., 2021; Haroon et al., 2021); (c) a heterogenous effect of the COVID-19 pandemic on firm (sectoral) performance belonging to different sectors of different countries (see Gu et al., 2020; Song et al., 2020; Liu et al., 2020; He et al., 2020; Shen et al., 2020; Salisu and Sikiru, 2020; Prabheesh et al., 2020; Zhang et al., 2021).[1] However, none of these studies explicitly examine the relationship between investor attention to the COVID-19 pandemic and stock market volatility.

Based on the pieces of evidence provided by these two strands of literature, we would expect investor attention to increase stock market volatility. Whether this is the way stock market volatility have behaved during the COVID-19 pandemic is unknown and is an empirical issue, which is the subject of our paper. It is likely that the public's reaction towards the COVID-19 pandemic is heterogonous. To capture their overreaction or underreaction, we divide investor attention into two segments: expected and unexpected. On the one hand, expected attention largely derives from the severity of the pandemic in the light of its infection spread and death cases, dealing a direct blow to the stock market, and therefore this attention segment is rational and informational. On the other hand, unexpected attention relates to the overreaction or underreaction to the pandemic, which can be perceived as an indicator of irrationality among investors, and therefore this attention segment is irrational and noisy. Thus, we expect that these two types of investor attention should significantly affect stock market volatility in a heterogeneous manner.

Moreover, our insight on stock market volatility is twofold: realized stock market volatility, based on stock prices, and fundamental stock market volatility, based on stock intrinsic values (also called fundamental values or efficient prices). The first volatility captures the fluctuation of stock prices during a given period, which is easily observed by the public, and the second volatility focuses on the variation of unobserved intrinsic values hidden in observed prices, which captures the permanent intrinsic value shocks due to new information. Under the pandemic attack, we expect that expected attention, which is rational and informational, increases both realized and fundamental volatility, but unexpected attention, which is irrational and noisy, only increases realized volatility because it does not relate to the information about fundamentals.

This paper is the first to relate investor attention to these two types of volatility in the stock market during the COVID-19 pandemic.[2] While the main body of our empirical analysis focuses on the U.S. stock market, we also concern the Chinese stock market in the additional analysis. We test our hypothesis by employing the U.S. stock level data covering the period from January 1 to December 31, 2020. More specifically, we use Google Search Volume Index to measure investor attention to the COVID-19 pandemic, and then we segment the attention series by regressing it on the severity measures of the pandemic. This segmentation process reflects the expected investor attention, which relates to the pandemic's severity, as well as, captures the unexpected investor attention, which relates to investors' additional sentiment beyond the pandemic. We then investigate the specific effects of these two investor attention segments on the two different measures of volatility (i.e., realized volatility and fundamental volatility).

Our main findings are as follows. First, we find a positive relationship between investor attention to the COVID-19 pandemic and realized stock market volatility. More importantly, it is unexpected attention that dominates such a positive realized volatility effect, although the corresponding effect of expected attention is also significant. This implies that, while both investor attention segments induce stock price fluctuations, the unexpected segment exerts a greater effect and is thus more harmful to the stock market.

Second, we estimate the variation of stock intrinsic values due to new information through the decomposition approach of Beveridge and Nelson (1981) and use this variance to measure fundamental volatility. Our results indicate that there is also a positive relationship between investor attention and fundamental volatility. However, it is expected attention that accounts for this positive relationship, thereby confirming that unexpected attention can only add noises to the market and that its effect on the stock market is non-informational and non-fundamental.

Third, we also establish that only a unidirectional Granger causality exists between expected attention and either type of stock market volatility. That is, expected attention to the pandemic increases the realized and fundamental volatility of stock prices but not vice versa. However, the interaction between unexpected attention and realized volatility is bidirectional. That is, not only does unexpected attention increase stock price volatility, volatile stock prices also increase unexpected attention. This, again, suggests a more harmful effect of the stock market of unexpected attention relative to expected attention. Hence, our results take the literature forward by showing that the COVID-19 pandemic increases stock market volatility. It sheds further insights by providing evidence, for the first time, that it is unexpected investor attention that inflicts more damage on the stock market.

Finally, to examine whether our results can be applicable to broader cases, we extend our main analysis of realized and fundamental volatility to the Chinese stock market, and find that the key results are highly consistent with those in the U.S. stock market. Therefore, we could confirm that our main findings based on the U.S. data are not just confined to the U.S. stock market but also

[1] Sha and Sharma (2020) and Sharma and Sha (2020) provide an overview.

[2] For prior studies focusing on investor sentiment or attention during the COVID-19 pandemic, it is worth noting that Chen et al. (2020) study the fear sentiment and dynamics of bitcoin prices; Huang and Zheng (2020) focus on investor sentiment and oil futures; and Salisu and Akanni (2020) develop a global fear measure to the pandemic and relate it to stock return predictability. However, none of these studies examine the effect of investor attention on stock market volatility during the pandemic.

applicable to the markets of other countries.

The contribution of our paper is twofold. First, our paper contributes to the rich literature focusing on the financial impacts of the COVID-19 pandemic. Despite ample COVID-19 related literature as discussed earlier, none of them examine the relationship between investor attention and stock market volatility during the pandemic period. We add to this literature by thoroughly examining the volatility of the U.S. stock market in response to investor sentiments associated with the COVID-19 pandemic. In other words, this paper helps us to better understand how the pandemic exerts volatility effects on the stock market through the public sentiments associated with the pandemic.

Moreover, stock market volatility and its determinants are an important theme of finance literature. In addition to realized volatility, which is widely used to capture the total fluctuation of stock prices/returns, this paper also looks into fundamental volatility, which relates to shocks to the unobserved intrinsic values of stocks due to information about fundamentals. Our study contributes to the volatility literature by providing an in-depth analysis of two different types of volatility. The paper makes the first contribution that unexpected (expected) attention to the pandemic is an important determinant of realized (fundamental) volatility of the stock market.

The remainder of the paper proceeds as follows. In Section 2, we provide a discussion of the data used in this study. Section 3 presents and discusses the results. We extend the main analysis to the Chinese stock market in Section 4. Section 5 investigates the robustness of our results. Section 6 sets forth the concluding remarks.

2. Data

Our main empirical study is based on the U.S. stock market. More specifically, we obtain daily stock data from the Center for Research in Security Prices (CRSP) database. Our data spans a one-year-period from January 1 to December 31, 2020. We use the Google Search Volume Index as our measure of investor attention to the COVID-19 pandemic and denote it by *Attention*. The Google Search Volume Index is available in Google Trends, which provides a time-series of searching query volume, which ranges between zero and a hundred and indicates activeness of the search keyword over the selected time period and location. Our attention variable focuses on the search keyword "COVID" during the COVID-19 pandemic period in the U.S. Additionally, we download two proxies of the COVID-19 pandemic, namely daily new infection (*Infection*) and daily new death cases (*Death*) for the U.S. from the website of Centers for Disease Control and Prevention (CDC). *Infection* and *Death* contribute to the attention segmentation whose detail is given in Section 3.1. In Panel A of Table 1, we report the descriptive statistics of aggregate investor attention (*Attention*) and its two specific segments: expected attention (*ExpAttention*) and unexpected attention (*UnexpAttention*).

Table 1
Descriptive statistics.

Panel A: Descriptive statistics of investor attention and its two specific segments

	$Attention_t$	$ExpAttention_t$	$UnexpAttention_t$
Mean	53.472	18.229	15.251
Median	54.000	14.947	9.788
Max	100.000	71.935	54.564
Min	0.000	0.000	0.053
Std. Dev	26.272	16.250	13.861

Panel B: Descriptive statistics of realized and fundamental volatility measures

	$RealV_{i,t}^{1min}$	$RealV_{i,t}^{5min}$	$FundaV_{i,t}^{1min}$	$FV_{i,t}^{5min}$
Mean	0.187	0.226	0.050	0.061
Median	0.159	0.198	0.046	0.053
Max	1.270	1.390	0.369	0.470
Min	0.012	0.010	0.003	0.004
Std. Dev	0.213	0.255	0.062	0.069

Panel C: Descriptive statistics of control variables

	$Illiquidity_{i,t}$	$Volume_{i,t}$	$Capitalization_{i,t}$
Mean	0.004	0.009	0.013
Median	0.003	0.008	0.008
Max	0.102	0.105	0.390
Min	0.000	0.001	0.010
Std. Dev	0.006	0.023	0.020

The table displays the summary statistics of our regression variables. Panel A reports investor attention (*Attention*) and its two specific segments: expected attention (*ExpAttention*) and unexpected attention (*UnexpAttention*). Panel B is of volatility measures including realized and fundamental volatility of the stock market. $RealV_{i,t}^{1min}$ and $RealV_{i,t}^{5min}$ are the realized variance of one-minute and five-minute intraday stock returns, respectively. $FundaV_{i,t}^{1min}$ and $FundaV_{i,t}^{5min}$ are the variance of shocks to intrinsic values estimated by the decomposition of Beveridge and Nelson (1981) at the one-minute and five-minute frequencies, respectively. Panel C is of control variables, and they include the illiquidity factor of Amihud (2002) ($Illiquidity_{i,t}$), trading volume ($Volume_{i,t}$), and market capitalization ($Capitalization_{i,t}$), for each stock. The sample period is from January 1 to December 31, 2020.

The dependent variable in our analysis is stock market volatility (i.e., realized and fundamental volatility). For the daily measure of realized volatility, we focus on the realized variance of one-minute or five-minute stock returns for each trading day. Turning to the measure of fundamental volatility, we apply the classic approach of Beveridge and Nelson (1981) to estimate the variation of unobserved intrinsic values—detail is given in Section 3.3. In Panel B of Table 1, we provide statistics of these measures. They include realized volatility (i.e., $RealV_{i,\,t}^{1min}$ and $RealV_{i,\,t}^{5min}$, which are calculated at the one-minute and five-minute frequencies, respectively, for each day), and fundamental volatility (i.e., $FundaV_{i,\,t}^{1min}$ and $FundaV_{i,\,t}^{5min}$, which are estimated at the one-minute and five-minute frequencies, respectively, for each day). In short, $RealV_{i,\,t}^{1min}$ and $RealV_{i,\,t}^{5min}$ indicate the total fluctuation of stock prices, while $FundaV_{i,\,t}^{1min}$ and $FundaV_{i,\,t}^{5min}$ capture the variation of stock intrinsic values due to new information. The data source of intraday return series for volatility computation is Thomson Reuters Tick History (TRTH).

For robustness of our results, we include three control variables in our analysis. They are the illiquidity factor of Amihud (2002), market capitalization and trading volume. These variables are standard controls in the volatility literature (see, e.g., Chordia et al., 2001; Chordia et al., 2005; Wang and Xu, 2019). The data source for these control variables is CRSP. Their summary statistics are in Panel C of Table 1.

It is noticeable that since our sample is relatively short (i.e., only one year), the time-series of all regression variables considered in our analysis are well stationary. The unit-root test confirms their stationarity. Therefore, we use the untreated time-series of these variables rather than their detrended versions for our analysis. Their stationarity ensures that our empirical findings are not contaminated by spurious regressions.

3. Main findings

3.1. Segmentation of investor attention

Intuitively, investor attention to "COVID" is partly subject to the severity of the pandemic in terms of its (new) infection and death cases. Thus, we estimate the following time-series regression model:

$$Attention_t = a + \beta_1 Infection_{t-1} + \gamma_1 Death_{t-1} + \beta_2 Infection_{t-2} + \gamma_2 Death_{t-2} + e_t \tag{1}$$

where *Infection* and *Death* are the daily new infection and death cases, respectively, reported in the U.S. It is noticeable that we regress $Attention_t$ on the first two lagged terms of *Infection* and *Death* rather than on their contemporaneous terms for the reason that *Infection* and *Death* on day t is only disclosed to the public on day $t+1$. That is, investors who search "COVID" in Google on a day are only aware of the earlier days' new infection and death cases. The regression results are reported in Table 2.

It is quite apparent that the estimated coefficients of the four lagged terms are significantly positive, and the adjusted R-squared of the regression model is about 40%, indicating that (past) new infection and death cases of the pandemic can significantly explain about 40% of (current) investor attention. Therefore, we define expected investor attention as:

$$ExpAttention_t = \widehat{\beta}_1 Infection_{t-1} + \widehat{\gamma}_1 Death_{t-1} + \widehat{\beta}_2 Infection_{t-2} + \widehat{\gamma}_2 Death_{t-2}$$

where $\widehat{\beta}_i$ ($\widehat{\gamma}_i$) is the estimate of β_i (γ_i) obtained by estimating Eq. (1). Turning to unexpected attention, we define it as:

$$UnexpAttention_t = \left|\widehat{e}_t\right|$$

where $\left|\widehat{e}_t\right|$ is the estimated residual from Eq. (1), orthogonal to $ExpAttention_t$. For the robustness of our segmentation results from potential timing issues, we further include the third and fourth lags of *Infection* and *Death* to Eq. (1). The results for this extended exercise are reported in the second and third columns of Table 2. Obviously, none of these further lags exert a sizable effect, and therefore we only focus on Eq. (1) for attention segmentation.

3.2. Investor attention and realized volatility

This section examines the relationship between investor attention and realized volatility during the COVID-19 pandemic, with a particular focus on the effects of the two specific attention segments. Thus, we estimate the following two panel regression models:

$$Y_{i,t} = \alpha + \beta Attention_t + \gamma_i Controls_{i,t} + \pi Y_{i,t-1} + e_{i,t} \tag{2}$$

$$Y_{i,t} = \alpha + \beta_1 ExpAttention_t + \beta_2 UnexpAttention_t + \gamma_i Controls_{i,t} + \pi Y_{i,t-1} + e_{i,t} \tag{3}$$

where $Y_{i,\,t}$, the daily measure of realized volatility, is the realized variance of intraday stock returns calculated at the one-minute frequency ($RealV_{i,\,t}^{1min}$) or five-minute frequency ($RealV_{i,\,t}^{5min}$) for each day. In Eq. (2), $Attention_t$ is the aggregate investor attention on day t. In Eq. (3), $ExpAttention_t$ and $UnexpAttention_t$ are expected and unexpected segments of investor attention, respectively. The control variables include the illiquidity factor of Amihud (2002), trading volume, and market capitalization for each stock. To take volatility persistence into account, we include Y_{t-1}. To easily interpret the economic significance of these variables, we standardize all these daily variables (i.e., scaled by standard deviation) and then estimate the regressions. Moreover, standardization also helps to

Table 2
Investor attention segmentation.

	$Attention_t$		
	(1)	(2)	(3)
Constant	12.519***	10.102***	9.268***
	(6.97)	(5.76)	(5.36)
$Infection_{t-1}$	1.850×10^{-4}***	1.655×10^{-4}***	1.560×10^{-4}***
	(7.96)	(7.29)	(6.94)
$Infection_{t-2}$	6.65×10^{-5}***	5.498×10^{-5}***	5.039×10^{-5}**
	(3.06)	(2.60)	(2.42)
$Death_{t-1}$	7.270×10^{-3}***	6.503×10^{-3}***	6.021×10^{-3}***
	(4.39)	(3.98)	(3.73)
$Death_{t-2}$	3.160×10^{-3}**	2.704×10^{-3}*	2.514×10^{-3}*
	(2.01)	(1.83)	(1.70)
$Infection_{t-3}$		Insignificant	Insignificant
$Infection_{t-4}$			Insignificant
$Death_{t-3}$		Insignificant	Insignificant
$Death_{t-4}$			Insignificant
Adjusted R-squared	0.40	0.40	0.40

The table reports the segmentation process of investor attention to the pandemic (*Attention*). *Infection* and *Death* are daily new infection and death cases, respectively. The sample period is from January 1 to December 31, 2020. The *t*-statistics are in parentheses and symbols ***, ** and *indicate the significance at the 1%, 5% and 10% levels, respectively.

minimize noises in daily data. We also control for stock fixed effects and cluster the standard errors at the stock level. The results are reported in Table 3.

The first two columns concern Eq. (2). We can see that investor attention to the COVID-19 pandemic is positively correlated with realized volatility, suggesting that stock prices fluctuate with investor attention during the pandemic. Then we investigate this positive relationship by estimating Eq. (3) with the two specific attention segments. In the third and fourth columns, we show that unexpected attention has a much stronger explanatory power over realized volatility as compared with expected attention, although their effects are both significant. For example, the estimates in Column 3 indicate that the standard deviation of $RealV_{i,t}^{1min}$ increases by 10.8% for every standard deviation increase in $UnexpAttention_t$, but such an increase is only 6.6% for $ExpAttention_t$. The expected attention, according to its definition, derives from the infection spread and death cases. Therefore, this attention segment is rational and informational, which should deal a direct blow to the stock market, On the other hand, unexpected attention is of investors' overreaction or underreaction to the pandemic, which indicates their irrationality, and thereby this attention segment is noisy and leads to liquidity shocks. It is demonstrated that liquidity shocks are more likely to drive stock price changes than the trigger of information (see, e.g., Chan and Fong, 2006), and therefore it is likely that unexpected attention is more important in realized volatility. The outperformance of $UnexpAttention_t$ here confirmed its additional harm to the stock market beyond expected attention.

Turning to the control variables, we show significantly positive coefficients of illiquidity and trading volume and significantly negative coefficients of market capitalization in all columns. Also, the coefficients of Y_{t-1} are positive and quite significant. These observations are highly consistent with prior research (see, e.g., Chordia et al., 2001; Chordia et al., 2005; Wang and Xu, 2019).

3.3. Investor attention and fundamental volatility

Realized volatility captures the observed fluctuation of stock prices in which the variation of intrinsic values is hidden and unobservable. In other words, one cannot tell whether the observed price change (i.e., realized volatility) is due to information or noise. To pin down the price fluctuation due to changes in intrinsic values (i.e., due to information), we study fundamental volatility in this section. To measure this type of volatility, we apply the classic decomposition approach of Beveridge and Nelson (1981).[3]

To be specific, the decomposition is conducted in an Autoregressive (AR) model. For each day, the return series of a stock are regressed at the one-minute or five-minute frequency with thirty lags: $r_\tau = \sum_{k=1}^{30} A_k r_{\tau-k} + \varepsilon_\tau$. The regression produces the estimates $\Phi(1) = 1 - \sum_{k=1}^{30} \widehat{A}_k$ and residuals $\widehat{\varepsilon}_\tau$. In the light of Beveridge and Nelson (1981), $\Phi(1)^{-1}\widehat{\varepsilon}_\tau$ features the shocks to stock intrinsic values and its variance $\Phi^{-2}\mathrm{Var}\left(\widehat{\varepsilon}_\tau\right)$ can be perceived as the fundamental volatility, which we denote $FundaV^{1min}$ or $FundaV^{5min}$.

After we have constructed $FundaV^{1min}$ and $FundaV^{5min}$ for each stock and each day, we replicate Eqs. (2) and (3) by substituting $FundaV^{1min}$ or $FundaV^{5min}$ for the measures of realized volatility. The results are provided in Table 4.

In the first and second columns where the aggregate investor attention is considered, we observe positive coefficients of $Attention_t$ which are significant at the 1% level. This indicates that investor attention to the COVID-19 pandemic is positively associated with the fluctuation of intrinsic values due to information. The significant explanatory power of $Attention_t$ over fundamental volatility points to the fact that $Attention_t$ is partly informational. Additionally, we substitute $ExpAttention_t$ and $UnexpAttention_t$ for $Attention_t$ in the

[3] See, for example, Hasbrouck (1993), Boehmer and Kelley (2009) and Lee et al. (2016), for studies using similar approaches in efficient price decomposition.

Table 3
The relationship between investor attention and realized volatility.

	$RealV_{i,t}^{1min}$	$RealV_{i,t}^{5min}$	$RealV_{i,t}^{1min}$	$RealV_{i,t}^{5min}$
	(1)	(2)	(3)	(4)
$Attention_t$	0.078***	0.080***		
	(3.39)	(3.50)		
$ExpAttention_t$			0.066***	0.069***
			(2.86)	(2.99)
$UnexpAttention_t$			0.108***	0.113***
			(4.68)	(4.90)
$Illiquidity_{i,t}$	0.069***	0.066***	0.064***	0.061***
	(3.00)	(2.88)	(2.79)	(2.68)
$Volume_{i,t}$	0.203***	0.170***	0.190***	0.159***
	(8.86)	(7.40)	(8.30)	(6.92)
$Capitalization_{i,t}$	−0.064***	−0.061***	−0.059***	−0.056**
	(−2.79)	(−2.66)	(−2.59)	(−2.45)
First lag of dependent variable	0.232***	0.224***	0.228***	0.219***
	(10.12)	(9.77)	(9.96)	(9.58)
Constant	Yes	Yes	Yes	Yes
Stock fixed effect	Yes	Yes	Yes	Yes
Adj. R-squared	0.21	0.20	0.22	0.21

The table reports the panel regressions of realized volatility on investor attention and its two specific segments. $Attention_t$, $ExpAttention_t$ and $UnexpAttention_t$ are, respectively, aggregate investor attention, expected attention and unexpected attention. The dependent variable is $RealV_{i,t}^{1min}$ or $RealV_{i,t}^{5min}$, i.e., the realized variance of one-minute or five-minute stock returns. Control variables include the illiquidity factor of Amihud (2002) ($Illiquidity_{i,t}$), trading volume ($Volume_{i,t}$), and market capitalization ($Capitalization_{i,t}$), for each stock. The stock fixed effect applies with the standard errors clustered at the stock level. The sample period is from January 1 to December 31, 2020. The *t*-statistics are reported in parentheses, and symbols ***, ** and *indicate significance at the 1%, 5% and 10% levels, respectively.

Table 4
The Relationship between investor attention and fundamental volatility.

	$FundaV_{i,t}^{1min}$	$FundaV_{i,t}^{5min}$	$FundaV_{i,t}^{1min}$	$FundaV_{i,t}^{5min}$
	(1)	(2)	(3)	(4)
$Attention_t$	0.089***	0.091***		
	(3.87)	(3.94)		
$ExpAttention_t$			0.113***	0.118***
			(4.90)	(5.09)
$UnexpAttention_t$			0.035	0.038
			(1.53)	(1.64)
$Illiquidity_{i,t}$	0.056**	0.052**	0.050**	0.048**
	(2.42)	(2.28)	(2.17)	(2.09)
$Volume_{i,t}$	0.093***	0.077***	0.083***	0.069***
	(4.06)	(3.35)	(3.61)	(3.00)
$Capitalization_{i,t}$	−0.049**	−0.047**	−0.046**	−0.044*
	(−2.12)	(−2.04)	(−2.02)	(−1.91)
First lag of dependent variable	0.122***	0.113***	0.115***	0.110***
	(5.30)	(4.95)	(5.01)	(4.80)
Constant	Yes	Yes	Yes	Yes
Stock fixed effect	Yes	Yes	Yes	Yes
Adj. R-squared	0.15	0.15	0.16	0.16

The table reports the panel regressions of fundamental volatility on investor attention and its two specific segments. $Attention_t$, $ExpAttention_t$ and $UnexpAttention_t$ are, respectively, aggregate investor attention, expected attention and unexpected attention. The dependent variable is $FundaV_{i,t}^{1min}$ or $FundaV_{i,t}^{5min}$, i.e., the variance of shocks to intrinsic values estimated by the decomposition of Beveridge and Nelson (1981) at the one-minute or five-minute frequency. Control variables include the illiquidity factor of Amihud (2002) ($Illiquidity_{i,t}$), trading volume ($Volume_{i,t}$), and market capitalization ($Capitalization_{i,t}$), for each stock. The stock fixed effect applies with the standard errors clustered at the stock level. The sample period is from January 1 to December 31, 2020. The *t*-statistics are reported in parentheses, and symbols ***, ** and *indicate significance at the 1%, 5% and 10% levels, respectively.

regression model and report the results in columns 3–4. We show that the coefficients of expected attention are significant at the 1% level, whereas those of unexpected attention are rather insignificant. The results indicate that the standard deviation of $FundaV_{i,t}^{1min}$ ($FundaV_{i,t}^{5min}$) increases by 11.3% (11.8%) for every standard deviation increase of $ExpAttention_t$, but such an increase for $UnexpAttention_t$ is only 3.5% (3.8%). Therefore, although expected attention, which reflects the pandemic's severity, is significantly associated with the changes in stock intrinsic values, unexpected attention, which captures investors' irrationality, is not much relevant to such changes. This observation indicates that $UnexpAttention_t$ is non-informational, and the significant effect of $Attention_t$ in the first two columns is largely due to $ExpAttention_t$. In other words, expected attention, which refers to the pandemic's severity,

contains information about the market. This is actually intuitive because a more severe pandemic situation is usually a worse signal to the market. However, unexpected attention, which captures investors' irrationality, contains no information, and can just make the market noisier. Therefore, it is only the expected attention that can be influential to the fundamental volatility. This finding is consistent with Xu et al. (2019) that noisy trading leads no significant change on fundamental volatility.

3.4. Granger causality between investor attention and stock market volatility

We have provided evidence supporting the relationship between investor attention and stock market volatility during the COVID-19 pandemic, in terms of the particular effects of the two attention segments on the two types of stock market volatility. In this section, we examine whether these relationships are unidirectional or bidirectional. To do this, we perform Granger causality test between investor attention and stock market volatility in a Vector Autoregressive (VAR) system, which is given below:

$$Y_{i,t} = \alpha_1 + \sum_{k=1}^{l} \rho_{1,k} Y_{i,t-k} + \sum_{m=1}^{l} \pi_{1,m} Attention_{t-m} + \gamma_{1,i} Controls_{i,t} + e_{i,t} \tag{4}$$

$$Attention_t = \alpha_2 + \sum_{k=1}^{l} \rho_{2,k} Y_{i,t-k} + \sum_{m=1}^{l} \pi_{2,m} Attention_{t-m} + \gamma_{2,i} Controls_{i,t} + v_{i,t} \tag{5}$$

where Y is the measure of either realized volatility or fundamental volatility.

Eqs. (4) and (5) focus on aggregate investor attention. We further consider the two specific attention segments in a multivariate VAR framework as follows:

$$Y_{i,t} = \alpha_1 + \sum_{k=1}^{l} \rho_{1,k} Y_{i,t-k} + \sum_{m=1}^{l} \pi_{1,m} ExpAttention_{t-m} + \sum_{n=1}^{l} \varphi_{1,n} UnexpAttention_{t-n} + \gamma_{1,i} Controls_{i,t} + e_{i,t} \tag{6}$$

$$ExpAttention_t = \alpha_2 + \sum_{k=1}^{l} \rho_{2,k} Y_{i,t-k} + \sum_{m=1}^{l} \pi_{2,m} ExpAttention_{t-m} + \sum_{n=1}^{l} \varphi_{2,n} UnexpAttention_{t-n} + \gamma_{2,i} Controls_{i,t} + v_{i,t} \tag{7}$$

$$UnexpAttention_t = \alpha_3 + \sum_{k=1}^{l} \rho_{3,k} Y_{i,t-k} + \sum_{m=1}^{l} \pi_{3,m} ExpAttention_{t-m} + \sum_{n=1}^{l} \varphi_{3,n} UnexpAttention_{t-n} + \gamma_{3,i} Controls_{i,t} + \omega_{i,t} \tag{8}$$

We consider two lagged terms in the above VAR systems, i.e., $l = 2$.[4] These results are provided in Table 5. More specifically, Panels A and B report the interactions between aggregate investor attention and the two types of stock market volatility, respectively, whereas Panels C and D tabulate results related to the interactions between stock market volatility and the two specific attention segments. It is noticeable that we do not tabulate the results for $RealV_{i,t}^{5min}$ and $FundaV_{i,t}^{5min}$ here because they are highly similar to those for $RealV_{i,t}^{1min}$ and $FundaV_{i,t}^{1min}$ which are reported in Table 5.[5]

The existence of Granger causality is reflected by the joint significance of the explanatory variable's lags in the VAR model. That is, Granger causality exists if, at least, one of the lags of the explanatory variable is significant; otherwise, Granger causality does not exist. On the one hand, in Panels A and B, the coefficients of $Attention_{t-1}$ and $Attention_{t-2}$ are both significant, at least, at the 5% level in the regressions of $RealV_{i,t}^{1min}$ and $FundaV_{i,t}^{1min}$. On the other hand, the coefficient of $RealV_{i,t-1}^{1min}$ is significant in the regression of $Attention_t$ but the coefficients of $FundaV_{i,t-1}^{1min}$ and $FundaV_{i,t-2}^{1min}$ are both insignificant. Hereby, we can conclude that there is a bidirectional Granger causality between investor attention and realized volatility whereas the relationship between investor attention and fundamental volatility is unidirectional. In other words, more investor attention to the COVID-19 pandemic makes stock prices more unstable, and in the meantime, more unstable stock prices also generate more investor attention to the pandemic. For fundamental volatility, an increasing investor attention leads to greater fluctuation of intrinsic values, but not vice versa.

We then investigate the two specific attention segments. The results in Panels C and D only indicate a unidirectional Granger causality between expected investor attention and either type of stock market volatility. This finding is intuitive because expected attention relates to the pandemic's severity (i.e., new infection and death cases) according to its definition, which is irrelevant to stock market fluctuation. For the interaction between unexpected attention and realized volatility in Panel C, we observe a bidirectional Granger causality between them. Recalling the bidirectional interaction between aggregate investor attention and realized volatility in Panel A, one can safely conclude that such a bidirectional relationship is dominated by unexpected attention. This points to the fact that unexpected attention increases realized volatility, and more volatile stock prices also stimulate investors' irrationality, which in turn increase unexpected attention. This further strengthens the evidence of a harmful effect of unexpected attention on the stock market in the sense of a negative loop in which unexpected investor attention and realized volatility closely interact.

We must emphasize that we investigate the interaction between investor attention and stock market volatility in this section purely in terms of Granger causality. It is important to note that Granger causality is not actual causality, and it just implies the predictive

[4] The lag order in the VAR systems is determined by using the Akaike Information Criteria (AIC). We show that applying more lags to the VAR estimations generates highly consistent findings.

[5] These results are available from the authors upon request.

Table 5
Granger causality between investor attention and stock market volatility.

Panel A: Aggregate investor attention and realized volatility

	$RealV_{i,\,t}{}^{1min}$	$Attention_t$
$RealV_{i,\,t-1}{}^{1min}$	0.247***	0.052**
	(10.76)	(2.24)
$RealV_{i,\,t-2}{}^{1min}$	0.090***	0.017
	(3.90)	(0.76)
$Attention_{t-1}$	0.062***	0.086***
	(2.70)	(3.73)
$Attention_{t-2}$	0.047**	0.042*
	(2.03)	(1.82)
Controls and Constant	Yes	Yes
Stock fixed effect	Yes	Yes
Adj. R-squared	0.24	0.09

Panel B: Aggregate investor attention and fundamental volatility

	$FundaV_{i,\,t}{}^{1min}$	$Attention_t$
$FundaV_{i,\,t-1}{}^{1min}$	0.116***	0.030
	(5.03)	(1.31)
$FundaV_{i,\,t-2}{}^{1min}$	0.071***	0.0014
	(3.07)	(0.62)
$Attention_{t-1}$	0.072***	0.089***
	(3.15)	(3.85)
$Attention_{t-2}$	0.059**	0.044*
	(2.54)	(1.90)
Controls and Constant	Yes	Yes
Stock fixed effect	Yes	Yes
Adj. R-squared	0.17	0.08

Panel C: The two specific attention segments and realized volatility

	$RealV_{i,\,t}{}^{1min}$	$ExpAttention_t$	$UnexpAttention_t$
$RealV_{i,\,t-1}{}^{1min}$	0.227***	0.019	0.062***
	(9.90)	(0.85)	(2.70)
$RealV_{i,\,t-2}{}^{1min}$	0.080***	0.007	0.021
	(3.47)	(0.30)	(0.95)
$ExpAttention_{t-1}$	0.050**	0.101***	0.024
	(2.16)	(4.37)	(1.07)
$ExpAttention_{t-2}$	0.039*	0.054**	0.016
	(1.69)	(2.38)	(0.73)
$UnexpAttention_{t-1}$	0.074***	0.017	0.083***
	(3.24)	(0.72)	(3.60)
$UnexpAttention_{t-2}$	0.056**	0.008	0.037
	(2.42)	(0.35)	(1.60)
Controls and Constant	Yes	Yes	Yes
Stock fixed effect	Yes	Yes	Yes
Adj. R-squared	0.25	0.05	0.11

Panel D: The two specific attention segments and fundamental volatility

	$FundaV_{i,\,t}{}^{1min}$	$ExpAttention_t$	$UnexpAttention_t$
$FundaV_{i,\,t-1}{}^{1min}$	0.109***	0.014	0.035
	(4.76)	(0.61)	(1.51)
$FundaV_{i,\,t-2}{}^{1min}$	0.065***	0.005	0.018
	(2.82)	(0.22)	(0.83)
$ExpAttention_{t-1}$	0.090***	0.103***	0.026
	(3.90)	(4.48)	(1.15)
$ExpAttention_{t-2}$	0.070***	0.057**	0.017
	(3.04)	(2.50)	(0.79)
$UnexpAttention_{t-1}$	0.030	0.019	0.085***
	(1.30)	(0.80)	(3.70)
$UnexpAttention_{t-2}$	0.019	0.010	0.038
	(1.09)	(0.44)	(1.64)
Controls and Constant	Yes	Yes	Yes
Stock fixed effect	Yes	Yes	Yes
Adj. R-squared	0.18	0.05	0.10

Panel A concerns the VAR test between aggregate investor attention ($Attention_t$) and realized volatility ($RealV_{i,t}^{1min}$). Panel B is of the test between aggregate investor attention ($Attention_t$) and fundamental volatility ($FundaV_{i,t}^{1min}$). Panels C and D conduct the corresponding exercises to Panels A and B, respectively, but focus on the two specific attention segments instead of its aggregation. Control variables include the illiquidity factor of Amihud (2002), trading volume, and market capitalization for each stock. The stock fixed effect applies with the standard errors clustered at the stock level. The sample period is from January 1 to December 31, 2020. The *t*-statistics are reported in parentheses, and symbols ***, ** and *indicate significance at the 1%, 5% and 10% levels, respectively.

power of a variable over others by indicating "who occurs earlier than the other". While the evidence in this section is not about actual casualty, our findings are still supportive of a tight interaction between investor attention and stock market volatility.

4. Additional analysis: the Chinese stock market

We want to confirm whether our findings are also applicable to the stock markets of other countries. Therefore, we extend our main analysis to the Chinese stock market in this section. To economize the space, we only conduct the analysis considering the two specified attention segments.[6] Because the pandemic is under quite good control in China and the new infection data for the recent year is small and stable, we only obtain the spread data for the half-year period after its outbreak in December 2019. That is, the sample period in this analysis is January 1 to June 30, 2020. The attention data is obtained from Baidu Index, which is the Chinese leading search engine, similar to Google Search Volume Index in U.S. The intraday data for daily realized and fundamental volatility measures is from Wind database. The results are in Table 6 below.

From the table, we confirm that the previous findings about heterogeneous effects of the two types of investor attention to stock market volatility in U.S can also be observed in China. Consistently, evidence here indicates that, while unexpected investor attention is more important than expected attention in explaining realized volatility (see Columns 1 and 2), it is expected attention that accounts for fundamental volatility (see Columns 3 and 4). These findings are closely in line with previously. However, making a closer comparison between the results in the U.S. and Chinese stock markets, we find that the magnitude and significance of the effects in U.S. are slightly greater than those in China. This suggests that the Chinese stock market is relatively more stable than the U.S. market under the pressure of COVID-19 pandemic. However, a much shorter sample period in the Chinese analysis may also be the cause for such statistical disparity.

5. Robustness checks

For robustness of our empirical findings, we perform various further checks, which are summarized as follows. First, we modify our segmentation process of investor attention. In Table 2, none of the third and fourth lags of new infection and death cases are significant (as shown in the second and third columns). For robustness, we still include them in Eq. (1) for the attention segmentation. Second, we reconsider our measures of stock market volatility by using alternative intraday frequency and/or number of lags in the construction. For the realized volatility measures, we also use intraday returns in the fifteen-second or fifteen-minute interval. For the fundamental volatility measures, we reconduct the AR model with the fifteen-second or fifteen-minute returns over fifteen or fifty lags. Third, besides the panel regressions, we also conduct the time-series regression for each stock one-by-one. Fourth, we performed Granger causality test in the VAR system with only two lags in Section 3.4. We also extend the analysis to include three, five or ten lags for the test. Fifth, in addition to the conventional Granger causality test, we have also conducted the Granger non-causality tests developed by Toda and Yamamoto (1995), which yields highly consistent findings.

We replicate all exercises to accommodate the above changes. They result in quantitatively similar observations as those reported in the main estimations. We can thereby confirm the robustness of our findings. While the outputs are not tabulated here, they are available from the authors upon request.

6. Conclusion

This paper studies the relationship between investor attention to the COVID-19 pandemic and stock market volatility, with a new insight into two specific attention segments. We divide investor attention into an expected segment, which reflects the pandemic's severity, and an unexpected segment, which features investors' irrationality during the pandemic. Then, we focus on the specific effects of expected and unexpected investor attention on realized and fundamental volatility of the stock market.

Our results indicate that investor attention is positively correlated with realized and fundamental volatility. Looking into the specific effects of the two attention segments, we find that, while both segments can explain realized volatility, the explanatory power is dominated by unexpected attention on realized volatility. For fundamental volatility, unexpected attention only has a marginal effect on it, though the effect of expected attention is significant. Moreover, we show that the interaction between (unexpected) investor attention and realized volatility is bidirectional.

The implication of our study is twofold. It does not only contribute to the literature concerning the financial impact of the COVID-19 pandemic, but also helps market players and policy makers to better understand the factors driving stock price/return fluctuations during the pandemic. We demonstrate that investor attention to the COVID-19 pandemic plays an important role in stock market

[6] The results of aggregate investor attention are available from the authors upon request.

Table 6
Additional analysis on the Chinese stock market.

	$CNRealV_{i,t}^{1min}$	$CNRealV_{i,t}^{5min}$	$CNFundaV_{i,t}^{1min}$	$CNFundaV_{i,t}^{5min}$
	(1)	(2)	(3)	(4)
$CNExpAttention_t$	0.046**	0.050**	0.080***	0.085***
	(1.99)	(2.16)	(3.46)	(3.66)
$CNUnexpAttention_t$	0.075***	0.079***	0.029	0.026
	(3.25)	(3.44)	(1.27)	(1.15)
$CNIlliquidity_{i,t}$	0.049**	0.045**	0.041*	0.038*
	(2.15)	(1.98)	(1.78)	(1.67)
$CNVolume_{i,t}$	0.090***	0.072***	0.062***	0.051**
	(3.95)	(3.15)	(2.72)	(2.25)
$CNCapitalization_{i,t}$	−0.046***	−0.052**	−0.041*	−0.043*
	(−2.02)	(−2.30)	(−1.80)	(−1.95)
First lag of dependent variable	0.103***	0.095***	0.074***	0.069***
	(4.52)	(4.17)	(3.22)	(3.01)
Constant	Yes	Yes	Yes	Yes
Stock fixed effect	Yes	Yes	Yes	Yes
Adj. R-squared	0.16	0.16	0.12	0.12

The table reports the replication of the analysis in Tables 3 and 4 on the Chinese stock market. $CNRealV_{i,t}^{1min}$ and $CNRealV_{i,t}^{5min}$ are the realized variance of one-minute or five-minute Chinese stock returns, respectively. $CNFundaV_{i,t}^{1min}$ and $CNFundaV_{i,t}^{5min}$ are the variance of shocks to intrinsic values of Chinese stocks estimated by the decomposition of Beveridge and Nelson (1981) at the one-minute or five-minute frequency, respectively. $CNExpAttention_t$ and $CNUnexpAttention_t$ are, respectively, expected attention and unexpected attention in China. Control variables include Amihud's (2002) illiquidity factor ($CNIlliquidity_{i,t}$), trading volume ($CNVolume_{i,t}$), and market capitalization ($CNCapitalization_{i,t}$), for each Chinese stock. The stock fixed effect applies with the standard errors clustered at the stock level. The sample period is from January 1 to June 31, 2020. The *t*-statistics are reported in parentheses, and symbols ***, ** and *indicate significance at the 1%, 5% and 10% levels, respectively.

volatility. Our findings emphasize that market sentiments surrounding the COVID-19 pandemic can be quite noisy and informationally harmful, and it is inflicting an additional damage, beyond the pandemic itself, to stock market stability. This research encourages financial regulators to carefully consider the additional harm driven by the unexpected sentiments, and take effective measures and policies to stabilize the market.

References

Amihud, Y., 2002. Illiquidity and stock returns: cross-section and time-series effects. J. Financ. Mark. 5, 31–56.
Andrei, D., Hasler, M., 2015. Investor attention and stock market volatility. Rev. Financ. Stud. 28, 33–72.
Audrino, F., Sigrist, F., Ballinari, D., 2020. The impact of sentiment and attention measures on stock market volatility. Int. J. Forecast. 36, 334–357.
Beveridge, S., Nelson, C.R., 1981. A new approach to the decomposition of economic time series into permanent and transitory components with particular attention to the measurement of the "business cycle". J. Monet. Econ. 7, 151–174.
Boehmer, E., Kelley, E.K., 2009. Institutional investors and the informational efficiency of prices. Rev. Financ. Stud. 22, 3563–3594.
Brown, G.W., 2019. Volatility, sentiment, and noise traders. Financial Analyst Journal 55, 82–90.
Brown, G.W., Cliff, M.T., 2005. Investor sentiment and the near-term stock market. J. Empir. Financ. 11, 1–27.
Chan, C.C., Fong, W.M., 2006. Realized volatility and transactions. J. Bank. Financ. 30, 2063–2085.
Chang, C., Feng, G., Zheng, M., 2021. Government fighting pandemic, stock market return and COVID-19 virous outbreak. Emerg. Mark. Financ. Trade 57, 2389–2406.
Chen, C., Liu, L., Zhao, N., 2020. Fear sentiment, uncertainty, and bitcoin price dynamics: the case of COVID-19. Emerg. Mark. Financ. Trade 56, 2298–2309.
Chordia, T., Roll, R., Subrahmanyam, A., 2001. Market liquidity and trading activity. J. Financ. 56, 501–530.
Chordia, T., Sarkar, A., Subrahmanyam, A., 2005. An empirical analysis of stock and bond market liquidity. Rev. Financ. Stud. 18, 85–129.
De Long, J.B., Shleifer, A., Summers, L.H., Waldmann, R.J., 1990. Noise trader risk in financial markets. J. Polit. Econ. 98, 703–738.
Dzieliński, M., Rieger, M.O., Talpsepp, T., 2018. Asymmetric attention and volatility asymmetry. J. Empir. Financ. 45, 59–67.
Gu, X., Ying, S., Zhang, W., Tao, Y., 2020. How do firms respond to COVID-19? First evidence from Suzhou, China. Emerging Markets Finance and Trade 56, 2181–2197.
Haroon, O., Ali, M., Khan, A., Khattak, M.A., Rizvi, S.A.R., 2021. Financial market risks during the COVID-19 pandemic. Emerg. Mark. Financ. Trade 57, 2407–2414.
Hasbrouck, J., 1993. Assessing the quality of a security market: a new approach to transaction-cost measurement. Rev. Financ. Stud. 6, 191–212.
He, P., Sun, Y., Zhang, Y., Li, T., 2020. COVID-19's impact on stock prices across different sectors-an event study based on the Chinese stock market. Emerg. Mark. Financ. Trade 56, 2198–2212.
Huang, W., Zheng, Y., 2020. COVID-19: structural changes in the relationship between investor sentiment and crude oil futures price. Energy Research Letters 1 (2). https://doi.org/10.46557/001c.13685.
Lee, W.Y., Jiang, C.X., Indro, D.C., 2002. Stock market volatility, excess returns, and the role of investor sentiment. J. Bank. Financ. 26, 2277–2299.
Lee, C., Chung, K.H., Yang, S., 2016. Corporate governance and the informational efficiency of prices. Financ. Manag. 45, 239–260.
Liu, M., Choo, W.C., Lee, C.C., 2020. The response of the stock market to the announcement of global pandemic. Emerg. Mark. Financ. Trade 56, 3562–3577.
Mishra, A.K., Rath, B.N., Dash, A.K., 2020. Does the Indian financial market nosedive because of the COVID-19 outbreak, in comparison to after demonetization and the GST? Emerg. Mark. Financ. Trade 56, 2162–2180.
Phan, D.H.B., Narayan, P.K., 2020. Country responses and reaction of the stock market to COVID-19—a preliminary exposition. Emerg. Mark. Financ. Trade 56, 2138–2150.
Prabheesh, K.P., 2020. Dynamics of foreign portfolio investment and stock market returns during the COVID-19 pandemic: evidence from India. Asian Economics Letters 1 (2). https://doi.org/10.46557/001c.17658.
Prabheesh, K.P., Padhan, R., Garg, B., 2020. COVID-19 and the oil price—stock market nexus: evidence from net oil-importing countries. Energy Research Letters 1 (2). https://doi.org/10.46557/001c.13745.
Salisu, A., Adediran, I., 2020. Uncertainty due to infectious diseases and energy market volatility. Energy Research Letters 1 (2). https://doi.org/10.46557/001c.14185.

Salisu, A.A., Akanni, L.O., 2020. Constructing a global fear index for COVID-19 pandemic. Emerg. Mark. Financ. Trade 56, 2310–2331.
Salisu, A.A., Sikiru, A.A., 2020. Pandemics and the Asia-Pacific Islamic stocks. Asian Economics Letters 1 (1). https://doi.org/10.46557/001c.17413.
Sha, Y., Sharma, S.S., 2020. Research on pandemics special issue of the journal emerging markets finance and trade. Emerg. Mark. Financ. Trade 56, 2133–2137.
Sharma, S.S., 2020. A note on the Asian market volatility during the COVID-19 pandemic. Asian Economics Letters 1 (2). https://doi.org/10.46557/001c.17661.
Sharma, S.S., Sha, Y., 2020. Part A: special section on COVID-19 research. Emerg. Mark. Financ. Trade 56, 3551–3553.
Shen, H., Fu, M., Pan, H., Yu, Z., Chen, Y., 2020. The impact of the COVID-19 pandemic on firm performance. Emerg. Mark. Financ. Trade 56, 2213–2230.
Song, P., Zhang, X., Zhao, Y., Xu, L., 2020. Exogenous shocks on the dual-country industrial network: a simulation based on the policies during the COVID-19 pandemic. Emerg. Mark. Financ. Trade 56, 3554–3561.
Thorp, W.A., 2004. Investor Sentiment as a Contrarian Indicator. The American Association of Individual Investors. September-October 2004.
Toda, H.Y., Yamamoto, T., 1995. Statistical inference in vector autoregressions with possibly integrated processes. J. Econ. 66, 225–250.
Wang, H., Xu, L., 2019. Do exchange-traded fund flows increase the volatility of the underlying index? Evidence from the emerging market in China. Accounting and Finance 58, 1525–1548.
Xiong, H., Wu, Z., Hou, F., Zhang, J., 2020. Which firm-specific characteristics affect the market reaction of Chinese listed companies to the COVID-19 pandemic? Emerg. Mark. Financ. Trade 56, 2231–2242.
Xu, L., Yin, X., Zhao, J., 2019. Differently motivated exchange traded fund trading activities and the volatility of the underlying index. Account. Finance 59, 859–886.
Zhang, P., Gao, J., Li, X., 2021. Stock liquidity and firm value in the time of COVID-19 pandemic. Emerg. Mark. Financ. Trade 57, 1578–1591.