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Asymmetric Impact of COVID-19 on China's Stock Market Volatility: Media Effect or Fact?

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This study examines the asymmetric effects of positive and negative changes in media attention to COVID-19 and daily new confirmed COVID-19 cases on China's stock market volatility by utilizing the nonlinear autoregressive distributed lag (NARDL) model. Empirical results show that media attention has a pronounced effect on China's stock market volatility and this effect is greater than the direct impact of COVID-19. Finally, several important policy implications arise from these findings.

I. Introduction

The outbreak of the coronavirus (COVID-19) pandemic not only leads to enormous uncertainty for national economies (Iyke, 2020; Ji et al., 2020; Zhang et al., 2020), it also has received extensive attention from media around the world (Haroon & Rizvi, 2020). News reported by media related to infectious diseases such as COVID-19 may cause uncertainty and affect investor sentiment and investors' limited attention capacity (Iyke & Ho, 2021), which will further influence stock volatility. Indeed, in the face of this uncertainty, financial markets have already responded (Chen & Yeh, 2021; Sharma & Sha, 2020; Topcu & Gulal, 2020). Further, regional financial market volatility and individual country financial market volatility are significantly linked (Sharma, 2020).

Compared with the Great Depression (1929) and the Global Financial Crisis (2008), the impact of the COVID-19 pandemic on financial markets is broader and deeper. Different from previous crises, the rapid development of the internet allows news reports to spread more quickly than ever and individuals' insights on the current economic scenario and future expectations are largely shaped by the media (Ashraf, 2020; Bai et al., 2020; Erdem, 2020; Lyócsa & Molnár, 2020). This results in changes in investment decisions and fluctuations in the stock market. Therefore, it cannot be denied that the news media plays an increasingly important role in influencing investor sentiment and asset prices. At the onset of the COVID-19 pandemic, how to identify the impact of media attention to COVID-19 on financial market fluctuations and how to effectively prevent the spread of financial risk and ensure stable economic development became a major challenge for policymakers. Against this backdrop, this paper investigates the influence of media attention and daily new confirmed COVID-19 cases on stock market volatility in the context of China.

The main contribution of this paper is as follows. Different from existing studies that investigate the direct impact of COVID-19 on the stock market (Ashraf, 2020; Bal & Mohanty, 2021; Chen & Yeh, 2021; Gil-Alana & Claudio-Quiroga, 2020; Topcu & Gulal, 2020; Yan & Qian, 2020), we focus on the underlying role of media attention on stock price volatility. To our knowledge, while it is widely accepted that the media plays a key role in information spread and that the stock market is sensitive to new information, little research addresses the influence of media attention to COVID-19 on stock market price volatility. Thus, this study provides fresh evidence on whether media attention changes can influence stock market price volatility. In addition, we apply the nonlinear autoregressive distributed lag (NARDL) model to consider asymmetric transmission of the relevant determinants to stock market volatility, helping cast new light on corresponding research that merely considers the symmetric effect. Our asymmetric analysis may enrich understanding of the impact of media attention on stock market volatility.

This paper proceeds as follows. Section II presents the empirical method. Section III describes the data and empirical results. Finally, Section IV sets forth our conclusions.

II. Methodology

Our empirical methodology is based on the NARDL model proposed by Shin et al. (2014). The main advantage of the NARDL method is that it can detect the asymmetric short-run and long-run impact of each independent variable on the dependent variable. According to the theoretical framework proposed by Andrei & Hasler (2015), the NARDL model shows that stock market volatility will increase (decrease) under high (low) levels of attention, since infor-

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mation is included in prices only when investors pay great attention to the news. Thus, this paper proposes the hypothesis that media attention has a positive impact on return volatility. In particular, we consider the following asymmetric long-run equilibrium equation:

$$SPV_t = \beta'^{+} x_t^{+} + \beta'^{-} x_t^{-} + \varepsilon_t \quad (1)$$

Where SPV_t is the explained variable, or stock market volatility; ε_t denotes a random error term; $\beta'^{+}$and β'^{-} indicate the asymmetric long-run parameters; and $x_t^{+}= [COVID_t^{+}, MEDIA_t^{+}, SENTI_t^{+}, MP_t^{+}, VIX_t^{+}]'$, $x_t^{-}= [COVID_t^{-}, MEDIA_t^{-}, SENTI_t^{-}, MP_t^{-}, VIX_t^{-}]'$ represent partial cumulative sum processes of positive and negative changes in the explanatory variable. The specific calculation process is as follows:

$$\begin{aligned} x_t^{+} &= \sum_{k=1}^{t} \Delta x_k^{+} = \max(\Delta x_k, 0), \\ x_t^{-} &= \sum_{k=1}^{t} \Delta x_k^{-} = \min(\Delta x_k, 0) \end{aligned} \quad (2)$$

By embedding Equation (1) into the unrestricted linear ARDL (p, q) model, the asymmetric error correction model can be written as:

$$\begin{aligned} \Delta SPV_t &= \alpha_0 + rSPV_{t-1} + \xi^{+} COVID_{t-1}^{+} \\ &+ \xi^{-} COVID_{t-1}^{-} + \phi^{+} MEDIA_{t-1}^{+} \\ &+ \phi^{-} MEDIA_{t-1}^{-} + \varphi^{+} SENTI_{t-1}^{+} \\ &+ \varphi^{-} SENTI_{t-1}^{-} + \gamma^{+} MP_{t-1}^{+} \\ &+ \gamma^{-} MP_{t-1}^{-} + \eta^{+} VIX_{t-1}^{+} \\ &+ \eta^{-} VIX_{t-1}^{-} + \sum_{k=1}^{p-1} \vartheta_t \Delta SPV_{t-k} \\ &+ \sum_{k=0}^{q-1} (\pi_t^{+} \Delta COVID_{t-k}^{+} + \pi_t^{-} \Delta COVID_{t-k}^{-}) \\ &+ \sum_{k=0}^{q-1} (\mu_t^{+} \Delta MEDIA_{t-k}^{+} + \mu_t^{-} \Delta MEDIA_{t-k}^{-}) \\ &+ \sum_{k=0}^{q-1} (o_t^{+} \Delta SENTI_{t-k}^{+} + o_t^{-} \Delta SENTI_{t-k}^{-}) \\ &+ \sum_{k=0}^{q-1} (\rho_t^{+} \Delta MP_{t-k}^{+} + \rho_t^{-} \Delta MP_{t-k}^{-}) \\ &+ \sum_{k=0}^{q-1} (\omega_t^{+} \Delta VIX_{t-k}^{+} + \omega_t^{-} \Delta VIX_{t-k}^{-}) + e_t \end{aligned} \quad (3)$$

At this stage, we obtain the NARDL model, which can be employed to uncover asymmetric transmission.

III. Data and empirical results

The explained variable in this study is China's stock price volatility (*SPV*), which is measured by the SSE 50 ETF Volatility Index. The main explanatory variables are daily new confirmed COVID-19 cases (*COVID*) and media attention to COVID-19 (*MEDIA*). We also employ investor sentiment index (*SENTI*), monetary policy dynamic (*MP*), and the global fear index (*VIX*) as control variables in the empirical model. Media attention to COVID-19 is obtained from the Coronavirus Media Monitor[1] and the other datasets are obtained from the Wind dataset of China. The sampling period spans 20 January 2020 to 31 December 2020, and each dataset is at daily frequency. Primary statistics of each variable are given in Table 1, which shows that the standard deviation of COVID-19 is highest, meaning that daily new confirmed COVID-19 cases fluctuate sharply during the sample period. In addition, the results of the unit root test indicate that all involved variables are not $I(2)$ processes, thus meeting the requirements of the NARDL model.

Moreover, Table 1 (Panel B) reports stable long-term relationships between stock price volatility and the explanatory variables in the long- and short-run asymmetric cases, since the F_{PSS} statistics surpass the upper threshold critical value. The results of the Lagrange Multiplier (*LM*) test cannot reject the null hypothesis of no sequence correlation, indicating that there is no sequence correlation in each case. Further, among the four alternative models, Akaike and Schwarz information criterion both reach their minimum in the long- and short-term asymmetric cases. Also, adjusted R^2 is at the maximum in this case. In a word, the model with both short-and long-run asymmetries is best suited for empirical estimation.

Table 2 presents the NARDL estimates obtained from Equation (3). The lag order of the estimation model is selected by stepwise regression. The error correction coefficient shows that the NARDL estimation is stable, as it is negative and statistically significant. Specifically, the estimated long-term coefficients of COVID-19 are significant and show positive signs, implying that China's stock price volatility is positively affected by new confirmed COVID-19 cases. In addition, the long-term impact of an increase in new confirmed COVID-19 cases slightly cancels the impact of a decrease, suggesting that China's stock price volatility is more vulnerable to positive fluctuations in daily new confirmed COVID-19 cases in the long term. This may be so because a continuous increase in daily new confirmed COVID-19 cases can easily damage investor sentiment. Accordingly, it is easier to magnify panic in the market, which ultimately increases the volatility of stock market prices. Similarly, in the short term, the cumulative impact coefficients show positive signs, which indicates that China's stock price volatility is positively affected by daily new confirmed COVID-19 cases in the short term.

In a similar vein, the effect of positive shocks to daily new confirmed COVID-19 cases is more pronounced than that of negative shocks in the short run, indicating that China's stock price volatility shows a stronger response to rising daily new confirmed COVID-19 cases. One interpretation of these findings is that in the context of soaring daily new confirmed COVID-19 cases in the short run, stock market trading will become more uncertain. Consequently, ceteris paribus, growing panic in the stock market might cause investors to become more prudent, and a "waiting and seeing" mood may become more prevalent than in other contexts. At this time, investment activity in the market be-

1 https://coronavirus.ravenpack.com/

Table 1. Descriptive Statistics and Bound Cointegration Test

Panel A: Descriptive Statistics

Statistic	*SPV*	*COVID-19*	*MEDIA*	*SENTI*	*MP*	*VIX*
Mean	3.235	3.179	4.253	0.279	1.586	3.340
Maximum	3.688	9.555	4.505	0.725	2.523	4.415
Minimum	2.592	0.000	3.287	-0.237	0.602	2.549
Standard deviation	0.194	1.621	0.143	0.220	0.497	0.351
Skewness	0.181	1.473	-2.668	-0.094	-0.232	0.541
Kurtosis	2.389	5.795	18.045	1.703	2.021	3.952
Jarque-Bera	4.858*	158.802***	2452.632***	16.525***	11.295***	19.987***
PP (Level)	-2.917**	-2.743*	-7.130***	-1.693	-4.398***	-2.570*
ADF (Level)	-3.112**	-2.266	-2.987**	-1.562	-3.826***	-2.833*
PP (1st Difference)	-19.952***	-22.212***	-20.117***	-18.878***	-20.912***	-17.726***
ADF (1st Difference)	-10.993***	-21.963***	-14.135***	-18.818***	-12.232***	-7.073***

Panel B: Bound Cointegration Test

SR and LR Symmetry		SR Asymmetry and LR Symmetry		LR Asymmetry and SR Symmetry		LR and SR Asymmetry	
F_{PSS}	1.662	F_{PSS}	3.517*	F_{PSS}	4.843***	F_{PSS}	8.539***
–	–	$W_{SR}{}^{COVID}$	0.004			$W_{SR}{}^{COVID}$	1.304
–	–			$W_{LR}{}^{COVID}$	1.955	$W_{LR}{}^{COVID}$	9.125***
–	–	$W_{SR}{}^{MEDIA}$	1.512			$W_{SR}{}^{MEDIA}$	16.975***
–	–			$W_{LR}{}^{MEDIA}$	9.019***	$W_{LR}{}^{MEDIA}$	23.041***
–	–	$W_{SR}{}^{SENTI}$	0.859			$W_{SR}{}^{SENTI}$	26.195***
–	–			$W_{LR}{}^{SENTI}$	2.882*	$W_{LR}{}^{SENTI}$	14.504***
–	–	$W_{SR}{}^{MP}$	9.585***			$W_{SR}{}^{MP}$	9.099***
–	–			$W_{LR}{}^{MP}$	0.997	$W_{LR}{}^{MP}$	0.005
–	–	$W_{SR}{}^{VIX}$	3.782*			$W_{SR}{}^{VIX}$	1.021
–	–			$W_{LR}{}^{VIX}$	9.973***	$W_{LR}{}^{VIX}$	14.376***
Adj. R^2	0.486	*Adj. R*^{2}	0.401	*Adj. R*^{2}	0.348	*Adj. R*^{2}	0.487
AIC	-3.157	*AIC*	-3.239	*AIC*	-3.236	*AIC*	-3.302
SC	-2.836	*SC*	-2.685	*SC*	-2.820	*SC*	-2.955
χ^2_{SC}	0.896 [0.552]	χ^2_{SC}	0.556 [0.875]	χ^2_{SC}	1.537 [0.114]	χ^2_{SC}	0.788 [0.663]

This table reports the descriptive statistics (Panel A) and the bound cointegration test results (Panel B). F_{PSS} is the F-statistic that is used to test for cointegration among variables. W_{SR} and W_{LR} are *Wald* statistics that are used to test for the short- and long-term asymmetry. The p-values are shown in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.

comes inactive, resulting in a crash in stock prices, which can be interpreted as increasing China's stock price volatility.

In addition, media attention to COVID-19 exerts a clear asymmetric long-run impact on China's stock price volatility. Further, the long-term effect of a decrease in media attention significantly cancels the effect of the increase, suggesting that China's stock price volatility is more vulnerable to negative fluctuations in media attention (media coverage decrease) in the long term. From the short-run perspective, there is a significant lag effect concerning the influence of negative and positive shocks on China's stock price volatility. The short-term cumulative effect of media attention in the positive shock beats the negative shock, which differs from the long-term effect. Our results thus indicate that increased media attention in the short term plays a more important role in affecting China's stock price volatility. However, from a long-term perspective, a reduction in media attention has a major impact on alleviating stock market fluctuations. One possible explanation for this is that increased media coverage of COVID-19 in the short term will release a strong signal that individuals' health and safety have been severely impacted and that there are serious uncertainties in the market. Faced with this situation, investor panic selling is prone to herding behavior, which can exacerbate the volatility of China's stock prices. However, in the long term, media coverage can help reduce information asymmetry between markets. At this stage, a decrease in media attention will increase stock market volatility. These observations explain to some extent the asymmetric responses of stock price volatility to media attention.

Table 2. Estimation result of the NARDL models for concerned factors of China's stock volatility

Long-term coefficients			Short-term coefficients						
$Constant$	0.922*** [8.282]	–	ΔSPV_{t-2}	0.255*** [4.208]	$\Delta SENTI_{t-6}^{+}$	0.118** [2.439]	ΔMP_{t-9}^{+}	-0.038** [-2.166]	–
SPV_{t-1}	-0.212*** [-7.131]	–	$\Delta COVID_{t-3}^{+}$	0.017** [1.787]	$\Delta SENTI_{t-4}^{-}$	0.250** [2.247]	ΔMP_{t-1}^{-}	0.046* [1.746]	–
$COVID_{t-1}^{+}$	0.014** [2.498]	–	$\Delta COVID_{t-4}^{+}$	0.029** [2.943]	$\Delta SENTI_{t-5}^{-}$	0.249** [2.004]	ΔVIX_{t-2}^{+}	-0.137** [-2.392]	–
$COVID_{t-1}^{-}$	0.013** [2.392]	–	$\Delta COVID_{t-1}^{-}$	0.017** [1.819]	ΔMP_{t-1}^{+}	-0.077*** [-3.747]	ΔVIX_{t-3}^{+}	-0.244*** [-4.257]	–
$MEDIA_{t-1}^{+}$	0.119* [1.725]	–	$\Delta COVID_{t-5}^{-}$	0.028** [3.120]	ΔMP_{t-2}^{+}	-0.045** [-2.130]	ΔVIX_{t-6}^{+}	-0.138*** [-2.682]	–
$MEDIA_{t-1}^{-}$	0.316** [4.633]	–	$\Delta MEDIA_{t-1}^{+}$	0.155** [1.742]	ΔMP_{t-3}^{+}	-0.041** [-2.018]	ΔVIX_{t-9}^{+}	-0.154*** [-3.053]	–
$SENTI_{t-1}^{+}$	0.088** [2.178]	–	$\Delta MEDIA_{t-3}^{+}$	0.164** [1.985]	ΔMP_{t-4}^{+}	-0.045** [-2.245]	ΔVIX_{t-1}^{-}	0.237*** [2.722]	–
$SENTI_{t-1}^{-}$	0.085** [2.174]	–	$\Delta MEDIA_{t-6}^{+}$	0.177** [2.153]	ΔMP_{t-5}^{+}	-0.054*** [-2.690]	ΔVIX_{t-3}^{-}	-0.191** [-2.030]	–
MP_{t-1}^{+}	0.037** [2.252]	–	$\Delta MEDIA_{t-7}^{+}$	0.167* [1.965]	ΔMP_{t-6}^{+}	-0.043** [-2.317]	ΔVIX_{t-4}^{-}	-0.268*** [-3.294]	–
MP_{t-1}^{-}	-0.044 [-3.753]	–	$\Delta MEDIA_{t-8}^{-}$	0.126** [2.071]	ΔMP_{t-7}^{+}	-0.039** [-2.181]	ΔVIX_{t-5}^{-}	-0.329*** [-3.807]	–
VIX_{t-1}^{+}	0.140*** [6.568]	–	$\Delta SENTI_{t-1}^{+}$	0.177** [2.443]	ΔMP_{t-8}^{+}	-0.072*** [-3.904]	–	–	–
VIX_{t-1}^{-}	0.271*** [6.381]	–	–	–	–	–	–	–	–

Long-term transmission effects

L_{COVID}^{+}	L_{MEDIA}^{+}	L_{SENTI}^{+}	L_{MP}^{+}	L_{VIX}^{+}	L_{COVID}^{-}	L_{MEDIA}^{-}	L_{SENTI}^{-}	L_{MP}^{-}	L_{VIX}^{-}
0.067**	0.561*	0.413**	0.172**	0.662***	0.059**	1.490**	0.401**	-0.209	1.278***

Model statistics and diagnosis

F_{PSS}	t_{BDM}	AIC	SC	χ^2_{SC}
8.539***	-7.121***	-3.302	-2.955	0.788

The numbers in brackets are the *t*-values. Long-run coefficients can be computed as follows: $L_x^+ = -\xi^+/r$ and $L_x^- = -\xi^-/r$; χ^2_{SC} indicates the *LM* tests for serial correlation. t_{BDM} is the *t-statistic* for testing the null hypothesis of no cointegration. *, ** and*** represent significance at 10%, 5% and 1% level, respectively. – denotes empty cells.

Our empirical analysis thus finds significant asymmetric effects from the relevant factors on China's stock market volatility. In particular, we find that media attention strongly affects China's stock market volatility, with positive shocks to media attention resulting in intensification of China's stock market volatility. These findings shed new light on the literature, which does not consider the role of media attention and ignores the nonlinear effect when investigating the influence of COVID-19 on the stock market.

IV. Conclusion

This study examines the effects of media attention to COVID-19 and daily new confirmed COVID-19 cases on China's stock price volatility, via the NARDL model. The empirical results show that positive shocks to media attention will lead to increased stock price volatility in China; this effect is greater than the direct impact of COVID-19. This implies that information originating from media news reports about COVID-19 can provide useful information to help investors and policymakers forecast stock price volatility.

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