Finance Research Letters 36 (2020) 101669

Contents lists available at ScienceDirect

Finance Research Letters

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

COVID-19's disasters are perilous than Global Financial Crisis: A rumor or fact?

Khurram Shehzad[a,*], Liu Xiaoxing[a], Hayfa Kazouz[b]

[a] School of Economics and Management, Southeast University, Nanjing, China
[b] Faculty of Economic sciences and Management, University of Sousse, Sousse, Tunisia

ARTICLE INFO

Keywords:
COVID-19
Global Financial Crises
APGARCH model
Financial markets
Leverage effect

JEL codes:
G01
G11
G14
G15

ABSTRACT

This investigation employed the Asymmetric Power GARCH model and found that COVID-19 substantially harms the US and Japan's market returns. Moreover, COVID-19 has influenced the variance of the US, Germany, and Italy's stock markets more than the Global Financial Crises (GFC). However, GFC indicated a more significant impact on the financial volatility of the Nikkei 225 index and SSEC than COVID-19. The study confirmed the leverage effect for the S&P 500, Nasdaq Composite Index, DAX 30, Nikkei 225, FTSE MIB, and SSEC. The analysis authenticated that the health crisis that befell due to COVID-19 have imperatively originated the financial crisis globally; however, the Asian markets still make available better prospects for portfolio optimization.

1. Introduction

In the past, World health organization (WHO) revealed various epidemics that influenced the vast number of people and economies around the world, e.g., Influenza, Ebola, and Severe Acute Respiratory Syndrome (SARS). These epidemics greatly affected the economy of the world; particularly, 5% gross domestic product (GDP) of the US was reduced owing to Influenza (Palese, 2004); while, the US encountered the economic deficit of $53 billion as result of EBOLA and it caused more than 11,300 deaths in the world (Hai et al., 2004). The SARS transpired from China in 2002 and affected more than 8000 people. It depreciated the 1% GDP of China and instigated the economic damage of $54 billion worldwide (Peiris et al., 2003). Recently, a new pandemic reported from Wuhan, China, known as a novel coronavirus (COVID-19), with a specific ability to transmit from one person to another, has spread nearly all over the world, and prominently distracted the lives of the people universally. On April 17, 2020, more than 1,865,413 people have been infected, and 110,008 deaths have been documented due to COVID-19 in the world (Financial Times, 2020). In order to stop the transmission of COVID-19, each nation has locked its business, markets, and people are forced to live in their houses. Subsequently, unemployment has been enriched; the supply side has been damaged, economic growth, tourism level, and sale of the traveling sector have been reduced (Leduc and Liu, 2020). Also, the stock markets of the world confronted an extreme collision in their market values. The market value of the Standard & Poor (S&P) 500 index dropped to 30% since the outbreak of COVID-19. Fig. 1 exhibited the diminution in the market value of the world's reputed stock index due to COVID-19. The verdicts reported that, during March, stock markets of Germany, France, and Italy encountered extreme deterioration in their market values.

Moreover, the US, UK, Spain, Hong Kong, and China's stock markets run into a decline of 14.9%, 21.4%, 25.1%, 14.7%, and

* Corresponding author at: School of Economics and Management, Southeast University, Nanjing 211189, China.
E-mail addresses: 233189917@seu.edu.cn (K. Shehzad), Jiulonghu198@seu.edu.cn (L. Xiaoxing), haifa.kazouz@fsegso.u-sousse.tn (H. Kazouz).

https://doi.org/10.1016/j.frl.2020.101669
Received 18 April 2020; Received in revised form 20 June 2020; Accepted 25 June 2020
Available online 26 June 2020
1544-6123/

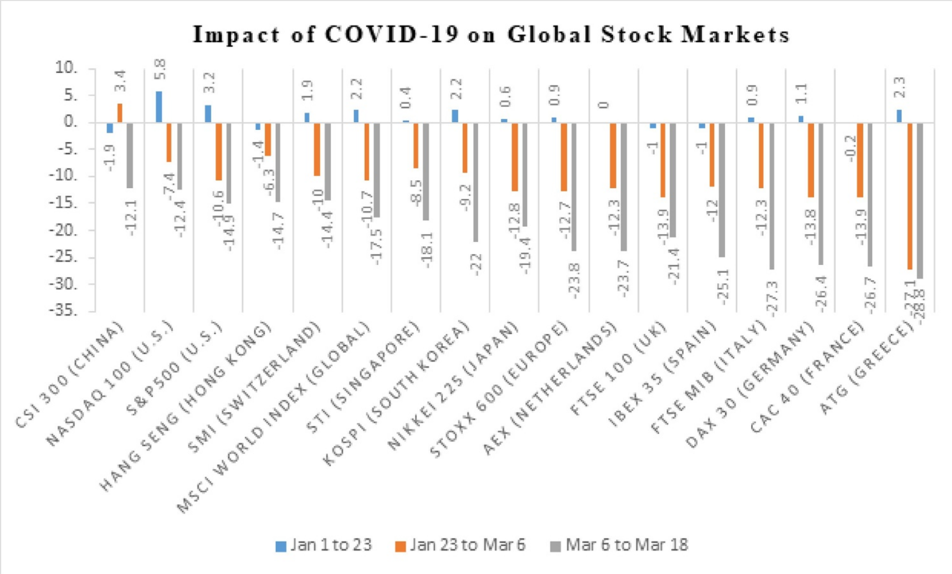

Fig. 1. Decline in stock market values due to COVID-19
Data source: Statista.com.

12.1% in their prices since March 08 – March 18, respectively. Notably, the market value of the MSCI World Index faced 17.5% dropped from March 06 - March 18. Adam (2020) reported that financial markets are near to collapse as they were during the financial crises of 2008. Georgieva (2020) argued that COVID-19 brought the earth near to financial crises more perilous than Global Financial Crises (GFC) 2007-2009. Additionally, the financial volatility index (VIX), also known as "Fear gauge," has moved to the uppermost level, higher than the GFC era, while the US 10 year treasury yield index moved down to record low level (Leduc and Liu, 2020). The Asian Development Bank evaluated that the global cost of COVID-19 can be $4.1 trillion (ADB, 2020). Hence, this information intimated the importance of exploring the impacts of COVID-19 on reputed stock markets of the globe and resembled its impact on disasters of GFC. This investigation sought the impact of COVID-19 and GFC on the returns and variance of stock markets of the US, Germany, Italy, China, and Japan; and compared the parameters of both periods.

Also, the study analyzed the role of China and the US trade war on their stock market returns and variance. The investigation also scrutinized the influence of news and volatility persistence by reason of COVID-19 in these markets. This project answers the superior queries of the policymakers, investors, financial analysts, portfolio managers, and academicians. For instance, first, does the COVID-19 generated a more significant crash in stock markets than GFC? Second, does COVID-19 has a higher impact on stock returns than GFC? Third, does the volatility that ensued in stocks as a result of COVID-19 are higher than GFC? Fourth, do markets have a significant leverage effect? Fifth, do shocks befell in these markets continued for the long term period? Sixth, what tactics can be used to stabilize the market volatility? The author deems that answers to these queries will clear the role of COVID-19 and GFC for financial markets. As per the author's best information, no study has been conducted to analyze and compare the imperious role of COVID-19 and GFC on stock market returns and variance.

First, this study engaged the Augmented Dickey-Fuller test, and Phillip Perron test to examine the unit root level of study variables and then Autoregressive Conditional Heteroskedasticity-Lagrange Multiplier (ARCH-LM) test is employed to ascertain the ARCH effect in the data. The findings disclosed that all the variables are stationary at I(0), and a significant ARCH effect exists. Moreover, the Jarque-Bera test revealed that these market's returns are not normally distributed. Consequently, Asymmetric Power Generalized Autoregressive Conditional Heteroskedasticity (APGARCH) model is appropriate for this study. The rest of this project is outlined as follows. Chapter 2 reviews the methodological section, chapter 3 debates on the findings of this project, chapter 4 epitomizes the conclusion, and chapter 5 provides the references applied in this project.

2. Methodological path

2.1. Data

This investigation utilized the day-wise data from the period of June 30, 2007, to April 07, 2020. The day-wise prices of the US (S&P 500, Nasdaq Composite index), Germany (DAX 30), Italy (FTSE MIB), Japan (Nikkei 225), and Chinese (SSEC) stock markets are salvaged from the database of Yahoo Finance. Further, this investigation used the dummy variables (0, 1) to ascertain the impact of GFC and COVID-19. Likewise, Choudhry, 2010 and Kiymaz and Berument (2003) utilized the dummy variables to analyze the impact of daily and yearly anomalies on stock returns.

2.2. Methodology

The study has calculated the daily returns of S&P 500 (SPR), Nasdaq Composite Index (NSR), DAX 30 (DXR), FTSE MIB (FMBR), Nikkei 225 Index (NKR), and SSEC (SCR) by following the method of Shehzad and Sohail (2018) as follows,

$$R_t = (ln(CS_t/CS_{t-1}))*100 \tag{1}$$

here R_t, CS_t, and CS_{t-1} signify the projected day-wise returns, the closing price of a stock at time t, and closing value of a stock on the previous day, while ln symbolizes the natural log. In order to capture the non-linear influence of COVID-19 and GFC in the daily returns and variance of financial markets, this investigation employed Asymmetric Power GARCH model introduced by Ding et al. (1993). Moreover, this analysis utilized the student-t distribution, as it can handle excess kurtosis (Bollerslev, 1987). The mean and variance equation of APGARCH model can be defined as (Ding et al., 1993),

$$\lambda_{ti} = \xi_0 + \xi_1 GFC_{ti} + \xi_2 COVID_{ti} + \varepsilon_{ti} \tag{2}$$

$$\Psi_{ti}^{v} = \vartheta_0 + \phi_1 \mathrm{GFC}_{ti} + \phi_2 \mathrm{COVID}_{ti} + \sum_{i=1}^{p} (\alpha_i |z_{t-1}| + \chi_i z_{t-1})^{v} + \sum_{i=1}^{q} \beta_i \Psi_{ti-1}^{v} \tag{3}$$

where,

$$Z = \frac{\varepsilon_{ti}}{\varpi_{ti-1}} \sim t.\ d.\ (0,\ \Psi_{ti},\ \Gamma) \tag{4}$$

here in the mean equation Eq. (2), λ_{ti} and ε_{ti} denotes the returns and error term of stock market *i*, respectively. The error term is founded on historical information (ϖ_{ti-1}) and presumed that it follows the student-t density (t.d.), with Γ degree of freedom. Moreover, ξ_0, ξ_1, and ξ_2 indicate the constant term, dummy variable of GFC, and COVID-19. Likewise, in the variance equation Eq. (3), β_i directs the variations in its own variance series, i.e., GARCH effect and v denote the power term coefficient. Moreover, α_i and χ_i evaluate the effects of return changes on its own series, i.e., ARCH effect and asymmetric impact of series *i*, i.e., leverage effect, respectively. A positive χ_i indicates that negative news has a greater impact than positive news on market volatility (Ding, 2011). Besides, φ_1 and φ_2 determine the effect of GFC and COVID-19 on variance series *i*, respectively. By considering the methodology of (Ding et al., 1993; Hentschel, 1995), various standard ARCH and GARCH models can be nested in APGARCH model by stipulating the permitted values for α_i, χ_i, β_i, and v (Teräsvirta, 2012). Table 1 defines the inherent limitations to produce the various ARCH and GARH models nested in APGARCH model. This study assigned the number 1 to the days of GFC, i.e., June 30, 2007- December 30, 2009, and 0 otherwise. While to evaluate the sway of COVID-19, the number 1 is assigned from January 01, 2020 – April 07, 2020, otherwise 0. This examination does not consider the dummy variable of the normal period to avoid the dummy trap. Further, the investigation include the dummy variable of the trade war between China and the US for the stock markets of China and the US as follows,

$$\lambda_{ti} = \xi_0 + \xi_1 GFC_{ti} + \xi_2 COVID_{ti} + \xi_3 CWAR_{ti} + \varepsilon_{ti} \tag{5}$$

$$\Psi_{ti}^{v} = \vartheta_0 + \phi_1 \mathrm{GFC}_{ti} + \phi_2 \mathrm{COVID}_{ti} + \phi_3 \mathrm{CWAR}_{ti} + \sum_{i=1}^{p} (\alpha_i |z_{t-1}| + \chi_i z_{t-1})^{v} + \sum_{i=1}^{q} \beta_i \Psi_{ti-1}^{v} \tag{6}$$

where ξ_3 and φ_3 denote the impact of China and the US trade war in mean (Eq. (5)) and variance (Eq. (6)) equation, respectively.

3. Results and discussions

The summary statistics of study variables given in Table 2 informed that all the stock markets have negative mean returns during

Table 1
Nested ARCH and GARCH model limitations.
Source: author's calculation.

Approach	Ai	χi	βi	ν
ARCH	independent	0	0	2
GARCH	independent	0	independent	2
GJR GARCH	αi(1+χi)2	4αiχi	0	2
GJR ARCH	αi(1+χi)2	4αiχi	independent	2
TARCH	independent	|χ|≤1	0	1
Taylor ARCH	independent	0	0	1
Taylor GARCH	independent	0	independent	1
NARCH	independent	0	0	independent
Generalized TARCH	independent	|χ|≤1	independent	1
Asymmetric ARCH	independent	|χ|≤1	0	2
Asymmetric GARCH	independent	|χ|≤1	independent	2
PGARCH	independent	0	independent	independent
APGARCH	independent	|χ|≤1	independent	independent

Table 2
Summary statistics of stock returns.
Source: author's calculation.

	NKR	FMBR	SCR	NSR	SPR	DXR
Mean	-0.313724	-0.402455	-0.147617	-0.215405	-0.147623	-0.51546
Std. Dev.	2.445463	3.453028	1.769321	3.626117	2.977544	2.925632
Skewness	0.505023	-2.31595	-1.558152	-0.510258	-0.556915	-0.875228
Kurtosis	4.942365	14.04434	8.030458	5.449286	7.903214	9.651646
Jarque-Bera	12.78127	424.3192	90.4602	19.36125	106.3956	130.0984
Probability	0.001677	0	0	0.000062	0	0

the COVID-19 era. In addition, all the markets exposed negative skewness with high kurtosis values, inferring that chances of loss are in height. Table 3 stated the results of the Augmented Dickey-Fuller (ADF) test Dickey et al., 1979, Phillip Perron (PP) test (Perron, 1988), and Autoregressive Conditional Heteroskedasticity (ARCH) test (Engle, 1982). The findings described that all the return series are stationary at I(0), and the significant ARCH effect is present. Hence, the APGARCH model perfectly fits the study.

3.1. Mean model reckoning

The aftermaths of the mean equation for each returns series, specified in Table 4, discovered that GFC (ξ_1) and COVID (ξ_2) have a negative sway on SPR. However, the coefficient of GFC (ξ_1) remains inconsequential. Moreover, CWAR indicated a positive but insignificant impact on SPR. The mean equation of NSR publicized that GFC (ξ_1) has a negative and substantial relationship with NSR. Nonetheless, COVID (ξ_2) and CWAR (ξ_3) demonstrated a positive but insignificant influence on NSR. The outcomes of DXR remain extraneous, but NKR quantified that GFC (ξ_1) and COVID (ξ_2) have negative control on NKR, but the effect of COVID (ξ_2) is insignificant. Further, GFC (ξ_1) disclosed a destructive and momentous effect on FMBR, whereas the impact of COVID (ξ_2) on FMBR is noted to be positive and irrelevant. The return series of SCR designated that GFC (ξ_1) has a positive, but CWAR (ξ_3) has an adverse reaction on it; however, COVID-19 divulged positive and minor control.

3.2. Variance equation fallouts

The inferences of the variance equation for each market are unveiled in Table 5. It defines that all constant values (ϑ_0) are significant, implying that mean values are divergent from zero. The fluctuations in returns due to GFC (φ_1) and COVID (φ_2) imperatively affect the instability of SPR. However, COVID (φ_2) revealed a trifling effect on the stability of NSR. Also, the instability caused by CWAR (φ_3) indicated an inconsequential effect. The findings of DXR and NKR variance equation stated that uncertainty occurred due to GFC (φ_1) at time t, expressively upsurge the volatility of these markets at time t + 1. Further, variability happened owing to COVID (φ_2) dramatically influence the variance of DXR, but it showed inconsequential sway on the variance of NKR. Likewise, COVID (φ_2) documented the feeble effect as compared to GFC (φ_1) for FMBR. The variance reckoning of SCR particularized that the coefficient of CWAR (φ_3) and GFC (φ_1) exposed a positive and insignificant, although the coefficient of COVID (φ_2) nominated positive and significant impact on the market variance. Fig. 2 confirmed that stock markets of the US, Germany, and Italy have high conditional variance because of COVID-19 as compared to GFC. On the other hand, the conditional variance of Nikkei 225 and SSEC is high during the GFC period.

The investigation specified that negative news has a more significant impact on these markets as compared to positive news of the same magnitude, as χ_i showed positive and significant values for these markets. Moreover, the study originates that shocks measured through standardized residuals, and one-period lag variance extensively distress its own impulsiveness, inferring that resilient ARCH (α_i) and GARCH (β_i) effect exist in these markets, respectively. The sum of the ARCH (α_i) and GARCH (β_i) coefficients represents the volatility persistence in a market (Dedi and Yavas, 2016). This evaluation argued that shocks generated due to COVID-19 would persist for an extended period in these markets, as the sum of ARCH (α_i) and GARCH (β_i) parameters of these markets is near to one. In addition, the power term identified the value of 0.86, 0.89, 0.87, 0.86, 1.06, and 1.38 for SPR, NSR, DXR, NKR, FMBR, and SCR,

Table 3
Unit root and Heteroskedasticity test

	ADF		PP		ARCH-LM
Variable	Level	1st Diff.	Level	1st Diff.	F-statistics
SPR	-66.03021***	-22.63017***	-66.25453***	-828.5502***	426.7328***
NSR	-64.45909***	-64.63904***	-65.08732***	-816.2465***	466.3889***
DXR	-56.48601***	-22.39084***	-56.48463***	-785.2905***	48.2608***
NKR	44.8633***	21.9552***	-53.6732***	-721.3891***	329.7114***
FMBR	-59.11521***	-26.05068***	-59.1209***	-810.3178***	80.99362***
SCR	-54.81653***	-23.65203***	-54.84421***	-521.7985***	109.9907***

Note: *, **, and *** denotes the 10%, 5%, and 1% level of significance, respectively. Source: author's calculation.

Table 4
Results of mean equation.
Source: author's calculation.

Variable	Coefficient	Std. Err	Z-Statistics	Prob.
SPR				
ξ1	-0.074166	0.051206	-1.448404	0.1475
ξ2	-0.033553	0.03892	8.625601	0.0000
ξ3	0.024108	0.031249	0.771508	0.4404
ξ0	0.046116	0.013268	3.475718	0.0005
NSR				
ξ1	-0.07019	0.057106	-2.91165	0.0359
ξ2	0.068919	0.049588	1.389834	0.1646
ξ3	0.029659	0.059823	0.49578	0.62
ξ0	0.071684	0.016054	4.465119	00000
DXR				
ξ1	-0.074194	0.053305	-1.391876	0.164
ξ2	0.003962	0.05155	0.076855	0.9387
ξ0	0.043952	0.017596	2.497806	0.0125
NKR				
ξ1	-0.105667	0.059912	-1.763687	0.0778
ξ2	-0.046816	0.054285	-0.862421	0.3885
ξ0	0.052843	0.019775	2.672166	0.0075
FMBR				
ξ1	-0.114119	0.057484	-1.985253	0.0471
ξ2	0.017097	0.129362	0.132167	0.8949
ξ0	0.017786	0.022873	0.777598	0.4368
SCR				
ξ1	0.159696	0.081796	1.952361	0.0509
ξ2	0.088564	0.093508	9.471250	0.0000
ξ3	-0.031935	0.049069	-0.650818	0.5152
ξ0	0.034007	0.02037	1.669487	0.095

respectively. It indicates the utilization of the model, which permits the power factor to be analyzed. The degree of freedom parameter (Γ) of these markets is significant, and earned fair values range from 4.4 to 8.03. It recognized that the investigation has efficaciously captured the actual fat-tailed returns distribution of these stocks.

3.3. Diagnostic measures

In order to ascertain the serial correlation and Heteroskedasticity in the square of standardized residuals of the model, this examination employed Ljung-Box Q and ARCH LM test. The consequences accessible from Table 6, mentioned that there was no serial correlation and Heteroskedasticity in the square of standardized residuals for each model, concluding that all the models performed are correct.

4. Conclusion

This study applied the APGARCH model to analyze the non-linear behavior of financial markets of the US, Germany, Italy, Japan, and China during the COVID-19 and GFC period. The findings specified that COVID-19 has a substantial and harmful impact on stock returns of the S&P 500; however, it showed an inconsequential impact on the Nasdaq Composite index. As well, the conditional variance of European and the US markets, during the era of COVID-19, is high as compared to the GFC epoch; but conditional variance during the GFC period is high in Asian markets. Hence, the European and the US markets are more affected by COVID-19 as compared to Asian markets. Thus, Asian markets still provide better opportunities to diversify financial risk. Additionally, this investigation confirmed the leverage effect in these markets. The investigation argued that COVID-19 had stopped the economic circle throughout the world, and it can cause more dangerous shocks in these markets. The study confirmed that the health crisis of COVID-19 has successfully produced the financial crisis. Consequently, a significant portion of the budget should be spent to mitigate this kind of pandemic in the future. Fallouts of this study have the same implications for the other markets of the US, Europe, and Asia. These findings are vital for policymakers, investors, academicians, portfolio managers, and researchers.

Funding

The study is supported by National Natural Science Foundation of China (No.71673043).

CRediT authorship contribution statement

Khurram Shehzad: Methodology, Software, Writing - original draft. **Liu Xiaoxing:** Supervision. **Hayfa Kazouz:** Writing - review

Table 5
Results of variance equation.
Source: author's calculation.

Variable	Coefficient	Std. Err	Z-Statistics	Prob.
SPR				
ϑ0	0.037938	0.004409	8.604057	0
α_i	0.138593	0.01163	11.91649	0
χ_i	0.994209	0.069184	14.3704	0
β_i	0.861692	0.011788	73.09983	0
Φ1	0.036573	0.009111	4.014814	0.0001
Φ2	0.000766	0.006152	1.448201	0.0737
Φ3	-0.000543	0.005079	-0.10683	0.9149
ν	0.869052	0.098541	8.819156	0
Γ	6.44113	0.707081	9.109459	0
NSR				
ϑ0	0.049766	0.005443	9.142806	0
α_i	0.124476	0.008233	15.11968	0
χ_i	0.999998	0000000	4800000	0
β_i	0.861615	0.010638	80.99348	0
Φ1	0.03738	0.009882	3.782666	0.0002
Φ2	0.003984	0.007429	0.53633	0.5917
Φ3	0.006086	0.00959	0.634627	0.5257
ν	0.897292	0.095359	9.409617	0
Γ	7.359537	0.910916	8.079272	0
DXR				
ϑ0	0.034172	0.005377	6.355084	0
α_i	0.073512	0.008658	8.490796	0
χ_i	0.997048	0.084556	11.79154	0
β_i	0.922762	0.009217	100.1114	0
Φ1	0.008138	0.004861	1.674201	0.0941
Φ2	0.008571	0.010051	0.852748	0.3938
ν	0.879833	0.134396	6.546564	0
Γ	8.037546	0.937191	8.576207	0
NKR				
ϑ0	0.05136	0.006832	7.518056	0
α_i	0.104771	0.010673	9.816201	0
χ_i	0.883281	0.081964	10.77651	0
β_i	0.883054	0.011243	78.54085	0
Φ1	0.023895	0.007921	3.016814	0.0026
Φ2	-0.003074	0.006092	-0.504632	0.6138
ν	0.864164	0.111283	7.765457	0
Γ	6.600645	0.658709	10.02058	0
FMBR				
ϑ0	0.0346	0.004874	7.098794	0
α_i	0.090903	0.007194	12.63516	0
χ_i	0.999987	0.000001	4800000	0
β_i	0.898316	0.009178	97.87958	0
Φ1	0.01981	0.00834	2.37527	0.0175
Φ2	0.001447	0.006227	-2.32424	0.0100
ν	1.064429	0.118983	8.946031	0
Γ	6.246663	0.689603	9.058344	0
SCR				
ϑ0	0.011564	0.003894	2.969629	0.003
α_i	0.067482	0.009789	6.893807	0
χ_i	0.13211	0.069902	1.889922	0.0588
β_i	0.938788	0.007753	121.0913	0
Φ1	0.024274	0.016066	1.510895	0.1308
Φ2	0.000971	0.008832	10.99064	0.0000
Φ3	0.003074	0.005022	0.612173	0.5404
ν	1.382652	0.265928	5.199348	0
Γ	4.475004	0.405198	11.04399	0

& editing, Data curation.

Declaration of Competing Interest

"The authors reported no potential conflict of interest"

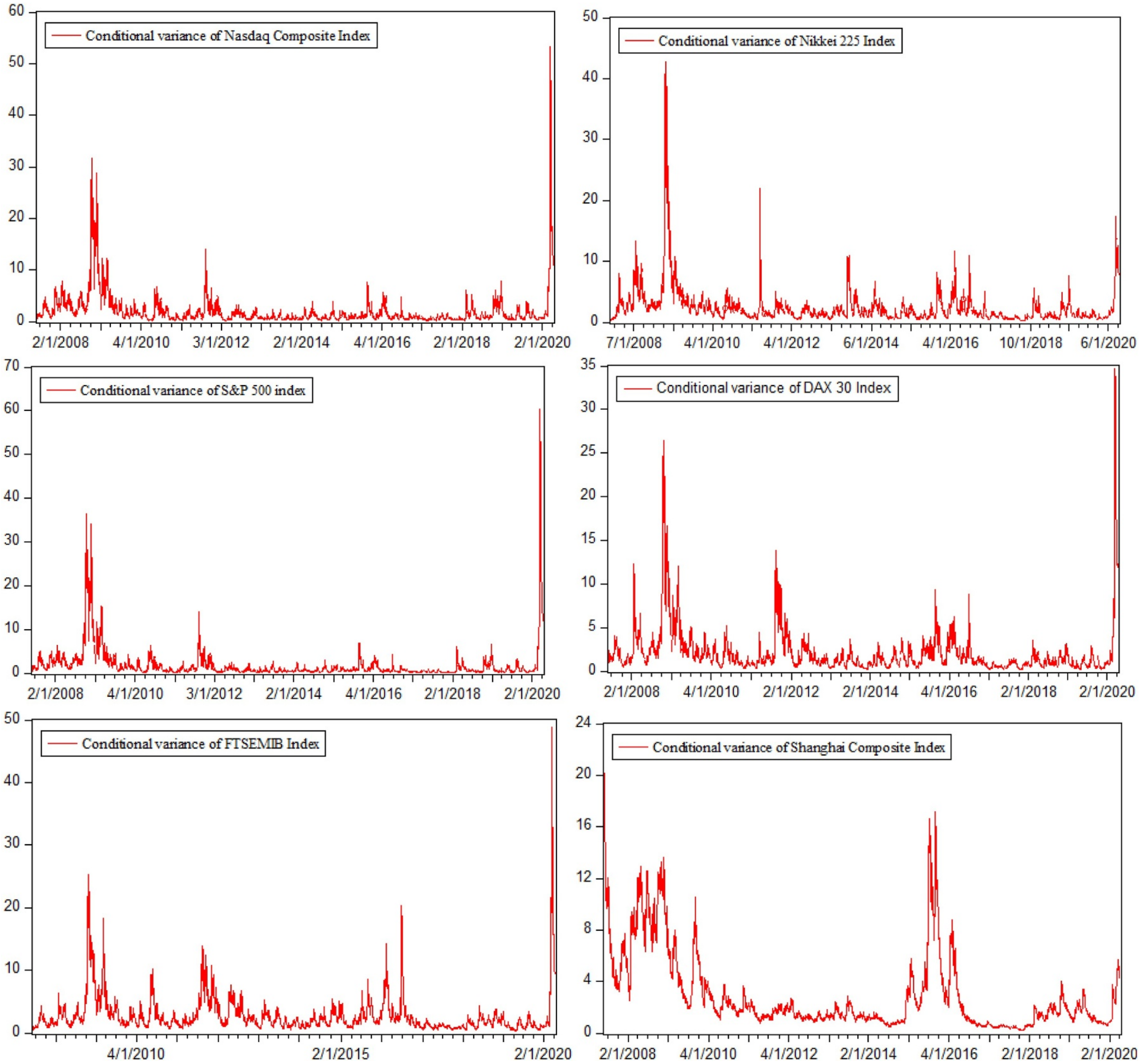

Fig. 2. Conditional variance plots of each stock market.

Table 6
Diagnostic parameters.
Source: author's calculation.

	Serial Correlation		Heteroskedasticity	
Variables	Q statistics	*P*-value	*F*-statistics	*P*-value
SPR	33.071	0.609	2.127126	0.1448
NSR	42.096	0.224	2.238769	0.1067
DXR	46.167	0.119	2.275491	0.1315
NKR	28.143	0.822	0.531143	0.4662
FMBR	37.113	0.417	0.117112	0.7322
SCR	44.462	0.157	1.353077	0.2448

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.frl.2020.101669.

References

Adam, T., 2020. How coronavirus almost brought down the global financial system [WWW Document]. URLhttps://www.theguardian.com/business/2020/apr/14/

how-coronavirus-almost-brought-down-the-global-financial-system (accessed 4.17.20).
ADB, 2020. Global cost of coronavirus may reach $4.1 trillion, ADB Says - Bloomberg [WWW Document]. URLhttps://www.bloomberg.com/news/articles/2020-04-03/global-cost-of-coronavirus-could-reach-4-1-trillion-adb-says?srnd = premium-europe(accessed 4.17.20).
Bollerslev, T., 1987. A conditionally Heteroskedastic time series model for speculative prices and rates of return. Rev. Econ. Stat. https://doi.org/10.2307/1925546.
Choudhry, T., 2010. Day of the week effect in emerging Asian stock markets : evidence from the GARCH model Day of the week e ect in emerging Asian stock markets : evidence from the GARCH model37–41. https://doi.org/10.1080/096031000331653.
Dedi, L., Yavas, B.F., 2016. Return and volatility spillovers in equity markets: an investigation using various GARCH methodologies. Cogent Econ. Financ. 4, 1–18. https://doi.org/10.1080/23322039.2016.1266788.
Dickey, D., Fuller, A., W., A., 1979. Distribution of the estimators for autoregressive time series with a unit root. J. Am. Stat. Assoc. 74, 427–431.
Ding, D., 2011. Proj. Report-Uppsala Univ. Proj. Report-Uppsala Univ. 54.
Ding, Z., Granger, C.W.J., Engle, R.F., 1993. A long memory property of stock market returns and a new model. J. Empir. Financ. https://doi.org/10.1016/0927-5398(93)90006-D.
Engle, R.F., 1982. Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. Econometrica 50, 987. https://doi.org/10.2307/1912773.
Financial Times, 2020. Coronavirus: US death toll passes 16,000 level | Financial Times [WWW Document]. URLhttps://www.ft.com/content/55a136c0-05f1-39f4-b946-9e099dd05256(accessed 4.13.20).
Georgieva, K., 2020. IMF managing director Kristalina Georgieva's statement following a G20 ministerial call on the coronavirus emergency.
Hai, W., Zhao, Z., Wang, J., Hou, Z.-G., 2004. The short-term impact of SARS on the Chinese economy. Asian Econ. Pap. 3, 57–61. https://doi.org/10.1162/1535351041747905.
Hentschel, L., 1995. All in the family Nesting symmetric and asymmetric GARCH models. J. Financ. Econ. https://doi.org/10.1016/0304-405X(94)00821-H.
Kiymaz, H., Berument, H., 2003. The day of the week effect on stock market volatility and volume : 12, pp. 363–380. Review of Financial Economics. https://doi.org/10.1016/S1058-3300(03)00038-7.
Leduc, S., Liu, Z., 2020. The uncertainty channel of the coronavirus. FRBSF Econ. Lett.
Palese, P., 2004. The great influenza The epic story of the deadliest plague in history. J. Clin. Invest. 114, 146. https://doi.org/10.1172/JCI22439.
Peiris, J.S.M., Yuen, K.Y., Osterhaus, A.D.M.E., Stöhr, K., 2003. The severe acute respiratory syndrome. N. Engl. J. Med 349, 2431–2441.
Phillips, P.C.B., Perron, P., 1988. Testing for a unit root in time series regression. Biometrika. https://doi.org/10.1093/biomet/75.2.335.
Shehzad, K., Sohail, N., 2018. An evidence of calendar effects on the stock market of Pakistan : a case study of (KSE-100 index) 46–56. https://doi.org/10.24081/nijesr.2018.1.0006.
Teräsvirta, T., 2012. Nonlinear models for autoregressive conditional Heteroskedasticity. Handb. Volatility Model. Appl. 47–69. https://doi.org/10.1002/9781118272039.ch2.