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Estimation of Volatility and Leverage Effect during the Outbreak of Covid-19 Pandemic: A Study based on Selected International Stock Markets

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Abstract: *This research work has been conducted to find out the volatility and leverage effect of the select countries' stock market index during the outburst of the novel coronavirus (Covid-19). In conducting this research work, daily time series data from 1st January 2020 to 26th June 2020 have been analysed using descriptive statistics, GARCH model, EGARCH model, and TGARCH model. The standard deviation value substantiates the increasing volatility in the select stock market index during the outbreak of Covid-19. GARCH result validates the stronger existence of volatility in all the selected stock markets except the stock market of Russia, during the period of Covid-19. EGARCH result confirms that there does not exist any leverage effect in the select stock market during the outbreak of Covid-19. The result definitely talks about the effect of bad news in the select international stock market activities during the outbreak of Covid-19 pandemic.*

Keywords: *Stock market, Covid-19, GARCH, EGARCH, TGARCH.*

1. INTRODUCTION

Share exchanges are perceived to be the pillar of every country's economic growth. The existence of high stock market volatility has driven investors to remove their hard-earned money from the stock market owing to the panic of losses. Some unpredictability on the stock market has finally made a country's economic situation fragile. Since the 13th century , the world has seen economic slowdown and many fatalities due to the impact of many epidemics and pandemics such as cholera, dengu, ebola, SARS, MERS, spanish flu, swine Flu, zika and so on (Cambre, 2020 and Nathan, 2020). The first case of unknown pneumonia was observed and confirmed to the WHO Country Office in China on 31 December 2019 and, as a consequence, the WHO announced the international level Public Health Emergency on 30 January 2020 by calling this unknown pneumonia as Covid-19. The estimated number of affected persons was more than 95 lakh and the death rate was more than 4,89 lakh worldwide due to the outbreak of coronavirus pandemic as on 26th May, 2020 (Wood *et al.*, 2020).

As indicated by the WHO, several countries have reached a protracted lock-down process owing to the outbreak of Covid-19. Lock-down strategies tend to increase the incidence of coronavirus transmission; however the economic situation and development levels are significantly decreased as a consequence of this lock-down. At the one side, employment losses in various industries are rising and, at the other hand, the production of commodities, the distribution of other facilities, domestic and cross-border transfers of products, domestic and foreign travel are being disrupted many times. The lockdown period eventually contributes to a decrease in GDP, international spending, interest rate, crude oil costs, etc., which continues to raise unemployment and inflation (Su, 2020). Lockdown also affects many countries economies in different angle and these countries are very near to a deep recession due to such lockdown (Mohan, 2020).

Based on the primary statistics for the first quarter of 2020, the U.S. GDP is expected to collapse at an average pace of 4.8 per cent, the highest decrease since the global financial crisis. The FIIs are removing their investment from Asian developed countries, which is projected to be $26 billion and out of which it is projected that they are expecting to withdraw about $16 billion from India (Jackson *et al.*, 2020). The International Monetary Fund expects that governments across the globe will borrow up to 9.9% of GDP in 2020. It's only that federal investment is expected to reach $4.5 trillion under long-term economic terms. It is also projected that the fiscal balance-to-GDP ratio for emerging countries will be about 9.1% and for developed nations about 10.7%. Several nations, such as the United Kingdom, France, Italy, Japan, Germany, India, etc., have declared budget spending for public sector funding programs to cope with this crisis (Fiscal Monitor, 2020).

Amid the outbreak of coronavirus, the stock price index of the most impacted countries was significantly decreased, and other reports support the long-term and short-term relationship of the numerous countries stock market. Further work has been carried out to assess the effect of the various adverse circumstances on the operation of the financial market as well as the economic factors in these chosen countries (Bailey and Stulz, 1990; Bhattacharya and Samantha, 2001; Chen *et al.*, 2006; Chen *et al.* 2009; Joshi, 2011) and it recorded a strong connection between market prices in the different countries during the crisis era. However, the stock market study of the fluctuations of the most impacted countries during the outbreak of the novel coronavirus is barely visible. This work was undertaken to check the volatility and leverage impact of the selected countries' stock market during the outbreak of coronavirus pandemic in the short-run and long-run.

2. LITERATURE REVIEW

Many studies have been done to recognise the volatility between the stock markets of the various countries, during its any crisis period and at any time when there is no such crisis situation. Several of these studies have examined the presence of strong volatility on the stock market of selected countries, and very few of them don't really talk about this volatility on the stock market of selected countries. This portion is split into two sections. Throughout the first section, a few researches are considered to provide proof of the volatility and leverage impact of the stock markets in various countries under any normal circumstance. On the opposite, in the second section, another few researches on the volatility of the stock market owing to some crisis times are addressed.

This section deals with the studies which were conducted to find out the volatility and leverage effect in the stock market of different emerging countries when there were no such crisis situation. Olowe (2009) applied the EGARCH model to observe the volatility and leverage effect in the Nigerian stock market returns by considering the daily data from 4th January 2004 to 2nd March 2009 and found the existence of volatility and relationship between the risk and stock market returns in the Nigerian stock market. Six years daily data ranging from March 2003 to March 2009 were considered in the study of Neokosmidis (2009) and the researcher experienced high volatility in the four US stock market indices namely Dow Jones, NASDAQ, NYSE and S&P 500 using ARCH, GARCH (1,1) and EGARCH (1,1) model. Joshi (2009) conducted a study to identify the volatility in the stock market of India and China using daily closing price from 1st January 2005 to 12th May 2009 using the GARCH (1,1) model and confirmed the existence of higher volatility in the Indian stock market. Chang *et al.* (2011) considered GJR-GARCH (1,1) model to test the volatility in the Taiwan Stock Exchange (TAIEX), S&P 500 index, and NASDAQ composite index from January 2000 to January 2004 and found considerable volatility and price transmission effect in the select stock market indices. In the study of Varughese and Mathew (2017), a strong volatility and leverage effect was found in the Indian stock market using GARCH, EGARCH and TGARCH model by considering daily time-series data from 1st April 2003 to 31st March 2015. In the study of Amudha and Muthukamu (2018) GARCH family models were used and the researchers confirm the evidence of volatility and leverage effect in the selected stock market. Kumar and Biswal (2019) used the GARCH family model to test the volatility of the select countries' stock prices and confirm the existence of volatility and leverage effect in the select stock market indices.

In this section, few studies are considered which were conducted to find out the volatility in the stock market during any crisis period. Olowe (2009) identified volatility during the global financial crisis in the Nigerian stock market using daily data from 4th January 2004 to 9th January 2009 and by applying the EGARCH model and confirmed the strong existence of volatility in the Nigerian stock market during the global financial crisis. Schwert (2011) used monthly data from 1802 to 2010, daily data from 1885 to 2010 and intraday data from 1982 to 2010 to test the volatility in the stock market of US and confirms the existence of strong volatility in the select stock market and mainly in the stocks of the financial sector due to global financial crisis in 2008. The researcher also concluded that there was a connection between the real economic activity in terms of the unemployment rate and the volatility in the stock market. Bhowmik *et al.* (2018) considered daily time-series data from January 2002 to December 2016 of six emerging Asian stock markets and using the GARCH model confirms that the volatility of the select countries' stock market was high during and after the global financial crisis period than the earlier. Silmane *et al.* (2013) used daily data from 1st July 2008 to 28th November 2008 to test the volatility and relationship among the three important European stock markets namely France, Germany and the UK by applying VAR-EGARCH model confirms the existence of volatility in the select countries' stock markets and the researchers also concluded that the stock market of Germany influenced the stock market of France and UK during the global financial crisis period. Rastogi (2014) studied the volatility and leverage effect of the ten emerging country's stock market using daily time-series data from March 2000 to May 2011. The researcher applied GARCH, TGARCH, and EGARCH model and concluded that there exists leverage effect before and after the global financial crisis but few of the selected countries reported a decrease in leverage effect after the crisis period.

3. DATA AND METHODOLOGY

For conducting this empirical research, daily time series data were obtained from the select countries' stock exchange database. As the first case of Covid-19 was reported to the local office of WHO by China on 31st December 2019, ongoing Covid-19 period has been identified from 1st January 2020 to 26th June 2020. As on 26th June 2020 eight affected countries stock market index, such as France (CAC 40), Germany (DAX 30), India (Nifty 50), Italy (FTSE MIB), Russia (IMOEX), Spain (IBEX 35), UK (FTSE 100), and USA (NYSE S&P 500) are considered in this study. Originally, all stock market index values have

been converted into natural logarithm since it significantly reduces the risk of heteroscedasticity in the model. In order to analyze the data, the GARCH models were considered. Because the purpose of the analysis is to understand the volatility and leverage impact of selected international stock markets, the GARCH models have been used in Eviews 9 software.

4. EMPIRICAL RESULTS

4.1. Descriptive statistics

Table 1 shows the descriptive statistics of the data set of the eight stock markets influenced by the Covid-19 era. The result confirms that the stock prices in Italy and Spain are the most volatile, as shown by the standard deviations of 0.16 and 0.16, respectively, while the US and Russian stock markets are the less volatile, with the standard deviations of 0.10 and 0.10, respectively, over the span of the outbreak of Covid-19. The value of Jarque-Bera statistics with respective probability illustrates that all the stock prices are not normally distributed during the period of Covid-19.

Table 1
Descriptive Statistics

	France	*Germany*	*India*	*Italy*	*Russia*	*Spain*	*UK*	*USA*
Mean	8.52	9.36	9.24	9.89	7.92	8.97	8.76	8.00
S.D.	0.15	0.13	0.14	0.16	0.10	0.16	0.13	0.10
Max	8.72	9.53	9.42	10.15	8.08	9.22	8.95	8.13
Min	8.23	9.04	8.94	9.61	7.66	8.72	8.52	7.71
Skewness	0.11	-0.43	-0.02	0.17	-0.26	0.29	0.12	-0.73
Kurtosis	1.60	2.13	1.67	1.50	2.46	1.39	1.70	2.85
J-B Stat	9.99	7.32	8.84	11.71	2.82	14.52	8.62	10.68
Prob.	0.01	0.03	0.01	0.00	0.24	0.00	0.01	0.00

4.2. Correlation statistics

Table 2 illustrates the correlation result of the data set of the eight stock markets during the outbreak of the Covid-19. The result confirms that all the select stock markets are highly correlated positively with each other.

4.3. GARCH test results

Table 3 displays the GARCH (1,1) test results of the daily stock prices of the select eight stock markets impacted during the Covid-19 era. The GARCH results are almost all positive throughout the outbreak of the Covid-19 other

Table 2
Correlation Statistics

	France	*Germany*	*India*	*Italy*	*Russia*	*Spain*	*UK*	*USA*
France	1.00							
Germany	0.95	1.00						
India	0.96	0.92	1.00					
Italy	0.99	0.94	0.95	1.00				
Russia	0.85	0.87	0.79	0.85	1.00			
Spain	0.98	0.90	0.96	0.99	0.80	1.00		
UK	0.99	0.96	0.96	0.98	0.88	0.97	1.00	
USA	0.88	0.96	0.83	0.86	0.88	0.80	0.89	1.00

than the Italian stock market. The GARCH effect is very high in the Spanish stock market and very low in the French stock market. In general, the volatility is calculated by adding the α and β value in the GARCH (1,1) model and the combined value of α and β ranges between 0.79 to 1.84 during the Covid-19 period. Test results show that, with the exception of the Russian stock market, all the selected stock markets have a stronger ARCH and GARCH impact during the Covid-19 period. This suggests that the volatility of equity markets may be demonstrated by a history of volatility, which is expected to continue over time. Perhaps we can arrive at the conclusion from the finding that the selected stock markets are much more volatile mostly during the Covid-19 era.

Table 3
GARCH (1, 1) Test Results

	France	*Germany*	*India*	*Italy*	*Russia*	*Spain*	*UK*	*USA*
ω (constant)	1.07 (0.81)	1.99 (0.68)	0.00 (0.00)	7.07 (0.01)	2.35 (0.35)	1.50 (0.57)	5.61 (0.58)	3.46 (0.55)
α (arch effect)	1.70 (0.00)	0.81 (0.00)	0.87 (0.01)	1.93 (0.00)	1.02 (0.00)	-0.05 (0.38)	0.35 (0.01)	0.35 (0.01)
β (garch effect)	0.14 (0.05)	0.44 (0.00)	0.21 (0.20)	-0.03 (0.62)	0.23 (0.08)	1.05 (0.00)	0.74 (0.00)	0.69 (0.00)
α + β	1.84	1.25	1.08	1.90	0.79	1.00	1.09	1.04

Figures in parenthesis indicate probability

4.4. EGARCH Test results

The EGARCH (1,1) model is useful for analyzing the asymmetrical effect of news and data on volatility and leverage. The negative and statistically significant gamma (γ) in the EGARCH (1,1) model identifies the truth of the leverage

effect and demonstrates that positive shocks have even less influence on the explanatory variables and that the leverage effect (gamma) is anticipated to be negative and statistically significant. Table 4 shows that the sum of α and β in the EGARCH (1,1) model are ranging between 0.07 and 1.26 during the outbreak of Covid-19. The sum of α and β is more than one indicate, a stronger existence of ARCH and GARCH shocks on volatility and conditional variance is volatile. The results show that the sum of α and β is more than one only in the stock market of Italy during the period of Covid-19, which means there exist ARCH and GARCH shocks on volatility and conditional variance is volatile.

Table 4
E- GARCH Test Results

	France	*Germany*	*India*	*Italy*	*Russia*	*Spain*	*UK*	*USA*
ω (constant)	-1.48 (0.00)	-0.76 (0.20)	-0.41 (0.41)	-10.55 (0.00)	-1.86 (0.00)	-3.90 (0.04)	-0.01 (0.90)	-0.52 (0.08)
α (arch effect)	0.92 (0.00)	0.41 (0.02)	0.21 (0.15)	0.98 (0.00)	1.05 (0.00)	0.83 (0.01)	0.12 (0.38)	0.30 (0.07)
β (garch effect)	-0.14 (0.22)	0.10 (0.15)	0.09 (0.24)	0.28 (0.27)	-0.09 (0.38)	-0.19 (0.21)	-0.05 (0.33)	0.01 (0.88)
α + β	0.78	0.51	0.30	1.26	0.96	0.64	0.07	0.31
γ (leverage effect)	0.92 (0.00)	0.94 (0.00)	0.96 (0.00)	-0.06 (0.76)	0.85 (0.00)	0.64 (0.00)	0.98 (0.00)	0.96 (0.00)

Figures in parenthesis indicate probability

The gamma parameter (γ) is the indicator for asymmetric volatility; but it is positive all the select stock market other than the stock market of Italy during the outbreak of the Covid-19 which is statistically insignificant. This indicates that leverage effect does not exist in the select stock market during the outbreak of coronavirus pandemic.

4.5. TGARCH Test results

TGARCH (1,1) test results have been used to recognize the asymmetric performance or leverage effect. Table 5 shows that the volatility or the sum of α and *β* in the TARCH (1,1) model, ranging from 0.28 to 1.13 during the period of Covid-19. The sum is more than one only in the stock market of Russia indicating a stronger subsistence of ARCH and GARCH shocks on volatility but the coefficient of ARCH and GARCH are not statistically significant.

Table 5
TGARCH Test Results

	France	*Germany*	*India*	*Italy*	*Russia*	*Spain*	*UK*	*USA*
ω (constant)	1.31 (0.70)	8.83 (0.47)	4.54 (0.50)	3.76 (0.32)	2.80 (0.36)	7.75 (0.00)	4.99 (0.54)	2.60 (0.67)
α (arch effect)	1.31 (0.00)	0.63 (0.12)	0.74 (0.09)	0.84 (0.01)	0.59 (0.07)	0.37 (0.21)	0.93 (0.02)	0.45 (0.07)
β (garch effect)	0.37 (0.58)	-0.35 (0.00)	-0.25 (0.00)	-0.46 (0.19)	0.54 (0.24)	0.45 (0.39)	-0.15 (0.70)	-0.15 (0.52)
α + β	0.94	0.28	0.49	0.38	1.13	0.82	0.78	0.30
γ (leverage effect)	0.16 (0.14)	0.96 (0.06)	1.00 (0.11)	0.51 (0.09)	0.28 (0.06)	-0.16 (0.12)	0.44 (0.07)	0.68 (0.10)

Figures in parenthesis indicate probability

However, the gamma parameter (γ) is positive and greater than zero in case all the selected stock markets other than the stock market of Spain which is statistically not significant during the period of Covid-19. This designates that leverage effects do not exist in the select stock markets during the outbreak of the pandemic.

During the period of Covid-19, France stock market discloses higher α (ARCH effect) than other seven stock markets that designate the effects in earlier periods have a propensity to stay more or less for a longer time or less market efficiency than it does in other seven stock markets under study. Again, the β (GARCH effect) values point out long-term influences on stock market volatility. During the period of Covid-19, the stock market of Russia discloses higher β (GARCH effect) than other seven stock markets that designates the long-term influences on stock market volatility. During the period of Covid-19, γ (leverage effect) value in the Indian stock market is higher than the other seven stock markets.

5. CONCLUSIONS

This study aims to find out the volatility and leverage effect of selected international stock markets during the period of Covid-19. Descriptive statistics result confirms that Italy and Spain stock markets are most volatile and Russia and USA are the least volatile during the period of the Covid-19. The GARCH test results show that except the stock market of Russia, all the select stock market has a stronger existence of ARCH and GARCH impact during the period of Covid-19. EGARCH test results show that leverage effect leverage effect does not exist in the select stock market during the outbreak of coronavirus pandemic. TGARCH test results also show that leverage effect

does not exist in the select countries stock market during the period of Covid -19. Therefore, international stock markets have been more volatile during the period of Covid-19 but there does not exist any leverage effect using the select data set during the period of Covid-19. Finally it can be concluded that the impact of Covid-19 pandemic in terms of bad news has a bigger influence on international stock markets. The result could have been different and significant if more affected countries are considered in the paper. So, this can be the further scope of the study.

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