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ASSESSING THE CHANGES IN STATISTICAL PROPERTY OF SELECTED STOCK MARKETS BEHAVIOUR BEFORE AND AFTER COVID-19 PANDEMIC: A CASE STUDY

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ABSTRACT:
THIS RESEARCH PAPER FOCUSES TO CAPTURE CHANGES IN STATISTICAL PROPERTY BEFORE AND AFTER THE COVID-19 PANDEMIC IMPACT. WE COLLECTED SAMPLE DATA FROM JANUARY 2018 TO SEPTEMBER 2021 FOR TWO RANDOMLY SELECTED STOCK MARKETS, SUCH AS: BELGIUM (BRUSSELS STOCK EXCHANGE) AND INDONESIA (JAKARTA STOCK EXCHANGE). THE MAIN OBJECTIVE OF THIS PAPER IS TO TEST CHANGES IN NORMALITY PATTERN CONSIDERING AUGMENTED DICKER FULLER TEST AND TO DEMONSTRATE CHANGES IN RETURN PLOTS USING LOESS FITNESS, AND WITH ESTIMATED DENSITY PLOTS. THE COVID 19 PANDEMIC HAD A SIGNIFICANT EFFECT ON THE BEHAVIOUR OF STOCK MARKETS, WHILE THE GLOBAL ECONOMY HAS BEEN SEVERELY AFFECTED.

KEY WORDS: GARCH FAMILY MODELS, VOLATILITY PATTERNS, COVID-19 PANDEMIC, LOESS FITNESS ANALYSIS, STOCK MARKET

INTRODUCTION

The recent pandemic has impacted entire economic sectors across the world. Most of financial markets (whether emerging or developed) are not excluded from such impacts. We consider sample of small but emerging financial markets from Europe and Asia to demonstrate whether there is impact over statistical property due to global pandemic. The purpose of selection of smaller financial markets is to capture identify whether such

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pandemic impact also reflects in the markets where comparative trading and volume of trading is lower. We randomly selected two stock markets from Europe and Asia with comparatively lower volume of trading to capture changes in volatility during the period of COVID-19 pandemic. Thus, we selected data from January 2018 to September 2021 daily closing index for a pair of randomly selected stock markets, which are the following: Belgium (Brussels Stock Exchange) and Indonesia (Jakarta Stock Exchange).

Recent pandemic has impacted all financial markets of the world up to some or more extent. Many developed and emerging financial markets from Asia, Europe and America have faced pandemic situations including Dow Jones, FTSE100, SSE, NSE etc. are some of financial markets with very high volume of activity. We focus on sample with comparatively low volume of activity and demonstrate impact of shocks on selected stock markets.

LITERATURE REVIEW

Spulbar and Birau (2018) have conducted a complex empirical study and examined the behavioral dynamics of some emerging stock markets like: Romania, Poland, India and Hungary for the selected period January 2000 to July 2018. The empirical findings revealed that there is no long-term causality and efficient market hypothesis has been rejected for all three forms of efficiency, inclusive for weak-form efficiency. Trivedi et al. (2021) investigated volatility spillovers and correlation between certain European stock markets, like: Spain, UK, Germany, and France (developed stock markets) and Poland, Hungary, Croatia and Romania (emerging stock markets) using GARCH (1, 1) family models for the sample period January 2000 to July 2018. Moreover, Spulbar et al. (2019) analyzed the existance of volatility patterns, causality and international contagion between a cluster of developed stock markets, such as: USA, Canada, France and UK based on GARCH (1, 1) model for the selected time period January 2000 to June 2018.

Ejaz et al. (2020) suggested that emerging stock markets are characterized by more attractive investment opportunities based on global diversification opportunities compared to developed stock markets. Ghasemi et al. (2021) discussed the importance of sustainable development and highlighted that sustainable criteria include economic, social, and environmental issues. Palma-Ruiz et al. (2020) concluded that sustainable and responsible investing (SRI) represents a main strategy which intends to cover both financial return and social good. Meher et al. (2020) argued that sustainable investment is is strongly related to the concept of sustainable investing, based on environmental, social and governance (ESG) scores. In addition, Chiappini et al. (2021) indicated that the currect global health crisis known as COVID-19 pandemic encouraged research studies on sustainable investments and stock market shock, but the empirical findings remain still inconclusive.

RESEARCH METHODOLOGY

This paper focuses on the impact of COVID-19 pandemic on stock markets volatility pattern. We consider randomly selected a European anda Asian financial markets i.e. Financial Market of Belgium and Indonesia. The study on sample indicates impact on statistical property of financial market returns (closing returns) changes with extra-ordinary news impact. Daily closing returns from 1st January 2018 to 30th September 2021 considered for the study. First we convert series returns into log returns to overcome unit root problems.

Log conversion is applied as follows:

$$r_t = \ln\left(\frac{p_t}{p_{t-1}}\right) = \ln(p_t) - \ln(p_{t-1})$$

ADF regression process is managed as follows:

$$\Delta y_t = c + \beta \cdot t + \delta \cdot y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \varepsilon_t$$

ADF process is managed as follows:

$$(1 - L)yt = \beta 0 + (\alpha - 1)yt - 1 + \varepsilon i$$

Symmetric GARCH (1, 1) model is applied as follows:

$$h_t = \omega + \alpha_1 u_{t-1}^2 + \beta_1 h_{t-1}$$

Generalized Autoregressive Conditional Heteroscedastic is a generalized version of ARCH model by Engle. GARCH (1, 1) processes 1 ARCH effect and 1 GARCH effect. Processing mean and variance equations is another important step in the econometric approach.

The mean equation is applied as follows:

$$rt = \mu + \varepsilon t$$

Mean equation indicates sum of average return denoted by (μ) that is returns of asset in time (t), and residual return denoted by (εt).

The variance equation is applied as follows:

$$\sigma_t^2 = \omega + \alpha \varepsilon_{1t-t}^2 + \beta \sigma_{1\,t-1}^2$$

Variance equation assumption process assures that value of constant is higher than 0, following the value of $\alpha + \beta$. The GARCH (1, 1) model represents symmetric model that is extensively used to estimate volatility in time series returns.

EMPIRICAL RESULTS

Considering no constant and no trend impact; $\Delta y_t = \gamma y_{t-1} + v_t$ .Result property for BEL, specimen for Belgium financial market considering 4 lags and (BIC) criterion indicates asymptotic p-value 0.6879 where, 1st-order autocorrelation coefficient for e: 0.006 and lagged differences: F(2, 943) = 13.180 [0.0000]. The sample test obtained with 946 observations and indicates presence of unit root in the series returns, indicating non-stationary impact.

Further changing property with trend and with constant $\Delta y_t = \alpha + \gamma y_{t-1} + \lambda_t + v_t$indicates asymptotic p-value 0.08417 where, 1st-order autocorrelation coefficient. for e: 0.005, and lagged differences: F(2, 942) = 14.358 [0.0000] with same observations. Both of the process passes through (1-L)y = b0 + (a-1)*y(-1) + ... + e.

The stock market of Indonesia such as (JKSE) Jakarta stock exchange processes with same model property considering 939 daily observations provides results (with no constant-no trend) asymptotic p-value 0.6682, where 1st-order autocorrelation coefficient for e: 0.058. However, considering constant and trend impact it suggests asymptotic p-value 0.7669. Where 1st-order autocorrelation coefficient for e: 0.061, indicating unit-root null hypothesis a= 1.

Belgium_KPSS, T = 948, Lag truncation parameter = 12, Test statistic = 0.0869059, the fitness is not significant as it appears at 10%, 5% and 1%, the Critical values; 0.348, 0.462 and 0.743 making P-value > .10. Considering the same value, the Jakarta stock markets

provides, T = 939, Lag truncation parameter = 10, Test statistic = 0.0961884, Critical values; 0.348, 0.462 and 0.743 respectively.

Table no.1 Belsley-Kuh-welsch Collinearity diagnostics

Variance proportions				
lambda	cond	const	d_l_BELC~	d_l_JKSE~
1.251	1.000	0.000	0.375	0.375
1.000	1.118	1.000	0.000	0.000
0.749	1.292	0.000	0.625	0.625

lambda = eigenvalues of inverse covariance matrix (smallest is 0.74925)
Conditional = condition index
Note: variance proportions columns sum to 1.0

According to BKW, cond>= 30 indicates "strong" near linear dependence,and condition between 10 and 30 "moderately strong". Parameter estimates whose, variance is mostly associated with problematic conditional values may themselvesbe considered problematic.
Count of condition indices >= 30: 0
Count of condition indices >= 10: 0

There is no evidence of excessive collinearity found in selected Belgium (Brussels Stock Exchange) and Indonesia (Jakarta Stock Exchange).

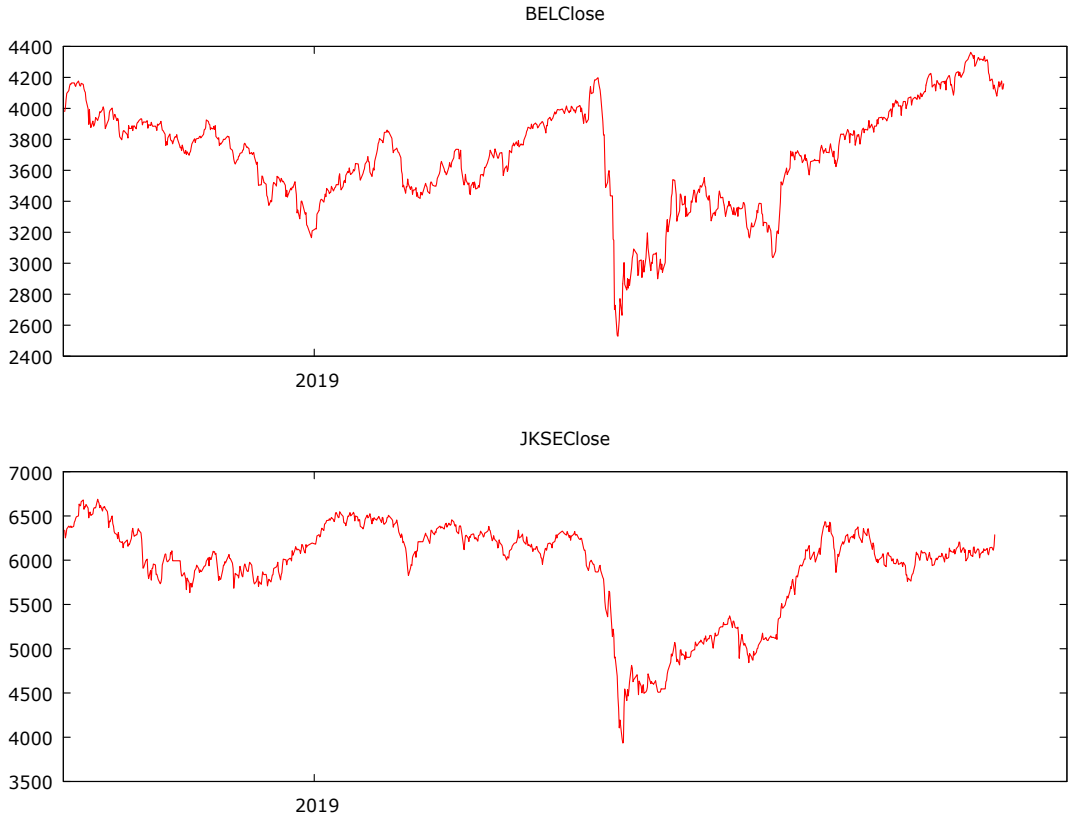

Fig.1 Belgium (Brussels Stock Exchange) and Indonesia (Jakarta Stock Exchange) time-series plot
Source: Author's computation using daily closing data from 1st January 2018 to 30th September 2021

Graphical presentation (see fig.1) demonstrates the movement of Belgium and Jakarta financial markets. Before COVID-19 pandemic impact Belgium stock market appears with much bullish trend from trading level 3240 to approaching over 4200, and the pandemic impact is clearly visible that shows straight down trend resulting more than 42% of market capitalization during the pandemic period. However, Jakarta stock market appears to have minor corrections and movements seems lower than the mean before the pandemic impact. The pandemic sketches and draw straight downfall in market capitalization from about 6300 to almost 4100 level resulting more than 33% loss of market capitalization. We found that compared to Belgium stock market, Indonesian stock market reacted lesser in terms of market capitalization loss during the same time-period. Interestingly, the market recovery also appears rapid and more aggressive in thee case of stock market of Belgium while having more correction and slow recovery at Jakarta Stock Exchange.

The comparative graph pattern with Loess FIT for Belgium and Indonesia stock emarkets represents the following impact:

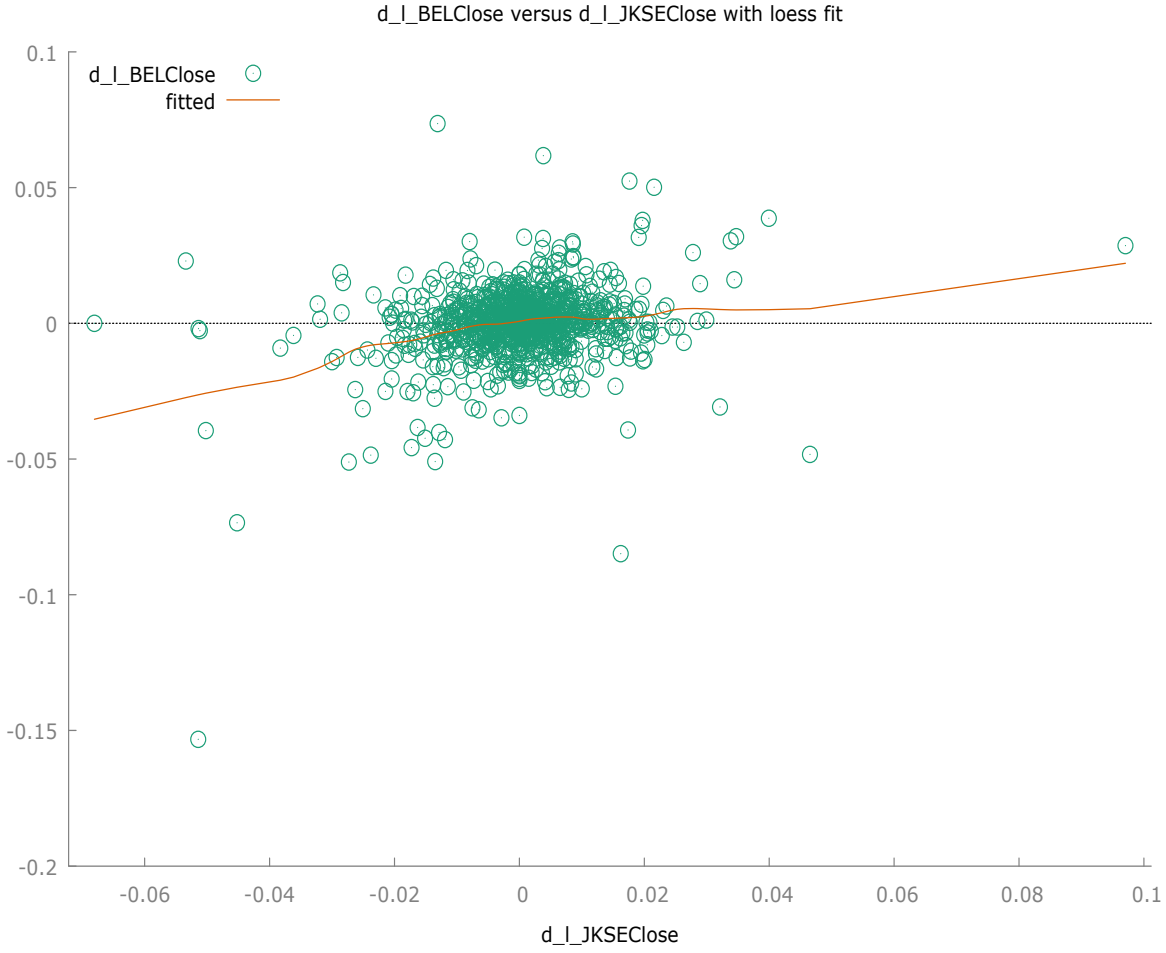

Fig.2 Loess fitness plot for Belgium (Brussels Stock Exchange) and Indonesia (Jakarta Stock Exchange)
Source: Author's computation using daily series returns of selected period

Loess test property provides visible impact where returns from Jakarta Stock Exchange scattered and plotted with no relationship (no correlation found) with the financial market movement of the Belgium stock exchange. However, it indicates that there was no

relationship between movements of each financial market during selected period. The fitted residuals indicated with a line in the Fig1 property where most of the residuals have lower volatility sketches and have even amount of shocks that reflected the market movement in same direction. However, we tested correlation and found that there is no significant correlation between Belgium and Indonesian stock markets. Belgium market has more scatter plot compared to Indonesian stock market.

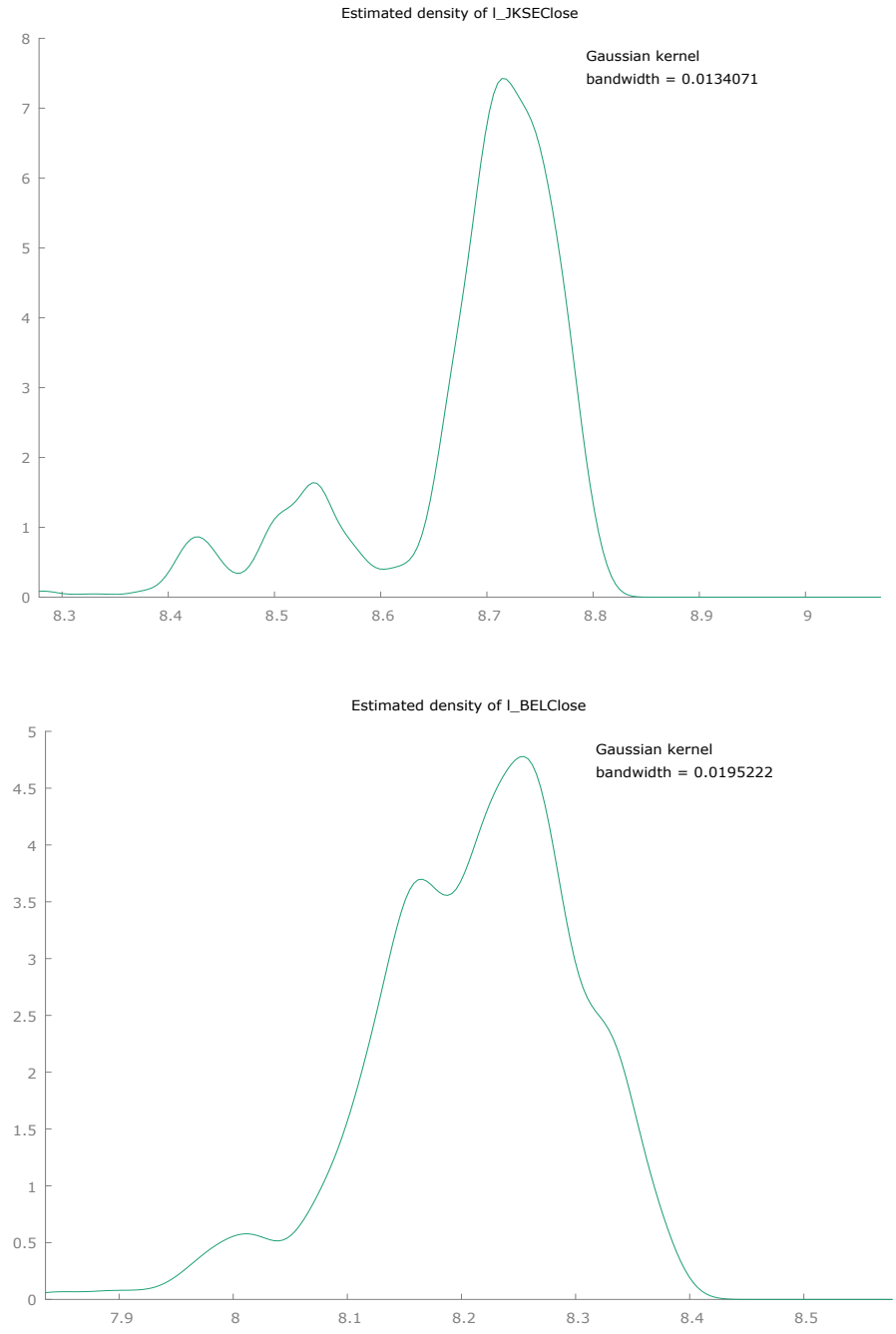

Fig.3 Estimated density plot for Belgium (Brussels Stock Exchange) and Indonesia (Jakarta Stock Exchange)
Source: Author's computation using daily closing returns from selected financial markets

Considering the pattern represented in above graph indicates that both of the market have different upside pattern, before the impact of COVID-19 pandemic. This aspect also includes different magnitudes of corrections whereas after the impact of COVID-19 pandemic both of selected stock markets attempted to bearish pattern.

Table 2 Descriptive statics property

Descriptive Statistics				
	Mean	**Std. Dev**	**Skewness**	**Ex. Kurtosis**
BELClose	4.6503e-005	0.013287	-2.0351	23.417
JKSEClose	-8.8217e-006	0.011332	-0.047846	9.4674

Source: Statistical property of selected financial markets

Belgium financial market is having the highest degree of investment risk as the kurtosis creates higher leptokurtic impact compared to Jakarta Stock Exchange for the covered period. The degree of standard deviation indicates almost similar i.e. 0.013 for Belgium and 0.011 for Indonesia, however, the mean return indicates negative return for Indonesia stock exchange and we can see positive mean return for Belgium stock exchange for the selected time period. It indicates that despite of higher degree of standard deviation merely 0.02, Belgium financial market has generated positive returns for investors during the January 2018 to Sep 2021 compared to negative returns for Jakarta Stock Exchange.

Table 3 GARCH computation main statistics

Descriptive Statistics				
	Constomega		**alpha**	**beta**
BELClose	0.00025	3.58180e-06	0.134	0.8455
JKSEClose	0.00031	9.84361e-06	0.150	0.758

*P-value for conditional mean equation not significant for 10%, 5% and 1% significance level for both of the selected financial markets.
** P-Value for conditional variance equation fitted at significance level of 5% and 1% respectively for omega and alpha &beta respectively for both of the selected financial markets.
Source: Author's computation

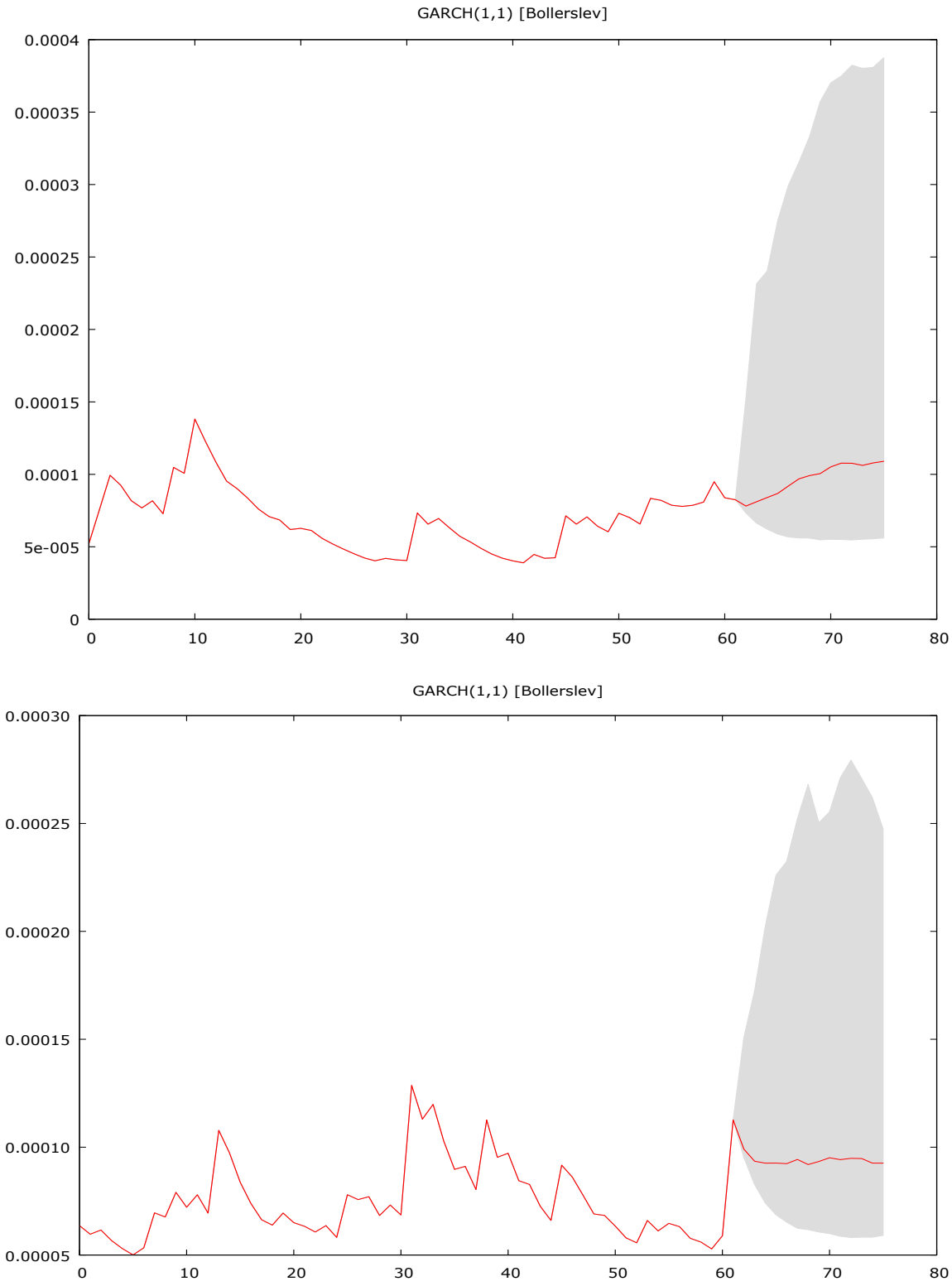

Fig.4 GARCH (1, 1) forecast for Belgium (Brussels Stock Exchange) and Indonesia (Jakarta Stock Exchange)
Source: Author's computation

Generalized autoregressive model, GARCH (1, 1) model was used to estimate the volatility for Belgium and Jakarta Stock markets. The model did not fit to any of market considering the mean equation property and does not have any strong significant fitness for any of selected financial markets. Variance equation fitted at significance level of 1% and 5% indicating higher alpha and lower beta for Jakarta stock market compared to higher beta and lower alpha for Belgium stock market. Both of the stock markets are having lower volume of trading compared with other emerging and frontier financial markets. We have selected stock markets with comparatively lower volume to capture changes in two different stock markets volatility where the volume of activity and trading is lower. We found that there is no significant evidence of correlation between both of these markets suggesting no transmitting effect of news from one market to another market. Though the mean equation did not fitted to any of the selected financial markets, we have attempted to forecast both of the markets using GARCH (1, 1) model suggests that Jakarta stock market of Indonesia will have stable movements and the graphical pattern for Belgium indicates that market will have bullish trend at the same future time-interval.

CONCLUSION

This research study demonstrates changes in statistical property of financial market series returns during the period of COVID-19 pandemic. It indicates that during the pandemic impact, the selected two emerging financial market have no significant correlation before the COVID impact and found significant pattern of moment while markets are falling due to pandemic impact. The normality test considering with constant and trend and without constant and trend provides how market behaved abnormally during the pandemic period. The results from the GARCH (1, 1) suggest that there is no significant evidence for fitness for mean variance for both of the selected markets. However, it the degree of alpha is higher and beta is lower for Belgium stock market compared to higher degree of beta and lower degree of alpha in Jakarta stock market for the selected period. We found that during the pandemic period, Jakarta Stock market reacted least volatile and resulted comparative less financial market capitalization loss than the Belgium stock market. We conclude that there is no correlation between selected two lower volume financial markets for the selected period, GARCH (1, 1) is not fitted for any of selected financial markets, with higher degree (0.02) of standard deviation, while the stock market of Belgium exhibits positive mean returns.

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