ORIGINAL PAPER

Modeling volatility in the stock markets of Spain and Hong Kong using GARCH family models in the context of COVID - 19 pandemic

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Abstract:
This research paper investigates changes in volatility and attempts to capture it using statistical property for randomly selected stock markets of Spain and Hong Kong. The COVID - 19 pandemic has significantly affected the global economy and financial markets all around the world in recent few years. We consider data from January 2015 to September 2021 and various statistical and econometric tools being employed i.e. ADF test, correlation analysis, KPSS test, and GARCH family models. To describe visible impact, we used Loess fitness analysis and other density plots which demonstrate volatility scatter impact. The empirical findings revealed that GARCH (1, 1) model is not fitted to any of selected stock markets. However, the volatility of IBEX index was found stronger in magnitude manner.

Keywords: *volatility pattern; Loess fitness analysis; GARCH models; investment, stock market.*

JEL Classifications: G14, E00

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1. 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. The World Health Organization (WHO) became aware of the existence of this new and very dangerous infectious disease at the end of the year 2019, based on an official report regarding the so called "viral pneumonia" spread in the province Wuhan in China. On the other hand, Cucinotta and Vanelli (2020) have discussed about the fact that on March 2020, the World Health Organization also known as WHO decreed that COVID-19 which is caused by the novel coronavirus SARS-CoV-2 represents a global pandemic. Ozkan (2021) examined the effect of COVID-19 crisis on stock market efficiency and identified a much more speculative behaviour of stock markets during current pandemic, while the expectation of abnormal returns increased due to inaccurate evaluation of the price of financial assets.

According to the most recent official report on FTSE Equity Country Classification, released by FTSE Russell on September, 2021, the stock markets are classified into the following four main categories, such as: developed, advanced emerging, secondary emerging and frontier. The two stock markets analyzed in this research article, i.e. Spain and Hong Kong are both included in the category developed stock markets, based on the selection criteria mentioned above. Moreover, Ejaz et al. (2020) suggested that developed countries are interested in achieving a high level of development for their national systems based on strong international interlinkages.

Hong Kong is not a country in the universally known sense, but it represents a "Special Administrative Region" of China (also known as the People's Republic of China). Moreover, Hong Kong is an autonomous region while also an "inalienable part" of China. The interesting aspect is that China is included in the secondary emerging category based on FTSE Equity Country Classification criteria, while Hong Kong is included in the developed category. In other words, although it is only part of China, Hong Kong is considered as developed market.

On the other hand, we considered this particular pair of developed stock markets from Europe and Asia in order to demonstrate whether there is any impact over statistical property due to global COVID-19 pandemic. The purpose of selection of smaller financial markets is to capture identify whether such pandemic impact also reflects in the markets where comparative trading and volume of trading is lower. Spain and Hong Kong have been selected as sample stock markets for this study based on their features. This research study on volatility performance provides a clear image on the changes in market movement patterns. We intend to capture changes in volatility for selected Asian and European financial markets and planned to impose Augmented Dickey Fuller test, KPSS, correlation analysis, and GARCH models. Volatility measurement provides vital information about market movement pattern. This information is useful for researchers, and practitioners across the world.

2. Literature review

In recent past, a wide number of research studies have been conducted using econometrics property in order to investigate stock market behaviour and volatility patterns. It provides changes and persistent level in volatility. Many researchers have worked to abstract changes in volatility considering two different markets for instance, Yong et al. (2021) considered Malaysia and Singapore, two Asian markets and found

that standard GARCH (1, 1) and EGARCH (1, 1) models fitted well to series returns. Further they also found that all normal distributions also fitted well before the pandemic impact but post-pandemic the impact remained insignificant. Further, Fang et al. (2020) worked with GARCH-MIDAS model and predicted long term volatility. The GARCH - MIDAS model that provides variable selections allowing maximizing the modelling effect on long term stock market volatility. The model estimation not only worked on estimation and forecasting, many researcher used model for hedge predictions. Such as Basher and Sadorsky (2016) used GO-GARCH with other models to predict changes in oil prices, gold prices and VIX bonds. Moreover, Liu and Chen (2020) used GARCH family models to nominate market efficiency using Sharps ratios based on ARMA-GARCH models. The paper captures the outcome based on new methods for comparing weak form of efficiency of financial markets and also Zhang et al. (2019) used volatility modeling to predict changes in crude oil prices.

The usage of statistical and econometric approach was not limited to predict gold or oil prices but was also used to forecast volatility changes in cryptocurrencies such as Bitcoin. For instance, Cheikh et al. (2020) used smooth transition GARCH models considering four cryptocurrencies. Moreover, Chu et al. (2017) have applied GARCH family models in order to forecast changes in asset prices. Other researchers such as Mohsin et al. (2020) investigated volatility of banking stock returns in Pakistan and the impact on sustainable economic development. Ghasemi et al. (2021) argued that sustainable criteria include economic, social, and environmental aspects. In other words, it is important to analyze the concept of sustainable stock market in the context of the current global economy.

Ho and Odhiambo (2015) investigated relevant aspect regarding the performance of Hong Kong stock market and highlighted the importance of its rapid growth and regulatory issues. Moreover, Ho and Odhiambo (2012) examined the linkage between the development of stock market and the economic growth in case of Hong Kong, and concluded that exists only a short-run causality relation from economic growth to the other variable, such as the stock market development.

Spulbar and Birau (2018) investigated the behaviour of certain emerging stock markets, such as: Romania, Poland, India and Hungary for the sample period January 2000 to July 2018 and concluded that there is no empirical evidence to support the existance of long-term causality, while efficient market hypothesis has been rejected even in the case of weak-form efficiency. Trivedi et al. (2021) examined volatility spillovers and correlation between a cluster of European stock markets, such as: Spain, UK, Germany, and France, which are developed markets and Poland, Hungary, Croatia and Romania, which are emerging markets. This empirical study used GARCH (1, 1) family models for the period January 2000 to July 2018, while the findings indicate that both recent and past news determine a significant impact on present volatility. In addition, Spulbar et al. (2019) investigated volatility patterns, causality and international contagion between certain developed stock markets, like USA, Canada, France and UK using GARCH (1, 1) model for the sample period January 2000 until June 2018.

3. Data collection, research methodology and empirical results

This research paper focuses on the impact of COVID-19 pandemic on financial market volatility patterns. We consider randomly selected a European and a Asian financial markets i.e. stock market of Hong Kong and Spain. The research study on

based on sample indices indicates an impact on statistical property of financial market returns (closing price returns) changes with extra-ordinary news impact. Daily closing returns from 1st January 2015 to 30th September 2021 have been considered for the study.

The log returns or also known as the continuously - compounded daily returns are obtained based on the log - difference of the sample stock market indices, such as :

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

where p represents the daily closing price.

Augmented Dickey Fuller test is used considering no constant and no trend impact, such as the following: $\Delta y_t = \gamma y_{t-1} + v_t$. Result property for the specimen of Hong Kong stock market is used 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 Spain (IBEX index) 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. We failed to find any correlation between selected developed stock markets.

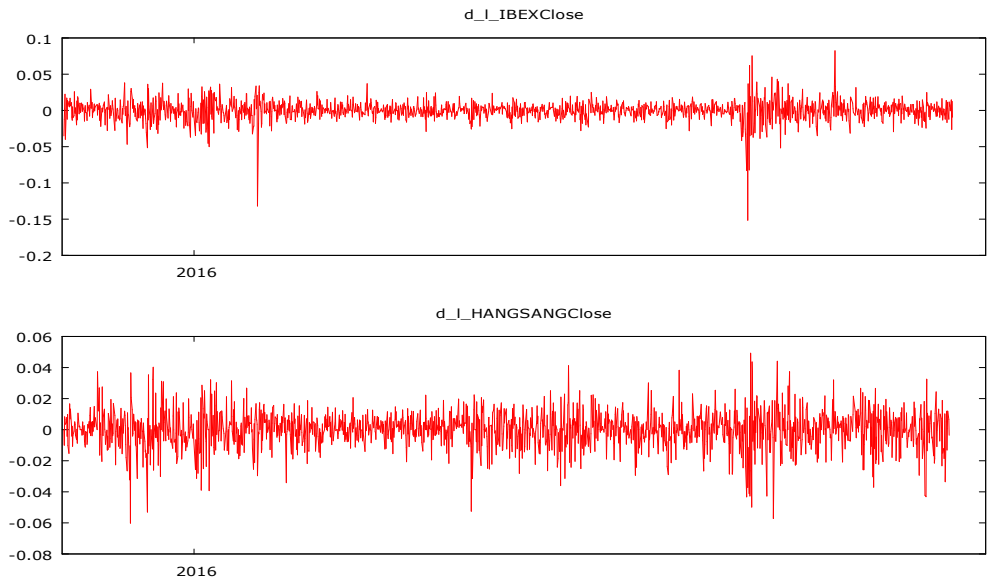

Fig. 1 Volatility sketches (Stationary series returns)
Source: Author's computation using daily series returns of selected period

It is important to highlight the fact that figure 1 provides property of first difference of log returns of selected stock markets. Large number of high and low magnitude sketches appears in Hang Sang stock market index, whereas the stock market index of Spain, i.e. IBEX represents a stable movement but with high magnitude and unpredictable shocks.

The comparative graph pattern with Loess FIT for Hong Kong and Spain stock exchanges represents the following impact presented in figure no.2.

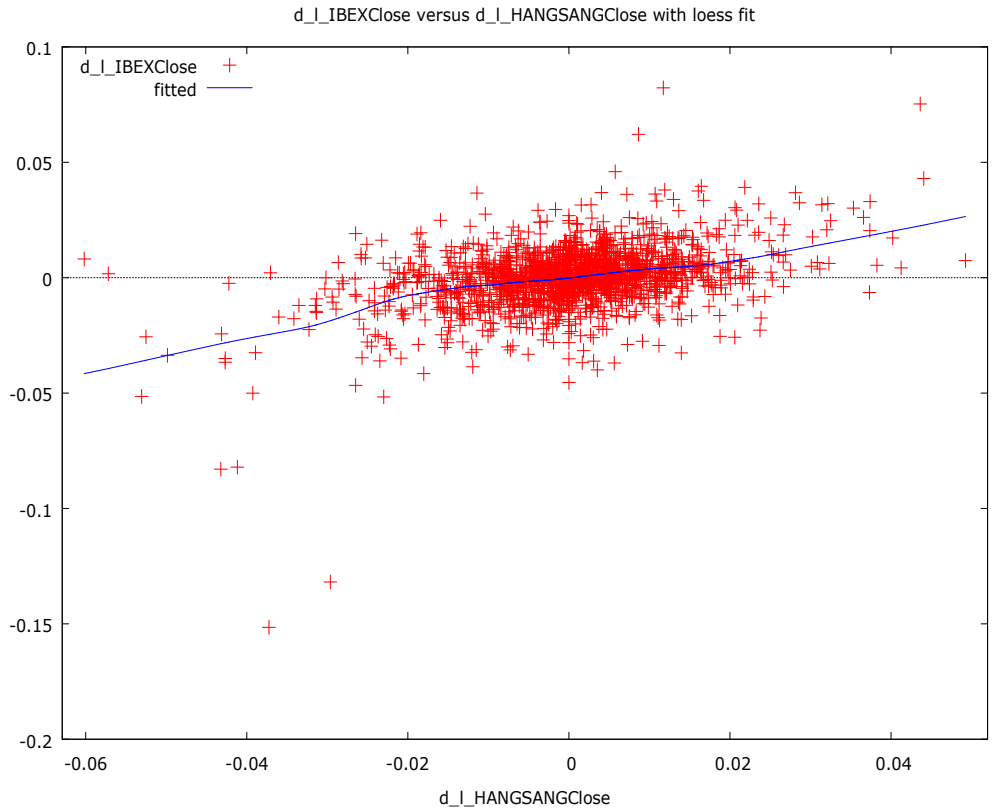

Fig. 2 Scatter Plot – Loess fitness plot for IBEX and Hang Sang stock indices
Source: Author's computation using daily series returns of selected period

Loess test property provides visible impact where returns from IBEX Stock Exchange scattered and plotted with no relationship (no correlation found) with the financial market movement of the Hong Kong stock exchange. However, it indicates that there was no relationship between movement of each financial markets during selected period.

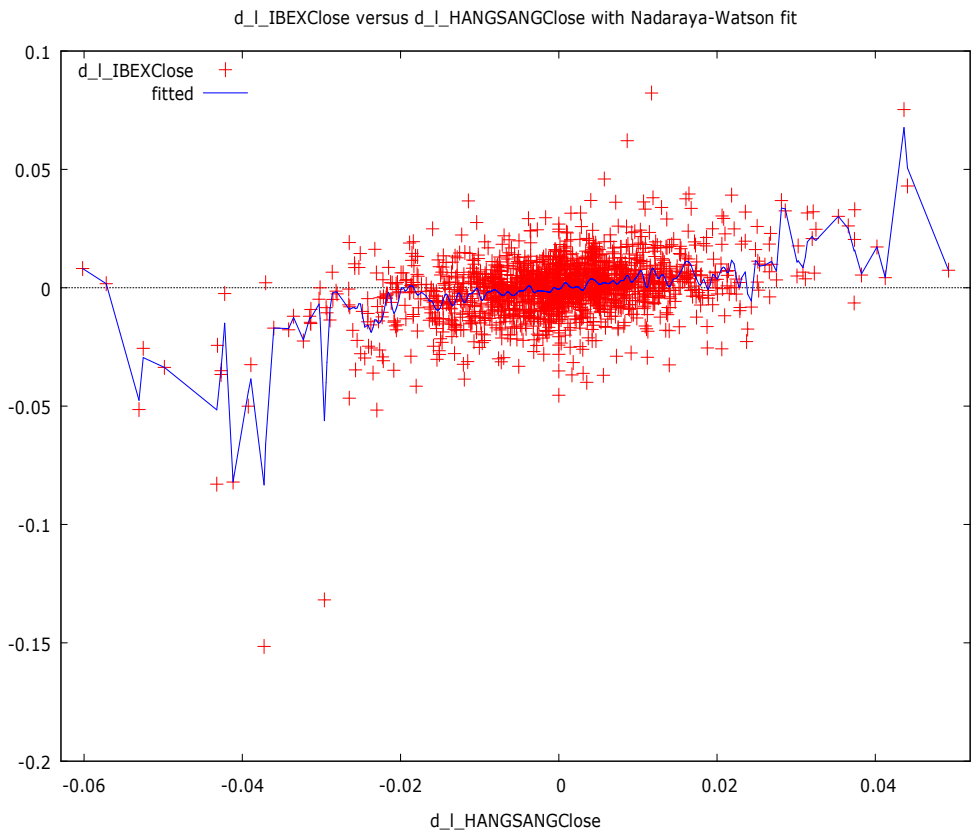

Fig.3 Estimated density plot for Spain and Hong Kong Stock Exchanges – Nadaraya – Watson fitness test

Source: Author's computation using daily closing returns from selected financial markets

Nadaraya - Watson fit provides different outcomes compared to Loess fitness. It indicates fitted variables of IBEX against Hang Sang financial markets.

Table 1 Descriptive statistics property

Descriptive Statistics				
	Mean	**Std. Dev**	**Skewness**	**Ex. Kurtosis**
IBEX	**-9.5054e-005**	**0.013287**	**-1.52**	**18.417**
HANGSANG	**2.0752e-005**	**011332**	**-0.374**	**2.4674**

Source: author's calculation

IBEX index of the stock market of Spain is having the highest degree of investment risk as the kurtosis creates higher leptokurtic impact compared to Hang Sang

Stock Exchange for the covered period. The degree of standard deviation varied more than 10 times with negative skewness. Kurtosis is creating leptokurtic impact for Spain and remained under control of Hang Sang index of Hong Kong stock market. The negative mean returns indicates that investors over a period of time generated negative returns.

Table 2 Empirical results of GARCH (1, 1) model for the stock market of Spain

Conditional mean equation				
coefficient	std. error	z	p-value	
const	0.000101803	0.000245412	0.4148	0.6783
Conditional variance equation				
coefficient	std. error	z	p-value	
omega	5.365e-06	1.71753e-06	3.124	0.0018 ***
alpha	0.138789	0.0352435	3.938	8.22e-05 ***
beta	0.834293	0.0307342	27.15	2.87e-162 ***
Llik:	5252.37598	AIC:	-10496.75195	
BIC:	-10474.97028	HQC:	-10488.69116	

(Normal), Dependent variable: d_l_IBEX Close
Sample: 2015-01-05 -- 2021-09-30 (T = 1712), VCV method: Robust method
Source: author's calculation

Table 3 Empirical results of GARCH (1, 1) model for the stock market of Hong Kong

Conditional mean equation				
const	0.000330106	0.000258844	1.275	0.2022
Conditional variance equation				
	coefficient	std. error	z	p-value
omega	2.487e-06	1.588e-06	1.565	0.1176
alpha	0.0567	0.01534	3.692	0.0002 ***
beta	0.926559	0.0239400	38.70	0.0000 ***

(Normal), Dependent variable: d_l_Hang Sang Close, (T = 1712), VCV method: Robust method
Source: author's calculation

The results included in both table 2 and 3 indicate that GARCH (1, 1) model did not fit to any of selected stock markets. However, the conditional variance equation fitted with 1% significance.

4. Conclusions

Currently, the COVID - 19 pandemic represents a significant challenge for the global economy.

We used GARCH (1,1) standard model to capture the volatility and found that GARCH (1,1) model provides insignificant and not fitted on any sample markets. However, changes in volatility is captured by summary of statistics and different fitness test. The stock market index of Spain, such as IBEX has been found to be more volatile compared to the stock market index of Hong Kong, such as Hang Sang. This research study demonstrates changes in statistical property of financial market series returns. It indicates that during the pandemic impact, the selected two developed stock markets have no significant correlation and found significant pattern of moment while markets are falling due to pandemic impact. The normality test considering with constant and trend, but also without constant and trend demonstrated how selected stock markets behaved abnormally during the COVID – 19 pandemic period.

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