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The Implementation of Generalized Autoregressive Conditional Heteroscedasticity (GARCH) Model on the Index Forecasting of Sharia Stocks in Asian Countries

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Abstract

The study of forecasting volatility of stocks has been discussed and investigated among scholars. Volatility plays important role in determining stock value as well as portfolio in stock market. This study investigates the use of GARCH model (generalized autoregressive conditional heteroskedasticity) in forecasting Islamic index stock in Asian countries. This study employs data from yahoo. finance including six countries namely India, Singapore, Japan, China, Malaysia, and Indonesia. There are 1304 data observation of daily closing price for the period between January 2016 and December 2020. The results of the study show that GARCH model can be employed as a mediation of forecasting sharia indexed stock. This implies that GARCH model can be used as forecasting steps in Islamic stock in Asian countries. Investors can take into account the model of GARCH in forecasting of Islamic stock market in Asian countries particularly India, Japan, China, Singapore, Malaysia and Indonesia.

Keywords: GARCH, forecasting, sharia stocks

1. Introduction

In the past decade, the research in the volatility forecasting remained an interesting topic to be examined and discussed by the investment agents and financial researchers (Kambouroudis & McMillan, 2015; Zhang & Choudhry, 2015, and Wang, et al. (2016). The volatility plays an important role in determining the stock prices and portfolio forming in the stock market.

The volatility in the stock markets can affect investors to make buying and selling decisions of stocks and other securities. Stock market is a place that can facilitate investors and shareholders to do financial instrument transactions and it plays an important role for the economic development (Husnan, 2015). However, the stock index in the stock market is fully affected by the volatility of stock values having time series pattern.

In measuring volatility, Bollerslev (1986) suggests a model known as Generalized Autoregressive Conditional Heteroskedasticity or GARCH model. This model is believed to be able to measure the volatility performance of stock index prices in the future.

The research findings of GARCH modelling have been reported in some studies such by Liu, et al.(2021), Luo (2017), De Gaetano (2020), and Fritz & Oertel (2021). The studies document that GARCH model gives a better performance to forecast the volatility measurements.

This research examines how investors make forecasting of sharia stock index in six countries, which are India, Japan, China, Singapore, Malaysia and Indonesia as a consideration before they make investments.

2. Theoretical Framework and Hypothesis

Investment

Tandelilin (2012) defines an investment as an activity to gain profits in the future from some funds or sources currently invested. Meanwhile, Reilly and Brown (2013) say that an investment is a commitment of one dollar in a specific period that will fulfil the investors' needs in the future by considering those spent funds, inflation rates, and volatility of economic condition in the future.

Referring to above-mentioned definitions, of experts, it could be concluded that an investment is a placement of some funds at the current time with one or more assets owned in a specific period to gain profits in the future. In the investment, there are attributes that cannot be separated from the investments, which are returns and risks. The investment made is aimed at gaining profits or improving prosperity in the future even though it is risky.

Data Stationary

In the time series measurement, data stationary is absolute. This stationary model can be measured based on historical data taken place earlier. Data are considered stationary if they show similarities in the means, variants, and auto-variants (Francq & Zakoian, 2010).

Makridakis (1995) defines stationary as data that do not change drastically. It can be seen from the fluctuating data that are not determined by time and variety. According to Wei (2006), stationary is divided into two parts: (i) stationary in a mean, where fluctuating data is around a constant average value and not depending on time and variations of these fluctuates. It can be frequently seen from the shape of data plot either stationary or not; (ii) stationary in variations, where time-series data is considered stationary if the fluctuating data is stable or constant. Stationary can also be seen from the plot of time series that shows fluctuates from time to time.

Time-series data shows variations and constant means. In contrast, if data are not stationary, it needs a differencing method to make that data be stationary. Whereas, differencing can be measured from the current data deducted from the previous data.

ARIMA Model

Autoregressive (AR) Model is a time-series regression modelling where the previous actual examination and observation values are interrelated. In other words, the AR model assumes that the current value is affected by the previous one. The concept of AR model is to see the

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forecasting result of future values by regressing an actual values of observation and the previous values of observation.

The modelling of AR (p) can be identified and determined by using the partial autocorrelation function (PACF). The number of previous values used in the model (p) shows the level of its model. For instance, AR Level 1 or AR (1) means only one previous value (Hendikawati, 2015). The equation of AR Model is as follows (Winarno, 2017).

$$Y_t = \beta_i + \beta_1 Y_{t-1} + \beta_2 Y_{t-2+\cdots+} \beta_p Y_{t-p} + e_t \quad (1)$$

Moving Average (MA) Model assumes that current data is affected by the residual value of previous data. In other words, MA model could describe where the observation at t time is a linear from a number of random errors (Hendikawati, 2015). MA (q) is MA with order of q. Furthermore, MAmodel can be identified and determined by using the autocorrelation function (ACF). MA has the following equation (Winarno, 2017).

$$Y_t = \alpha_0 + \alpha_1 e_t + \alpha_2 e_{t-1} + \cdots + \alpha_q e_{t-q} \quad (2)$$

Moreover, ARIMA model has this following equation (Winarno, 2017)

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \cdots + \beta_2 Y_{t-p} + \alpha_2 e_{t-1+\cdots+} \alpha_q e_{t-q} \quad (3)$$

Effect Test of ARCH or heteroskedasticity Test

The effect test of ARCH is one of the methods used to understand the heteroskedasticity condition of data. The heteroskedasticity condition is a condition where the data movement is not homogenous (Engle, 1982). The aim of this test is to understand whether the residual data still consist of heteroskedasticity element. The equation of heteroskedasticity test or effect test of ARCH is as follows (Engle, 1982):

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \alpha_j a_{t-j}^2 \quad (4)$$

Test of Autoregressive Conditional heteroskedasticity - Lagrange Multiplier (ARCH- LM) One of the methods to test residual homogenous variants (no effect of ARCH/GARCH) is the test of Lagrange Multiplier (LM). Engle (1982) introduced the test of ARCH-LM to understand the heteroskedasticity problems in time series. A residue does not only work from an independent variable but it must see the quadratic residue of previous period (Enders, 2004). The following is the equation of ARCH-LM test:

$$a_t^2 = a_0 + a_1 a_{t-1}^2 + a_2 a_{t-2}^2 + \ldots + a_q a_{t-q}^2 \quad (5)$$

Generalized Autoregressive Conditional heteroskedasticity Model (GARCH Model)

Engle (1982) first introduced ARCH (Autoregressive Conditional Heteroskedasticity) model. The GARCH model measures the time series by using the form of autoregressive (AR). Whereas, AR model is less suitable for the data forecasting of time series because of the availability of heteroskedasticity in data. The limitation of AR model is caused by the effect of stochastic in the time-series data causing the residue inconstant (heteroskedasticity). The general form of ARCH(q) model is as follows:

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \alpha_j a_{t-j}^2 \quad (6)$$

Bollerslev (1986) develop and introduced an equation development of ARCH model to become GARCH (p, q)to avoid a higher ordo in ARCH model. This led him to choose a simpler model and to guarantee that the variants are always positive (Enders, 1995). GARCH (p, q) model has the general equation as follows:

$$\sigma_t^2 = \omega \sum_{i=1}^{p} \beta_i \sigma_{t-1}^2 + \sum_{j=1}^{q} \alpha_j a_{t-j}^2 \quad (7)$$

Forecasting

Forecasting can be defined as a forecasting technique either finance or time in the future. This technique refers to the past with the current data. Forecasting can be made as the reference to make any decision since the decision should refer to the erratic (Gerlach & Wang 2016). Akgül& Sayyan(2008) divided forecasting into two parts; firstly the qualitative forecasting such as the use of historical data that do not have a representation of future forecasting; secondly, the forecasting of quantitative method where the historical data are analysed by using scientific norm. This quantitative method consists of two different ways, which are the regression method (causal) and time-series method.

Mean Absolute Percentage Error (MAPE)

In predicting the accuracy level of forecasting, MAPE is used. In addition, MAPE can indicate an error of forecasting by comparing the forecasting and actual values. Based on Lewis (1982), the value of Mean Absolute Percentage Error (MAPE) can be interpreted in four categories, which are:

Less than (<) 10 % = Very Accurate
Between 10 % -20% = Good
Between 20,1 % -50% = Fair
More than (>) 50% = Inaccurate or fail

The MAPE equation is as follow:

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$$MAPE = \left(\left(\sum_{t=1}^{n}\frac{y_t-\hat{y}_t}{y_t}\right)/n\right) x\ 100\% \tag{8}$$

Criteria of Model Selection

The best model selection or the accuracy of a model can be seen from the lowest value of Akaike Information Criterion (AIC) & Schwarz's Information Criterion (SIC) (Gujarati and Porter, 2009).

$$AIC = log\left(\frac{\sum e_i^2}{n}\right) + \frac{2k}{n} \tag{9}$$

$$SIC = \log\left(\frac{\sum e_i^2}{n}\right) + \frac{k}{n}\log n \tag{10}$$

Where,

k = the number of parameters estimated in the regression model. n = the number of observations

= quadratic residue

3. Method

Population and Sample

This type of research is a quantitative one and we use samples data of sharia index from six countries, which are India, Japan, China, Singapore, Malaysia, and Indonesia. Whereas, the sample selection method is purposive sampling technique. Moreover, the data collected to this study are from the daily closing price of stock during the observation period, as study by Hung, et al.(2013), for the period between January 2016 to December 2020.

Each of closing price data of those stocks can be accessed atwww.yahoofinance.com andwww.marketwatch.com. Data samples can be seen in the following Table 1:

Table 1: Stock Index of Asian Countries

Period: January 2016 – December 2020

Symbol	Stock Index
IND	FTSE Sharia of India
JAPN	FTSE Sharia of Japan 100
CHIN	FTSE Sharia of China
SGX	FTSE SGX Asia Sharia 100 (FTSGS100)
MALAY	FTSE Bursa Malaysia Hijrah Sharia
INDONESIA	Jakarta Islamic Index (JII)

Technique of Analysis

Data from the sharia stock index of six countries will be analysed by using the software of e-views 12. The followings are stages of analysis.

1. Collecting data of sharia stock index from six countries, India, China, Japan, Singapore, Malaysia, and Indonesia. Data obtained is an international sharia stock index accessed fromwww.marketwatch.com.

2. Making sure that data are stationary by using the Augmented Dickey Fuller test (ADF test). The identification process of data is made by examining observation data either it is stationary or not.

3. Data Differencing

Time-series data that are not stationary should be made stationary through differencing procedure. Data differencing is made by measuring the value changes or gap of observation data with the following equation:

$$\Delta Y_t = Y_t - Y_{t-1} \tag{11}$$

$Y_t =$ Variable Value of Y at a time of t

Y_{t-1} = Variable Value of Y at a time of t-1

4. Determining the best ARIMA Model

The next step is to determine the best ARIMA model that can be seen from the lowest Akaike Information Criterion (AIC) & Schwarz's Information Criterion (SIC) values. In this step, GARCH model will be formed following the model that has been formed and selected as the best ARIMA model.

5. Conducting heteroskedasticity Test

After determining the best RMA model, the next step is to conduct the heteroskedasticity test if data donot contain the heteroskedasticity element (homogeneous data) and therefore, this process cannot be continued using GARCH model. The applied model is as follows (Engle, 1982):

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \alpha_j a_{t-j}^2 \tag{12}$$

where,

σ_t^2 = residual variant at a time to (t)

ω = Constanta

α_j = Coefficient to-j

α^2_{t-j} = residual quadrate at a time to (t-j)

The hypothesis in this test is:

H_0 = time-series data does not contain heteroskedasticity H1 = time-series data contains heteroskedasticity
H_0 rejected if P value ≤ 5%, that means heteroskedasticity exists

H_0 accepted if P value ≥ 5%, that means heteroskedasticity does not xists

6. Effect Test of ARCH
The effect test of ARCH is a method used to understand the heteroskedasticity condition of data. The heteroskedasticity condition is a condition where the movement of data is not homogeneous. The effect test of ARCH itself is conducted to know whether data can be modelled with the time-series heteroskedasticity or not.

7. Forming GARCH Model
In this step, the best ARIMA Model has been determined. Following this step is to form GARCH Model and make forecasting.

8. Evaluating GARCH Model with the Test of ARCH LM
In this step, the best GARCH model has been formed. This step is to conduct the heteroskedasticity test by using the test of ARCH LM (Lagrange Multiplier). If the model does not contain heteroskedasticity anymore or the valueα is > 5%, then it is the best model and applicable.

9. Forecasting
The last step is forecasting. It is a science that predicts the future events by using old data (Heizer et al, 2019). This is conducted to obtain results used by investors to make any investment decision.

4. Results

The findings of the study showed that the model of GARCH in examining sharia index stock followed some steps as below.

Figure 1 exhibits the plot of Sharia Stock Index in six countries.

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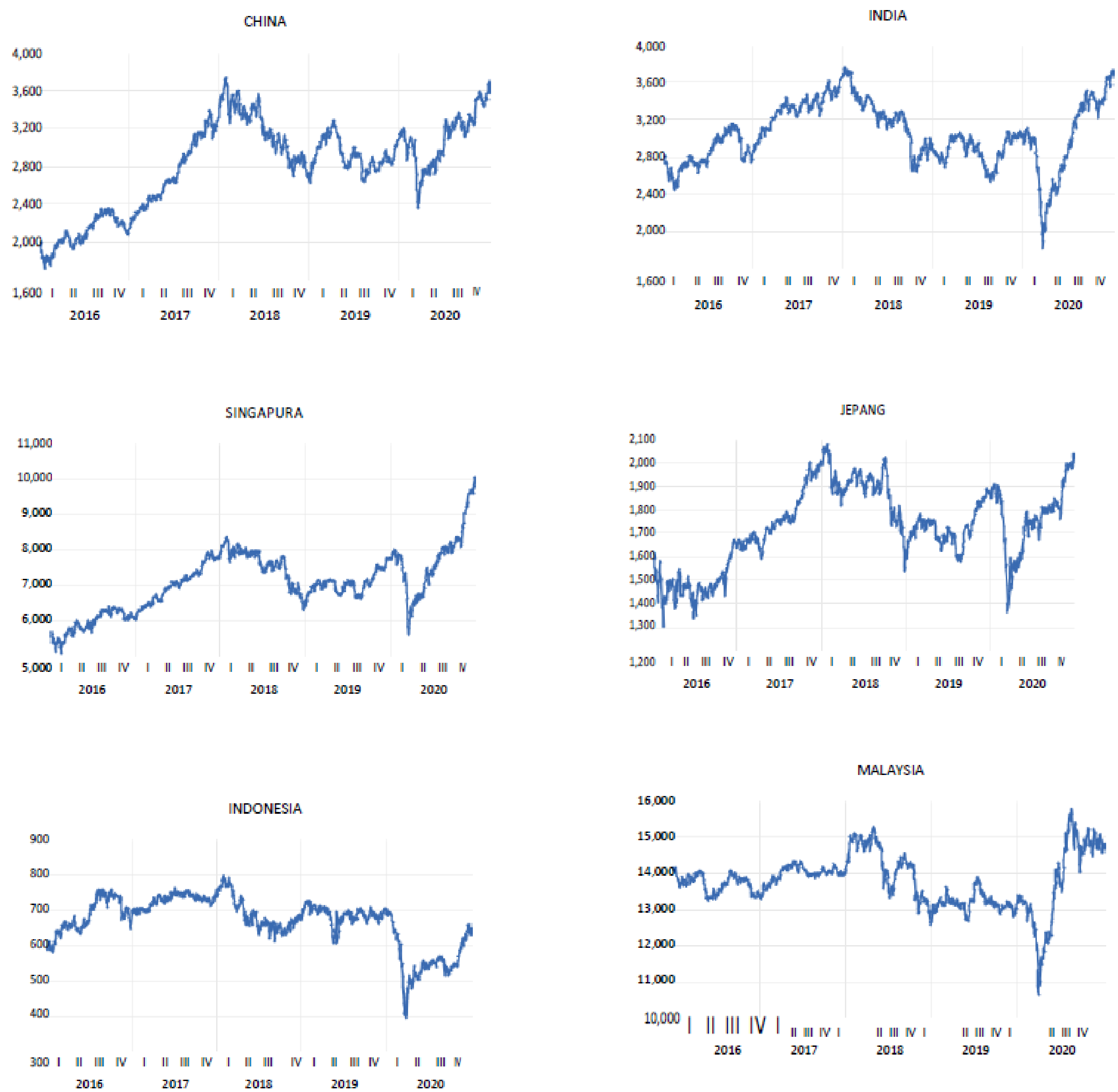
Figure 1
Plot of ASIAN Sharia Stock Index



As it seen from Table 1, data does not have constant means making the stationary test is necessary. The cycle pattern of Jakarta Islamic Index started with the decreasing trend in early 2020. This decreasing trend was followed by the increasing one in mid-2020. Therefore, this plot is not considered stationary because this plot shows the value increase based on time and it decreases regularly.

Test of Data Stationary

Data stationary can be identified by using Augmented Dickey Fuller test (ADF test). Data is obtained from sharia stock index from six countries. If the ADF value of probability test is < 5%, data are considered stationary. Conversely, if the ADF shows the probability > 5%, dataare not considered stationary.

Table 2
Results of ADF Test at the Level Stage

Stock Index Data	Probability	Remark
FTSE Sharia of India	0.5844	Not Stationary
FTSE Sharia of Japan 100	0.4127	Not Stationary
FTSE Sharia of China	0.6661	Not Stationary
FTSE SGX Asia Sharia 100	0.9767	Not Stationary
FTSE Bursa Malaysia Hijrah Sharia	0.1305	Not Stationary
Jakarta Islamic Index	0.2184	Not Stationary

Table 2 shows the results of the stationary test using ADF test in six countries. This result says that those six countries do not have stationary data the level stage. It can be seen that the probabilities of those six countries are more than (>) 0.05 or (5%). They are FSTSE Sharia of India at 0.5844, FTSE Sharia of Japan 100 at 0.4127, FTSE Sharia of China at 0.6661, FTSE

SGX Asia Sharia 100 at 0.9767, FTSE Bursa Malaysia Hijrah Sharia at 0.1305, and Jakarta Islamic Index at 0.2188.

Furthermore, since the ADF test does not show data stationary, the ADF test will be conducted at the 1st difference level using the e-views 12.

Table 3
Table 3: ADF Test Result in the 1st Difference Level

Stock Index	Probability	Remark
FTSE Sharia of India	0.0000	Stationary
FTSE Sharia of Japan 100	0.0000	Stationary
FTSE Sharia of China	0.0000	Stationary
FTSE SGX Asia Sharia 100	0.0000	Stationary
FTSE Bursa Malaysia Hijrah Sharia	0.0000	Stationary
Jakarta Islamic Index	0.0000	Stationary

The test result of ADF test at the 1st difference is illustrated in Table 3 consisting of six countries. This ADF test shows that data from six countries is stationary because the probability value is less than (<) 0.05. Data that make a stationary result at the 1st difference level is where the value of d = 1.

ARIMA Model

Before forming GARCH model, the first step made is to form ARIMA model. The general form of Arima is at AR (p), MA (q), and difference (d). The selection of the best ARIMA model can be seen from the autocorrelation plot (ACF) and partial autocorrelation plot (PACF). For AR model, it could refer to the PACF graphic and MA model can be seen from the ACF graphic. The model is selected when a lag passes the limit line and cuts of at the next lag.

Table 4
Best ARIMA Model

NO	STOCK INDEX	MODEL ESTIMATION	AIC CRITERION	SCHWARZ CRITERION	REMARK
1	FTSE Sharia of	ARIMA(2.1.0)	9.935340	9.947249	
	India	ARIMA(0.1.2)	9.935238	9.947147	Best Model
		ARIMA(2.1.2)	9.936751	9.952629	
2	FTSE Sharia of	ARIMA(2.1.0)	8.754128	8.766037	
	Japan 100	ARIMA(0.1.2)	8.753765	8.765674	
		ARIMA(2.1.2)	8.750136	8.766015	Best Model
3	FTSE Sharia of	ARIMA(3.1.0)	9.966031	9.977940	
	China	ARIMA(0.1.3)	9.965557	9.977466	Best Model
		ARIMA(3.1.3)	9.964702	9.980581	
4	FTSE SGX Asia	ARIMA(2.1.0)	11.21862	11.23053	
	Sharia 100	ARIMA(0.1.2)	11.21773	11.22964	
		ARIMA(2.1.2)	11.21579	11.23167	Best Model
5	FTSE Bursa	ARIMA(5.1.0)	12.11957	12.13148	
	Malaysia Hijrah	ARIMA(0.1.5)	12.11988	12.13179	
	Sharia	ARIMA(5.1.5)	12.11855	12.13443	Best Model
	Jakarta Islamic	ARIMA(1.1.0)	7.236754	7.248663	
6	Index	ARIMA(0.1.1)	7.235528	7.247437	Best Model
		ARIMA(1.1.1)	7.236536	7.252414	

It can be concluded that Table 4 shows the estimation result of the best RMA among six countries, which are India, China, Japan, Singapore, Malaysia, and Indonesia. FSTE Sharia of India received an ARIMA Model (0.1.2) with the AIC value at 9.935238 and Schwarz criterion at 9.947249 followed by FTSE Sharia of Japan 100 and FTSE SGX Asia Sharia 100. The estimation of the best ARIMA model is ARIMA (2.1.2) with the lowest AIC values at 8.750136 and 11.21579 respectively with Schwarz criterion at 8.766015 and 11.23167 correspondingly. FTSE Sharia of China received the estimation of ARIMA (0.1.3) model with the value of AIC at 9.965557 and Schwarz criterion at 9.965557. On the other hand, the estimation of the best ARIMA Model (5.15) of FTSE Bursa Malaysia Hijrah Sharia is 12.11855 for AIC and 12.13443 for Schwarz criterion.

Heteroskedasticity Test of ARIMA Model

The stage of heteroskedasticity test is conducted to prove that this model is suitable for further use in the GARCH model measurement. By seeing the probability value or Prob F that is smaller than 0.05 or (Prob F < 5%), that model has heteroskedasticity and consequently, it is reliable to form GARCH model.

Table 5
heteroskedasticity Test of ARIMA

NO	STOCK INDEX	MODEL ESTIMATION	Prob F
1	FTSE Sharia of India	ARIMA(0.1.2)	0.0000
2	FTSE Sharia of Japan 100	ARIMA(2.1.2)	0.0000
3	FTSE Sharia of China	ARIMA(0.1.3)	0.0000
4	FTSE SGX Asia Sharia 100	ARIMA(2.1.2)	0.0000
5	FTSE Bursa Malaysia Hijrah Sharia	ARIMA(5.1.5)	0.0000
6	Jakarta Islamic Index	ARIMA(0.1.1)	0.0000

Table 5 shows that the model obtained from the result of heteroskedasticity test of ARIMA model selected from six Asian countries consisting of heteroskedasticity element, or the probability F isless than 0.05(Prob F< 0.05). In other words, it can be concluded that this ARIMA model could be further processed to form GARCH model.

GARCH Model

Before forming GARCH model, residual quadratic r2 from the mean model or the best ARIMA model is formed. To see the length of ordo of that GARCH, correlogram could be the reference. According to Tsay (2005), to determine the ordo of ARCH model can be seen from PACF graphic of residual quadratic (αt2) while the GARCH model can be seen from ACF graphic of residual quadratic.

Table 6
Estimation of the Best GARCH Model

NO	STOCK INDEX	MODEL ESTIMATION	AIC CRITERION	SCHWARZ CRITERION
1	FTSE Sharia of India	GARCH (1.2)	9.865531	9.889349
2	FTSE Japan Sharia 100	GARCH((2.2)	8.562715	8.594512
3	FTSE Sharia of China	GARCH (1.3)	9.806316	9.834104
4	FTSE SGX Asia Sharia 100	GARCH (2.2)	11.04612	11.07394
5	FTSE Bursa Malaysia Hijrah Sharia	GARCH (1.5)	12.06352	12.10334
6	Jakarta Islamic Index	GARCH (1.1)	7.005392	7.025240

The results illustrated in Table 6 are the estimation of GARCH Model that has been formed from six Asian countries: GARCH (1.1) for Indonesia, GARCH (1.2) for India, GARCH (2.2) for Japan and Singapore, GARCH (1.3) for China, and GARCH (1.5) for Malaysia. It can be seen from the Table6that Jakarta Islamic Index with GARCH (1.1) gained the values of AIC and Schwarz criterion at 7.005392 and 7.025240 respectively. FTSE Sharia of India with the estimation of GARCH (1.2) Model obtained values of AIC and Schwarz criterion at 9.865531 and 9.889349 correspondingly. FTSE Sharia of Japan 100 with GARCH (2.2) model has the values of AIC at 8.562715 and Schwarz criterion at 8.594512. On the other hand, GARCH (2.2) model at FTSE SGX Asia Sharia 100 has the values of AIC at 11.04612 and Schwarz criterion at 11.07394.

Test of ARCH LM (Lagrange Multiplier)

The stage of ARCHLagrange Multiplier test at GARCH model is conducted to prove the adequacy of model. In other words, whether the model does not contain a heteroskedasticity element. By seeing the value of probability that is higher than 0.05 or (Prob F> 5%), that model does not contain of heteroskedasticity (homogeneity) so that the forecasting is reliable to be continued. In contrast, if the value of prob f is < 0.05, that model consists of heteroskedasticity. The results of the test are presented below:

Table 7
Test of ARCH LM GARCH

NO	NAME OF STOCK	MODEL ESTIMATION	Prob. F
1	FTSE Sharia of India	GARCH (1.2)	0.6715
2	FTSE Sharia of Japan 100	GARCH (2.2)	0.6871
3	FTSE Sharia of China	GARCH (1.3)	0.9007
4	FTSE SGX Asia Sharia 100	GARCH (2.2)	0.1374
5	FTSE Bursa Malaysia Hijrah Sharia	GARCH (1.5)	0.5606
6	Jakarta Islamic Index	GARCH (1.1)	0.5063

Based on the result illustrated in Table 7, it is obtained that GARCH model that has been formed from six countries does not consist of heteroskedasticity (the value of Prob F is > 0.05). Consequently, GARCH models are suitable and reliable to be applied. The values of probability F at FTSE Sharia of India are 0.6715, FTSE Sharia of Japan 100 at 0.6871, FTSE Sharia of China at 0.9007, FTSE SGX Asia Sharia 100 at 0.1374, FTSE Bursa Malaysia

Sharia at 0.5606, and FTSE Jakarta Islamic Index at 0.5063. The biggest Prob F was found at FTSE Sharia of China with the value of 0.9007 and the lowest Prob Fis found at FTSE SGX Asia Sharia 100 at 0.1374.

Forecasting Result of GARCH Model

Table4.8

Forecasting for 10-day Observation

Date	India	Japan	China	Singapore	Malaysia	Indonesia
01/01/2021	3.740	2.022	3.715	10053,4	14340,89	637,78
04/01/2021	3.741	2.023	3.719	10056,94	14340,27	637,92
05/01/2021	3.742	2.023	3.723	10060,33	14339,45	638,06
06/01/2021	3.743	2.024	3.725	10063,71	14340,34	638,20
07/01/2021	3.745	2.026	3.727	10067,09	14339,21	638,34
08/01/2021	3.746	2.027	3.729	10070,48	14339,54	638,48
11/01/2021	3.747	2.027	3.730	10073,87	14339,87	638,62
12/01/2021	3.748	2.029	3.732	10077,25	14340,19	638,75
13/01/2021	3.749	2.031	3.734	10080,64	14340,53	638,89
14/01/2021	3.750	2.031	3.736	10084,02	14340,85	639,03

The forecasting results of six Asian countries, India, Japan, China, Singapore, Malaysia, and Indonesia based on a 10-day observation seem to increase from 1 January through 14 January 2021. Furthermore, the forecasting results will be compared to actual data of six countries whether there is insignificant difference or accuracy. According to Lewis (1982), the value of Mean Absolute Percentage Error (MAPE) can be interpreted into four different categories, which are:

1.<10% = very accurate
2.10-20% = good
3.>20-50% = fair
4.>50% = inaccurate or fail

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Table 4.9
MAPE Value of FTSE Sharia
India

Date	Forecast	Actual	Actual-Forecasting (Absolute)	Absolute/Actual	MAPE
01/01/2021	3,740	3,737	2.414	0.000645945	
04/01/2021	3,741	3,798	57.1	0.015033041	
05/01/2021	3,742	3,790	47.421	0.012512996	
06/01/2021	3,743	3,772	28.761	0.007624463	
07/01/2021	3,745	3,757	12.042	0.003205558	
08/01/2021	3,746	3,822	76.083	0.019907844	
11/01/2021	3,747	3,836	89.223	0.023259264	
12/01/2021	3,748	3,858	110.204	0.028564171	
13/01/2021	3,749	3,845	95.525	0.024846797	
14/01/2021	3,750	3,865	114.825	0.02970908	0.165

Table 4.9 shows the measurement result of Mean Absolute Percentage Error (MAPE) of FTSE Sharia of India. MAPE is used to evaluate the accuracy of forecasting result. The result of MAPE obtained from the index of FTSE Sharia of India is 16.5 %, which means a good forecasting result.

Table 4.10
MAPE Value of FTSE Sharia of Japan 100

Date	Forecast	Actual	Actual-forecasting (Absolute)	Absolute/Actual	MAPE
01/01/2021	2,022	2,020	2.17	0.001074236	
04/01/2021	2,023	2,012	11,14	0.00553733	
05/01/2021	2,023	2,013	10.275	0.005104981	
06/01/2021	2,024	2,017	7.048	0.003493658	
07/01/2021	2,026	2,050	23.302	0.011368327	
08/01/2021	2,027	2,087	59.52	0.028523096	
11/01/2021	2,027	2,093	65.518	0.03130414	
12/01/2021	2,029	2,093	64.162	0.030656251	
13/01/2021	2,031	2,107	76.539	0.036322608	
14/01/2021	2,031	2,118	86.703	0.040932589	0.194

The measurement result of MAPE illustrated in Table 4.10 for the index of FTSE Sharia of Japan 100 shows the value of MAPE at 0.194 or 19.4% meaning that the forecasting result of FTSE Sharia of Japan 100 has a good forecasting result because it ranges from 10% to 20%.

Table 4.11
MAPE Value of FTSE Sharia of China

Date	Forecast	Actual	Actual-forecasting (Absolute)	Absolute/Actual	MAPE
01/01/2021	3,715	3,712	2.461	0.000662956	
04/01/2021	3,719	3,748	28.774	0.007676752	
05/01/2021	3,723	3,804	80.741	0.021226015	
06/01/2021	3,725	3,778	53.221	0.014086412	
07/01/2021	3,727	3,773	46.001	0.012192833	
08/01/2021	3,729	3,833	103.953	0.027123575	
11/01/2021	3,730	3,831	100.293	0.026181103	
12/01/2021	3,732	3,868	135.464	0.035024071	
13/01/2021	3,734	3,879	144.635	0.037289171	
14/01/2021	3,736	3,855	119.425	0.030976355	0.212

Table 4.11 demonstrates the value of Mean Absolute Percentage Error (MAPE) of FTSE Sharia of China. The obtained result shows that the stock index value of FTSE Sharia of China has a value of MAPE at 0.212 or 21.2% representing a fair forecasting result. This refers to Lewis (1982) stating that the value of Mean Absolute Percentage Error between 20% to maximum 50% is considered having a fair forecasting result.

Table 4.12
MAPE Value of FTSE SGX Asia Sharia 100

Date	Forecast	Actual	Actual - Forecasting (Absolute)	Absolut/Actual	MAPE
01/01/2021	10053.4	10048.07	5.33	0.00053045	
04/01/2021	10056.94	10176.93	119.99	0.011790393	
05/01/2021	10060.33	10234.05	173.72	0.016974707	
06/01/2021	10063.71	10248.48	184.77	0.018029015	
07/01/2021	10067.09	10404.40	337.31	0.032419938	
08/01/2021	10070.48	10665.68	595.2	0.055805162	
11/01/2021	10073.87	10691.32	617.45	0.057752457	
12/01/2021	10077.25	10688.20	610.95	0.057161168	
13/01/2021	10080.64	10812.97	732.33	0.067726998	
14/01/2021	10084.02	10790.36	706.34	0.065460281	0.384

The result shown in Table 4.12 is the result of Mean Absolute Percentage Error (MAPE) from Singapore or FTSE SGX Asia Sharia 100 for a 10-day observation conducted in the period of 1 January 2021 through 14 January 2021. The result of MAPE that has obtained is 0.384 or 38.4%.

By considering the forecasting result of FTSE SGX Asia Sharia 100 that ranges from 20% to 50%, this forecasting shows a fair forecasting value.

Table 4.13

MAPE Value of FTSE Bursa Malaysia Hijrah Sharia

Date	Forecast	Actual	Actual - Forecasting (Absolute)	Absolute/Actual	MAPE
01/01/2021	14340.89	14340.56	0.33	2.30117E-05	
04/01/2021	14340.27	14016.62	323.65	0.023090445	
05/01/2021	14339.45	14110.60	228.85	0.016218304	
06/01/2021	14340.34	13987.93	352.41	0.025193864	
07/01/2021	14339.21	14117.45	221.76	0.015708219	
08/01/2021	14339.54	14538.12	198.58	0.013659263	
11/01/2021	14339.87	14409.97	70.1	0.004864687	
12/01/2021	14340.19	14504.21	164.02	0.011308441	
13/01/2021	14340.53	14518.30	177.77	0.012244547	
14/01/2021	14340.85	14384.91	44.06	0.003062932	0.125

Table 4.13 shows the measurement result of MAPE at FTSE Stock of Malaysia Hijrah Sharia at 0.125 or 12.5%. This result illustrates that the forecasting result of FTSE Stock of Malaysia Hijrah Sharia ranges from 10% to 20% and this forecasting value is considered good.

Table 4.14

MAPE Value of Jakarta Islamic Index

Date	Forecast	Actual	Actual - Forecasting (Absolute)	Absolute/Actual	MAPE
01/01/2021	637.78	646.29	8.5087	0.013165452	
04/01/2021	637.92	646.29	8.3698	0.012950533	
05/01/2021	638.06	648.95	10.8908	0.016782187	
06/01/2021	638.20	638.83	0.6319	0.000989152	
07/01/2021	638.34	652.01	13.6729	0.020970384	
08/01/2021	638.48	667.05	28.574	0.042836369	
11/01/2021	638.62	671.15	32.535	0.048476496	
12/01/2021	638.75	665.37	26.6161	0.040001954	
13/01/2021	638.89	668.28	29.3871	0.043974232	
14/01/2021	639.03	671.59	32.5582	0.048479281	0.289

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Based on the result of MAPE, Jakarta Islamic Index illustrated in Table 4.14 above shows that forecasting accuracy level that has been made is at 0.289 or 28.9%. Consequently, the forecasting result of Jakarta Islamic Index is considered fair.

4. Discussion

Based on the pattern results of sharia stock index of six countries, it shows that the time-series process is not stationary as the movement of stock index prices of those six countries during the observation period starting from January 2016 to December 2020 fluctuated from time to time. The results obtained for each sharia stock index of six countries, which are India, China, Japan, Singapore, Malaysia, and Indonesia, document that FTSE Sharia of India is 16.5% indicating it has a good forecasting value; FTSE Sharia of Japan 100 (19.4%) showing a good forecasting result; FTSE Sharia of China (21.2%) meaning it has a fair forecasting result; Jakarta Islamic Index (28.9%) indicating a fair forecasting result, FTSE SGX Asia Sharia 100 (38.4%) showing a fair forecasting result, and FTSE Malaysia Hijrah Sharia (12.5%) indicating a good forecasting result.

The lowest MAPE result is Malaysia at 12.5%, while the highest one is FTSE SGX Asia Sharia 100 at 38.4%. Based on the forecasting results of those six countries, India, Japan, China, Singapore, Malaysia, and Indonesia, there is no value of Mean Absolute Percentage Error (MAPE) more than 50%, indicating the forecasting result is not accurate. In other words, the forecasting result fails but the value of MAPE of six countries ranges from 10% to 50%. This means the forecasting result is good or fair. Consequently, it can be concluded that GARCH model is applicable in the stock index forecasting in six Asian countries, India, Japan, China, Singapore, Malaysia, and Indonesia according to the research.

The result obtained from Jakarta Islamic Index is ARIMA (0.1.1) with each value of AIC and Schwarz criterion at 7.235528 and 7.247437 respectively. The best model that has been formed will be further used in forming GARCH model. The result obtained from FTSE Sharia of China is GARCH (1.3) with the values of AIC of 9.806316 and Schwarz criterion of 9.834104 correspondingly. Finally, FTSE Stock Malaysia Hijrah Sharia with its GARCH (1.5) model yields the values of AIC of 12.06352 and Schwarz criterion of 12.10334.

The findings confirmed the previous studies examining the use of GARCH model in forecasting sharia indices. This also add the new findings particularly in terms of how the GARCH model can be as a tools to forecast the stock index.

5. Conclusions and suggestions

The results of this study show that the estimation of the best GARCH models formed for six Asian countries are GARCH (1.1) for Indonesia, GARCH (1.2) for India, GARCH (2.2) for Japan and Singapore, GARCH (1.3) for China, and the last one, GARCH (1,5), for Malaysia. The values of Akaike Info Criterion (AIC) for each country are Jakarta Islamic Index (7.005392), FTSE Sharia of India (9.865531), FTSE Sharia of Japan 100 (8.562715), FTSE SGX Asia Sharia 100 (11.04612), FTSE Sharia of China (9.806316), and FTSE Malaysia Hijrah Sharia (12.06352).

The value results of Schwarz criterion from each country are Jakarta Islamic Index (7.025240), FTSE Sharia of India (9.889349), FTSE Sharia of Japan 100 (8.594512), FTSE SGX Asia Sharia 100 (11.07394), FTSE Sharia of China (9.834104), and FTSE Malaysia Hijrah Sharia (12.10334).

Referring to the forecasting results using Mean Absolute Percentage Error (MAPE), according to Lewis (1982), the value of Mean Absolute Percentage Error (MAPE) can be interpreted into four categories, which are <10% meaning very accurate, between 10% to 20% meaning a good forecasting result, between 20% to 50% showing a fair forecasting result, more than 50% that means the forecasting result is inaccurate or fail. Future studies are expected to use the GARCH model with more extensive data and observations.

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