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Data modeling diagnostics for share price performance of Islamic Bank in Malaysia using Computational Islamic Finance approach

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Abstract— *Bank Islam Malaysia Berhad is an institution that offers financing activity that complies with shariah (Islamic law) and its practical application through the development of Islamic economics. The objective of this study is to forecast the performance of share price for Islamic Bank in Malaysia. The method implemented in this study is autoregressive integrated moving average (ARIMA). From the analysis, there are two model of ARIMA that developed which are ARIMA (3,1,3) and ARIMA(3,1,4). The model of ARIMA (3,1,4) show larger value of R-squared and lower absolute value of Akaike info criterion (AIC). In addition, the mean absolute percentage error (MAPE) is 0.85% in ex-post data range. This results indicates ARIMA (3,1,4) is a reliable forecasting model . The findings from this study will help investors to select a better portfolio for their investment decision in order to gain better profits. In addition, the findings of this study also will help economists to understand the future condition of economic scenario in Malaysia*.

Keywords— Islamic banking, Islamic finance, ARIMA model, Share price, Malaysia

I. INTRODUCTION

The main objective of establish Islamic banking system is to provide a products and services according to *shariah* law. *Shariah* is referring to activities that follow Islamic law. All the transaction must be free from the prohibited element such as *riba*, *gharar* and *maisir*. The main source in Islamic law is Al-Quran and As-Sunnah.

The history of development Islamic banking in Malaysia was started with the establishment of Pilgrim Hajj (Tabung Haji) in 1969. Then, Bank Islam Malaysia Berhad (BIMB) was established in 1983. Since Malaysia was established Islamic banking system, the development of Islamic finance and banking was growth rapidly. According to the Asian Banker Research Group, the World's 100 largest Islamic banks have set an annual asset growth rate of 26.7% and the global Islamic Finance industry is experiencing average growth of 15-20% annually. Thus, it is important to Muslim peoples to support Islamic banking products and services.

Many researches study the outstanding performance of Islamic bank in Malaysia such as Ab Rahim et al. (2013)[1]. They found that average the main contributor of cost efficiency for Islamic domestic and foreign banks in Malaysia is allocated efficiency. Sufian (2007) found the domestic Islamic banks were more efficient compared to the foreign Islamic banks [2]. Even though, the development of Islamic bank in Malaysia show the outstanding growth but the demand for Islamic banking products and services are less than conventional bank. Thus it is important to analyze the performance of Islamic banking system in Malaysia market in order to encourage more investors' especially Muslim investors to invest in *shariah*-compliant shares.

Therefore, the main objective of this study is to forecast the performance of share price for Islamic Bank in Malaysia. This study chooses Bank Islam Malaysia Berhad (BIMB) because BIMB is the first Islamic bank in Malaysia. This research gives a new insight to investors and practitioners regarding the dynamic behavior of investment portfolio.

II. LITERATURE REVIEW

Stock price prediction is an important topic in finance and economics which has spurred the interest of researchers over the years to develop better predictive models (Adebiyi, et al, 2014)[3]. There are many methods used in prediction analysis. One of the famous methods is ARIMA model. ARIMA also known as Box-Jenkins method is a process of set an activity for identifying, estimating and diagnosing using time series data.

Various studies on ARIMA model are used by researchers to forecast the future value. The available literature such as the predictability of the Amman Stock Exchange using ARIMA Model by Al-Shiab (2014)[4], real estate market by Stevenson (2007)[5], currency by Balli and Elsamadisy (2012)[6] the construction industry and economy by Lam and Oshodi (2016)[7] and housing price by Jadevicius and Huston (2015[8]).

Abu Bakar and Rosbi (2017)[9] analyzing the currency exchange rate between Malaysian Ringgit and United State Dollar and found that the ARIMA (1, 1, 1) is suitable for clustering the data between January 2010 until April 2017. While Nochai and Nochai (2006) [10] found the ARIMA Model for forecasting farm price of oil palm is ARIMA (2,1,0).

III. RESEARCH METHODOLOGY

This paper forecast the performance of share price for Islamic Bank in Malaysia. The method implemented in this study is autoregressive integrated moving average (ARIMA).

3.1 Data selection

Bank Islam Malaysia Berhad (BIMB) is the first institution that offers Islamic Banking in Malaysia. Therefore, the objective this study is to evaluate the performance of the share price for BIMB. The performance of the share price is selected from January 2010 until June 2017 (90 observations).

3.2 Forecasting statistical method

This study forecast the performance of share price using the statistical procedure as shown in Fig. 1. The forecasting process is start with the identification of the data model using autoregressive integrated moving average (ARIMA).

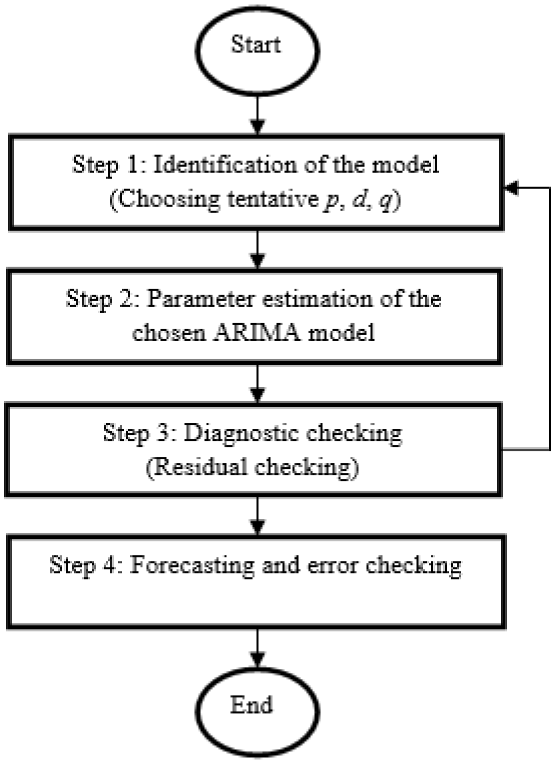


Fig. 1: Statistical forecasting procedure

Then, this research need to develop estimation of the parameter for chosen ARIMA model. In validating the model, diagnostics checking need to be developed. The residual is the difference between the observed value and the estimated value of the quantity of interest (sample mean). The residual should be uncorrelated, zero mean and zero variance. Then, forecasting and error checking stage can be performed.

3.3 Mathematical procedure of autoregressive integrated moving average (ARIMA)

In statistics, autoregressive integrated moving average (ARIMA) procedure provides the identification, parameter estimation, and forecasting of autoregressive integrated moving average model.

The AR part of ARIMA indicates that the evolving variable of interest is regressed on its own lagged values. The MA part indicates that the regression error is actually a linear combination of error terms whose values occurred contemporaneously and at various times in the past. The I (integrated) indicates that the data values have been replaced with the difference between their values and the previous values. The purpose of each of these features is to make the model fit the data as well as possible.

The autoregressive integrated moving average ARIMA (p, d, q) model is represented by Eq. (1).

$$\left(1-\sum_{i=1}^{p}\phi_i L^i\right)\left(1-L\right)^d X_t = \delta + \left(1+\sum_{i=1}^{q}\theta_i L^i\right)\varepsilon_t \qquad (1)$$

where L is the lag operator, ϕ_i are the parameters of the autoregressive part of the model, θ_i are the parameters of the moving average part and ε_t are error terms. The error terms ε_t are generally assumed to be independent, identically distributed variables sampled from a normal distribution with zero mean

ARIMA models are generally denoted ARIMA (*p*, *d*, *q*) where parameters *p*, *d*, and *q* are non-negative integers, *p* is the order (number of time lags) of the autoregressive model, *d* is the degree of differencing (the number of times the data have had past values subtracted), and *q* is the order of the moving-average model.

In this study, the degree of differencing is set to one. The purpose of this step is to confirm the stationarity of the data. Therefore Eq. (1) can be represented as below:

$$\Delta X_t = \delta + \varepsilon_t + \sum_{i=1}^{q}\theta_i\varepsilon_{t-i} + \sum_{i=1}^{p}\phi_i \Delta X_{t-i} \qquad (2)$$

3.3 Autocorrelation function(ACF) statistical method

Autocorrelation, also known as serial correlation, is the correlation of a signal with a delayed copy of itself as a function of delay.

The autocorrelation of a random process is the Pearson correlation between values of the process at different times, as a function of the two times or of the time lag. Let X is set as a stochastic process, and t is any point in time (t may be an integer for a discrete-time process or a real number for a continuous-time process). Then X_t is the value (or realization) produced by a given run of the process at time t. Consider the process has mean μ_t and variance σ_t^2 at time t, for each t. Then the definition of the autocorrelation between times s and t is described in below equation:

$$R(s,t)=\frac{\mathrm{E}\left[\left(X_t-\mu_t\right)\left(X_s-\mu_s\right)\right]}{\sigma_t\sigma_s} \tag{3}$$

If X_t is a stationary process, then the mean μ and the variance σ^2 are time-independent, and further the autocorrelation depends only on the lag between t and s: the correlation depends only on the time-distance between the pair of values but not on their position in time. This further implies that the autocorrelation can be expressed as a function of the time-lag, and that this would be an even function of the lag $\tau = s - t$. This gives the more familiar form in Equation (4).

$$R(\tau)=\frac{\mathrm{E}\left[\left(X_t-\mu\right)\left(X_{t+\tau}-\mu\right)\right]}{\sigma^2} \tag{4}$$

3.4 Partial autocorrelation function (PACF) statistical method

Partial correlation is a measure of the strength and direction of a linear relationship between two continuous variables whilst controlling for the effect of one or more other continuous variables (also known as 'covariates' or 'control' variables).

Formally, the partial correlation between X and Y given a set of n controlling variables $\mathbf{Z} = \{Z_1, Z_2, ..., Z_n\}$, written $\rho_{XY\cdot \mathbf{Z}}$, is the correlation between the residuals R_X and R_Y resulting from the linear regression of X with **Z** and of Y with **Z**, respectively. The first-order partial correlation (i.e. when n=1) is the difference between a correlation and the product of the removable correlations divided by the product of the coefficients of alienation of the removable correlations.

Partial autocorrelation function is described in below Equation (5).

$$\hat{\rho}_{XY\bullet \mathbf{Z}}=\frac{N\sum_{i=1}^{N}r_{X,i}r_{Y,i}-\sum_{i=1}^{N}r_{X,i}\sum_{i=1}^{N}r_{Y,i}}{\sqrt{N\sum_{i=1}^{N}r_{X,i}^2-\left(\sum_{i=1}^{N}r_{X,i}\right)^2}\sqrt{N\sum_{i=1}^{N}r_{Y,i}^2-\left(\sum_{i=1}^{N}r_{Y,i}\right)^2}}$$

IV. RESULT AND DISCUSSION

This section described the findings of stationary process, ARIMA model estimation process, residual diagnostics process and forecasting process.

4.1 Dynamic behavior analysis of share price

This study involved the monthly data of share price for Bank Islam Malaysia Berhad (BIMB). The selected data is collected from January 2010 until June 2017. This analysis involved 90 observations. Figure 1 shows the share price dynamic movement for Bank Islam Malaysia Berhad (BIMB). The maximum value of share price is MYR 4.622 in October 2013.The minimum value of share price is MYR 1.161 in February 2010.

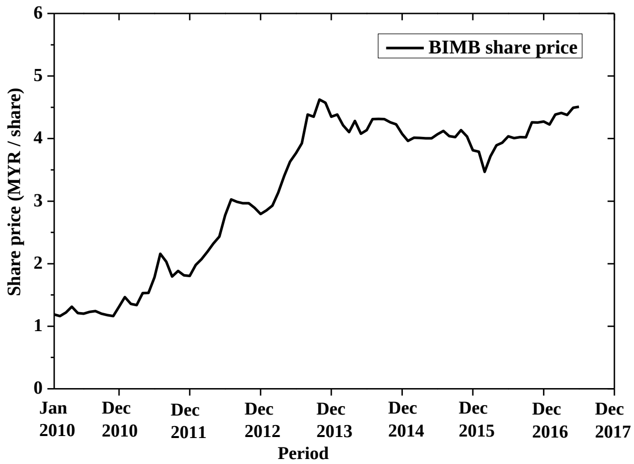
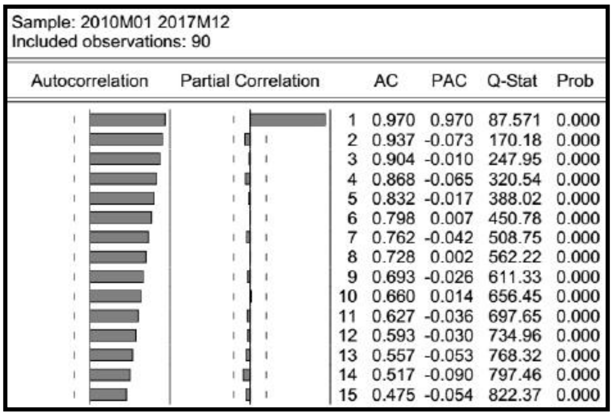


Fig. 2: Share price dynamic movement of BIMB

Next, this study performed the autocorrelation and partial correlation. Figure 2 shows the result of autocorrelation and partial correlation of share price. From Fig. 2, there is slow decay of autocorrelation number. Therefore, the data of share price is a non-stationary data. Statistical non-stationary is defined as statistical properties such as mean, variance are not constant over time.



Sample: 2010M01 2017M12
Included observations: 90

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.970	0.970	87.571	0.000
		2	0.937	-0.073	170.18	0.000
		3	0.904	-0.010	247.95	0.000
		4	0.868	-0.065	320.54	0.000
		5	0.832	-0.017	388.02	0.000
		6	0.798	0.007	450.78	0.000
		7	0.762	-0.042	508.75	0.000
		8	0.728	0.002	562.22	0.000
		9	0.693	-0.026	611.33	0.000
		10	0.660	0.014	656.45	0.000
		11	0.627	-0.036	697.65	0.000
		12	0.593	-0.030	734.96	0.000
		13	0.557	-0.053	768.32	0.000
		14	0.517	-0.090	797.46	0.000
		15	0.475	-0.054	822.37	0.000

Fig. 3: Autocorrelation and partial correlation analysis

4.2 Stationary transformation of share price

Next, share price is needed to be transforming to be a stationary in order to apply ARIMA model. Figure 3 shows the data of share price with first difference. Figure 3 shows the mean and variance is constant over time. Mean value for the first difference of share price is

0.0373. Meanwhile, standard deviation for first difference of share price is 0.13967.

Figure 4 shows the histogram for first difference of share price. The result shows the distribution of the data is follow normal distribution. This finding is validated with statistical normality test namely Shapiro-Wilk test as shown in Table 1.The findings in Table 1 shows the probabilities is 0.265 which is larger than 0.05. Therefore, the distribution of first difference of share price is not significantly different from normal distribution. Therefore, first difference of share price is stationary data.

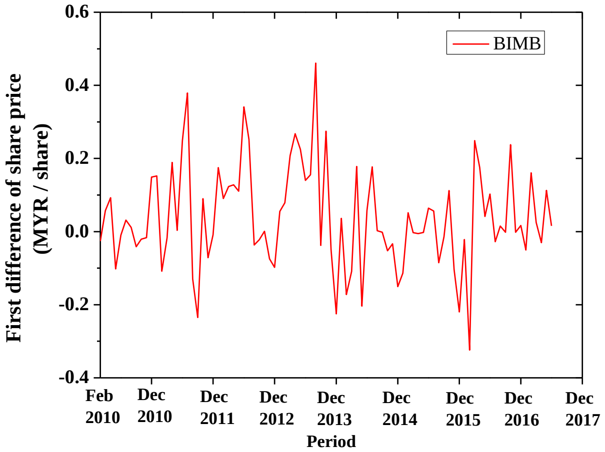


Fig. 4: First difference of share price

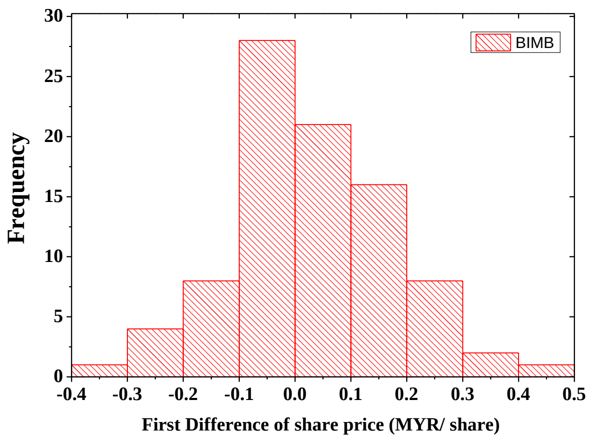


Fig. 5: Histogram for first difference of share price

Table 1: Statistical normality test

	Shapiro-Wilk		
	Statistic	df	Sig.
D_share_price	.982	89	.265

4.3 Autoregressive integrated moving average (ARIMA) model estimation

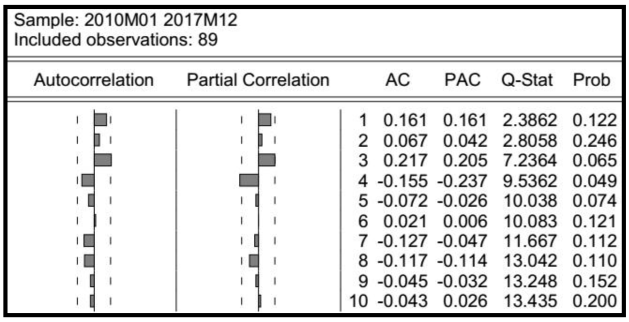
This section describes the selection of appropriate ARIMA model for modeling the data. Figure 5 shows the autocorrelation and partial correlation analysis for first difference of share price. From the analysis, there are two model of ARIMA that developed from this analysis which are ARIMA(3,1,3) and ARIMA(3,1,4).

Then, this study performed reliability test for ARIMA(3,1,3) and ARIMA(3,1,4). Table 2 shows the R-squared value and Akaike info criterion (AIC) for each of the ARIMA model. From this result, ARIMA (3,1,4) show larger value of R-squared and lower absolute value of Akaike info criterion (AIC). Residual diagnostics result is described in Fig. 6. Result shows there is no significant residual. This indicates the residuals is white noise for ARIMA(3,1,4). Therefore, ARIMA (3,1,4) is reliable data modeling for share price of BIMB.

Figure 7 shows the estimation of parameters for ARIMA (3,1,4). The equation for ARIMA (3,1,4) defined as Equation (6).

$$\Delta y_t = c + \phi_1 \Delta y_{t-1} + \phi_2 \Delta y_{t-2} + \phi_3 \Delta y_{t-3}$$
$$+ \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \theta_3 \varepsilon_{t-3} + \theta_4 \varepsilon_{t-4} + \varepsilon_t$$

$$\Delta y_t = 0.037152 + (-0.598733)\Delta y_{t-1} + (-0.710547)\Delta y_{t-2}$$
$$+ (-0.490745)\Delta y_{t-3}$$
$$+ (0.781313)\varepsilon_{t-1} + (0.888097)\varepsilon_{t-2} + (0.883007)\varepsilon_{t-3}$$
$$+ (0.079593)\varepsilon_{t-4} + 0.016326$$



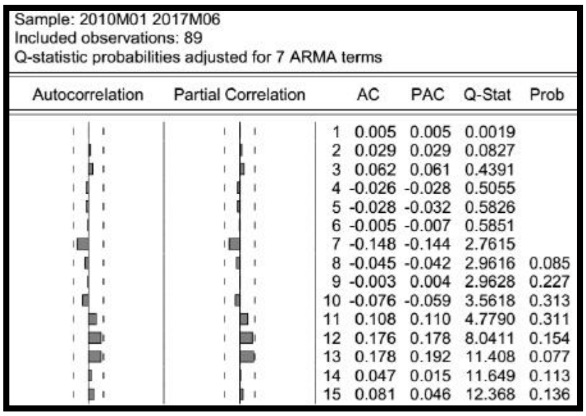
Sample: 2010M01 2017M12
Included observations: 89

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.161	0.161	2.3862	0.122
		2	0.067	0.042	2.8058	0.246
		3	0.217	0.205	7.2364	0.065
		4	-0.155	-0.237	9.5362	0.049
		5	-0.072	-0.026	10.038	0.074
		6	0.021	0.006	10.083	0.121
		7	-0.127	-0.047	11.667	0.112
		8	-0.117	-0.114	13.042	0.110
		9	-0.045	-0.032	13.248	0.152
		10	-0.043	0.026	13.435	0.200

Fig. 6: Autocorrelation and partial correlation analysis

Table 2: Statistical normality test

ARIMA (*p,d,q*)	R-squared	Akaike info criterion (AIC)
(3,1,3)	0.1503	-1.0766
(3,1,4)	0.1537	-1.0553



Sample: 2010M01 2017M06
Included observations: 89
Q-statistic probabilities adjusted for 7 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.005	0.005	0.0019	
		2	0.029	0.029	0.0827	
		3	0.062	0.061	0.4391	
		4	-0.026	-0.028	0.5055	
		5	-0.028	-0.032	0.5826	
		6	-0.005	-0.007	0.5851	
		7	-0.148	-0.144	2.7615	
		8	-0.045	-0.042	2.9616	0.085
		9	-0.003	0.004	2.9628	0.227
		10	-0.076	-0.059	3.5618	0.313
		11	0.108	0.110	4.7790	0.311
		12	0.176	0.178	8.0411	0.154
		13	0.178	0.192	11.408	0.077
		14	0.047	0.015	11.649	0.113
		15	0.081	0.046	12.368	0.136

Fig. 7: Autocorrelation and partial correlation analysis

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.037152	0.019448	1.910326	0.0597
AR(1)	-0.598733	0.541031	-1.106653	0.2718
AR(2)	-0.710547	0.143177	-4.962715	0.0000
AR(3)	-0.490745	0.381166	-1.287483	0.2016
MA(1)	0.781313	0.536539	1.456210	0.1492
MA(2)	0.888097	0.256829	3.457926	0.0009
MA(3)	0.883007	0.442127	1.997180	0.0492
MA(4)	0.079593	0.302026	0.263530	0.7928
SIGMASQ	0.016326	0.002318	7.043308	0.0000

R-squared	0.153652	Mean dependent var	0.037305
Adjusted R-squared	0.069018	S.D. dependent var	0.139673
S.E. of regression	0.134767	Akaike info criterion	-1.055355

Fig. 8: Autocorrelation and partial correlation analysis

4.4 Forecasting error diagnostics (ex-post data range)

In this section, this research using ARIMA (3,1,4) for evaluating the reliability of forecasting. The period involved in this diagnostics is starting from January 2017 until June 2017 as stated in Table 3.

Table 3 shows the error of forecasting that calculated from the differences between actual data and forecast data. The mean absolute percentage error (MAPE) is 0.85%.This value is small and it indicates ARIMA (3,1,4) is a reliable forecasting model .

Figure 8 shows the value of actual data, forecast value including forecasting range of two standard errors.

Table 3: Forecasting error diagnostics

Period	Actual data	Forecast data	Error	Error (%)
Jan. 2017	4.223	4.343	-0.120	-2.8
Feb. 2017	4.384	4.366	+0.018	+0.4
March 2017	4.409	4.411	-0.002	0.0
April 2017	4.379	4.439	-0.060	-1.4
May 2017	4.492	4.483	+0.009	+0.2
June 2017	4.507	4.518	-0.011	-0.3

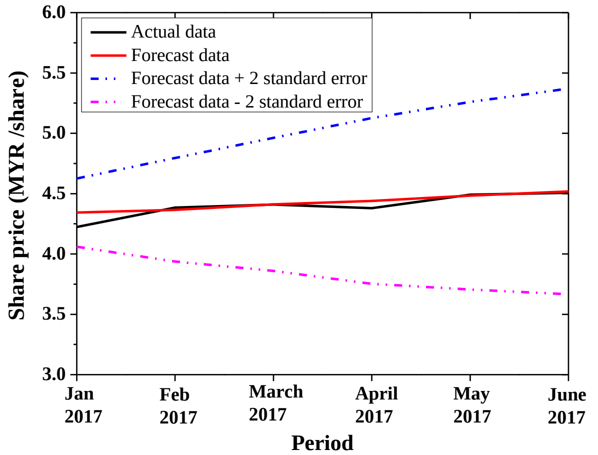

Fig. 8: Forecasting diagnostics region (ex-post data)

4.5 Forecasting error diagnostics (ex-ante data range)

This section is the main objective of this research paper. The objective is to forecast the share price performance of Islamic Bank namely Bank Islam Malaysia Berhad (BIMB).

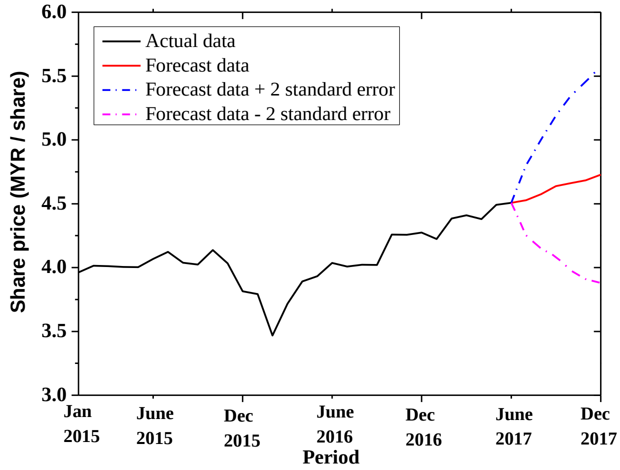

Fig. 9: Forecasting region (ex-ante data range)

Figure 9 shows the actual data value of share price including the forecast value. The range of the forecast is starting from July 2017 until December 2017 (6 months period of forecasting).The value forecast share price in July 2017 is MYR 4.523. The final value in December 2017 is MYR 4.727.

V. CONCLUSION

The objective of this study is to develop reliable forecasting model to evaluate the performance of share price for Islamic Bank in Malaysia namely Bank Islam Malaysia Berhad (BIMB). The findings from this study will help investors to select a better portfolio for their investment decision in order to gain better profits. In addition, the findings of this study also will help economists to understand the future condition of economic scenario in Malaysia. The main findings from this study are:

(i) This study involved the monthly data of share price for Bank Islam Malaysia Berhad (BIMB). The selected data is collected from January 2010 until June 2017. This analysis involved 90 observations. The maximum value of share price is MYR 4.622 in October 2013.The minimum value of share price is MYR 1.161 in February 2010.

(ii) This study performed reliability test for ARIMA(3,1,3) and ARIMA(3,1,4).From this study, ARIMA (3,1,4) show larger value of R-squared and lower absolute value of Akaike info criterion (AIC). Residual diagnostics result shows there is no significant residual. This indicates the residuals is white noise for ARIMA (3,1,4). Therefore, ARIMA

(3,1,4) is reliable data modeling for share price of BIMB.

(iii) This research using ARIMA (3,1,4) for evaluating the reliability of forecasting. This study calculated the error of forecasting from the differences between actual data and forecast data. The mean absolute percentage error (MAPE) is 0.85%.This value is relatively small and it indicates ARIMA (3,1,4) is a reliable forecasting model .

(iv) The value of forecast share price using ARIMA (3,1,4) in July 2017 is MYR 4.523. The final value in December 2017 is MYR 4.727.

The future stage of this research can be extending to find the determinants that contribute to the dynamic behavior of share price.

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