ISLAMIC BANKING AND FINANCE

IJIBFR VOL 11 NO 1 (2023) P-ISSN 2576-4136 E-ISSN 2576-4144

Available online at https://www.cribfb.com
Journal homepage: https://www.cribfb.com/journal/index.php/ijibfr
Published by CRIBFB, USA

STUDYING VOLATILITY IN SAUDI STOCK MARKET USING ARCH AND GARCH MODELS: A CASE STUDY OF AL RAJHI BANK

Yasser Saleh Ali Almonifi [(a)1] *Mohammed Murshed Ali Alkhasi* [(b)] *Abdullah Saleh Ali Sofian* [(c)]

[(a)] *Researcher, Department of Finance & Banking Sciences, Faculty of Administrative Sciences, Thamar University, Dhamar, Yemen; E-mail: almonifi1987@gmail.com*
[(b)] *Ph.D. Candidate, Faculty of Commerce and Management, Swami Ramanand Teerth Marathwada University, Nanded, India; E-mail: alkhasi2000@gmail.com*
[(c)] *Ph.D. Candidate, Faculty of Commerce and Management, Swami Ramanand Teerth Marathwada University, Nanded, India; E-mail: 777969910abdullah@gmail.com*

ARTICLE INFO

Article History:

Received: 4th January 2023
Revised: 28th February 2023
Accepted: 30th March 2023
Published: 14th April 2023

Keywords:

Al Rajhi Bank, Saudi Stock Market, Volatility, ARCH & GARCH Models

JEL Classification Codes:

E44, E58, G24, G18, H12

ABSTRACT

This study aims to empirically modeling the volatility of the daily closing share prices of Al-Rajhi Bank listed on Saudi stock exchange (Tadawul). The study approach related to quantitative method is based on the data collected through daily closing prices of Al Rajhi Bank shares for the period from 1/02/2018 to 9/23/2022. To analyze the data and test the study hypothesis, ARCH and GARCH models were applied in this paper. According to results of heteroskedasticity tests, values of R-squared, Akaike, Schwarz, and Hannan-Quinn of ARCH models, the GARCH (1, 1) model is suitable for describing the conditional variance and the estimation. The findings indicate that the positive shocks synchronizing with favorable conditions cause less severe fluctuations than the negative shocks synchronizing with unfavorable conditions. The research has some limitations that must be noted in terms of the study sample which represents only Islamic banks and therefore, the results cannot be generalized to other banks, similarly, the heterogeneity of banks in terms of the size of assets and finance capabilities. This research emphasizes the importance of developing banking performance and enhancing investment strategies to enhance the stability of bank share prices, especially during crises. Based on the results, investors may have the incentive to buy shares of Islamic banks according to stock price indices characterized by stability in the face of economic shocks. This study is considered as one of the main studies contributing to the analysis of the volatility of the daily closing share prices of Islamic Banks listed on the Saudi stock exchange (Tadawul).

INTRODUCTION

The financial markets and stock exchanges witnessed rapid growth and increased dealing in shares and securities in the local and international stock exchanges. Basically, investors prefer dealing in shares and securities with less risk, despite the relatively low returns, and avoiding high-risk investments. However, the situation is different for investors prefer dealing in shares and securities which are compatible with Islamic sharia. Stock exchanges provide instruments of investment compatible with Islamic sharia, the most important of which are the shares of Islamic banks and companies, as well as sukuk. Investors are exposed to many risks in the stock exchanges as the declining in the value of shares as a result of many factors such as the low financial position of the companies issuing the shares or the macroeconomic factors. Due to the difficulty of making investment decisions and identifying the conditions of the stock exchanges, the movement of indices and stock prices depend on the quantitative analytical models to know the fluctuations in stock exchanges and the trends of shares prices. The most important models used for studying the random movements of price and the time series are ARIMA models that help predict the future movement of prices and indices. Accurate analysis of the impact of fluctuations and

[1]*Corresponding author: ORCID ID: 0000-0002-3691-7932*

https://doi.org/10.46281/ijibfr.v11i1.1986

To cite this article: Almonifi, Y. S. A., Alkhasi, M. M. A., & Sofian, A. S. A. (2023). STUDYING VOLATILITY IN SAUDI STOCK MARKET USING ARCH AND GARCH MODELS: A CASE STUDY OF AL RAJHI BANK. *International Journal of Islamic Banking and Finance Research*, *11*(1), 9-19. https://doi.org/10.46281/ijibfr.v11i1.1986

positive or negative economic shocks on indices prices requires shifting from ARIMA models to the symmetrical and unsymmetrical of ARCH and GARCH models because they give more accurate results about the volatility of shares prices and indices.

LITERATURE REVIEW

According to Liqawqi and Sheikh (2017), in their study that aimed to model the daily closing prices of Etihad Etisalat in Saudi's telecom sector for period from 01 January 2010 to 31 December 2015, and after adopting and comparing the symmetrical and unsymmetrical ARCH models, the positive shocks associated with good news give less severe fluctuations than negative shocks associated with negative news. While Mohamed and Yadkar (2015) conducted a study on volatility of the daily closing stock prices of Iraq stock exchange index using ARCH models depending on daily data from 01 January 2005 to 29 December 2012, they concluded that the best model for conducting the study is GARCH (1, 2) model, and then predicting the index future values. Arabish, Nakkar, and Ismail (2011) examined the difference between positive and negative shocks and their impact on the returns of securities in Amman Stock Exchange using ARCH symmetrical and non-symmetrical models. The study concluded that fluctuations of shares price and indices are more sensitive to negative shocks and news but less sensitive to positive shocks and news. According to Gabo (2012) the stock prices in Amman Stock Exchange do not move randomly and sensitive to external shocks and negatively affected by the recent financial crises. Hasan (2014) studied the random movement of shares prices in Amman Stock Exchange during the period 2009-2013, the results showed that there is no normal distribution of the shares price series and the absence of random movement of shares prices. Yusof and Majid (2007) tried to explore to what extent the contingent volatility in the conventional and Islamic equity markets In Malaysia which related to the conditional volatility of monetary policy variables. The study found that interest rate fluctuations affect the conventional stock market volatility while the Islamic stock market volatility not affected, also the interest rate is not a significant variable in explaining stock market volatility in Islamic markets. Ghassan and Alhajhoj (2012) concluded that there is a positive relationship between return and risk, also the negative shocks through the lifting coefficient increase the volatility more compared to the positive shocks. While Almonifi et al. (2021) concluded that COVID-19 crisis no affected highly on Saudi Arabia's Islamic banking sector, especially Al Rajhi Bank, and the Islamic banks shares have ability to face the financial crisis more than commercial banks. As well as Rehman et al. (2021) indicated that Islamic banks in GCC countries achieved appropriate performance during the crisis of covid-19 and their shares in stock exchanges were not more affected by the crisis.

MATERIALS AND METHODS

Study data

The study sample is obtained data which represent the daily closing prices of Al Rajhi Bank shares listed on Saudi Stock Exchange and 1234 observations were recorded for period from 02 January, 2018 to 23 September, 2022. For testing and estimating the proposed research model, Eviews 12 software was adopted.

Hypothesis

The research tests the following null hypothesis**:**

H_0: The effect of positive and negative shocks on Al Rajhi Bank share index is symmetrical.

Profile of Al Rajhi Bank

Al Rajhi Bank established in 1957 and considered one of the largest banks in the world with total assets of SR 710 billion, paid-up capital of SR 40 billion (US$ 10.66 billion) and a staff more than 9,300 employees, and has a wide network of more than 515 branches, more than 4,824 ATMs, 373,046 POS machines with merchants and the largest customer in Saudi Arabia (Al Rajhi Bank website). Al-Rajhi Bank ranks 18th among the 20 largest banks in the world with a market value of $97.9 billion, and Saudi National Bank ranks 19th with a market value of $85.4 billion (Albayan, 2022).

Time Series Models

Linear Random Models (ARIMA)

Before moving to the ARCH models, ARIMA linear random time series models must be applied. By the available observations in the time series values, the prediction of values performed in future t +l. The forecasting helps in achieving the objectives and success of the commercial and production planning processes, inventory control and develop the industrial operations, and considered an essential tool for developing future plans of institutions, companies and governments (Box, et al., 2016). ARIMA model is suggested by Box and Jenkins in 1970s to predict future values. The model consists of AR, I and MA, AR model represents automatic regression, and (I) refers to cointegration that is order of single integer, while MA is moving average model. Firstly unit root test is conducted to check the series stationary at level, first difference or second difference, and the symmetric difference is as the order of single integer. ARIMA (p, d, q) model is requires differential steps. A non-stationary I (d) process that difference which is stationary by d differences (Ma et al., 2018). After the difference is combined with the automatic regression and moving average model, we obtain the non-seasonal ARIMA model: ARIMA (p, d, q) which can be written as:

$$\acute{y}_t = c + \emptyset_1 \, y'_{t-1} + \cdots + \emptyset_p \, y'_{t-p} + 0_1 \, \varepsilon_{t-1} + 0_q \, \varepsilon_{t-q} + \varepsilon_{t,} \ldots\ldots (1)$$

Where $\acute{y}_t$ is the differenced series, the parameters on right side including both lagged values of y_t and lagged errors which is ARIMA (p, d, q), where:

P = order of the autoregressive part
d = degree of first differencing involved
q = order of the moving average part

Stationary and invariability cases adopted for autoregressive and moving average models are apply to ARIMA model (Hyndman & Athanasopoulos, 2013). When time series data are stable, then it can be described by one of the Box Jenkins models as follows:

- Autoregressive (AR) Model

$$Y_t - \delta = a_1(Y_{t-1} - \delta) + a_1(Y_{t-1} - \delta) + \cdots a_p(Y_{t-p} - \delta) + \mu_t \quad \text{.......... (2)}$$

Therefor the equation form is: AR (p)

- Moving Average (AM) Model

$$Y_t = a_1 + \beta_0\, \mu_t + \beta_1\, \mu_{t-1} + \beta_2\, \mu_{t-2} + \cdots + \beta_q\, \mu_{t-q} \quad \text{.................... (3)}$$

The equation is: MA (q)

- Autoregressive and Moving Average (ARMA) Model

$$Y_t = \theta + a_1 + Y_{t-1} + \beta_0\, \mu_t + \beta_1\, \mu_{t-1} \quad \text{.. (4)}$$

Then, the equation model is: ARMA (p,q)

- Autoregressive Integrated Moving Average (ARIMA) Model

$$\acute{y}_t = c + \emptyset_1\, y'_{t-1} + \cdots + \emptyset_p\, y'_{t-p} + 0_1\, \varepsilon_{t-1} + 0_q\, \varepsilon_{t-q} + \varepsilon_{t,} \quad \text{.................. (5)}$$

The final form of the equation is: ARIMA (p, d, q)

Nonlinear Random Time Series Models

There are several types of nonlinear random time series including the following:

ARCH Symmetrical Models

ARCH Model

Engel (1982) proposed a non-linear model that expresses autoregressive conditional heteroskedasticity called ARCH model to estimate time series that contain heteroskedasticity. This model helps to explain the continuous fluctuations of time series values (Khalaf, 2015). The conditional variance equation of ARCH model generally is represented as follows:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i\, \varepsilon_{t-i}^2 \quad \text{.......... (6)}$$

GARCH Model

According to Engel (1995), this model has estimation with lower parameters and loses less degree of freedom. By GARCH model, the value of the variance is a function of the same lag variance for a period of time added to the square of the lag residuals for one time period. The general formula of GARCH model is as follows:

$$y_t = \alpha + \beta X_t\, \mu_t \quad \text{.......................... (7)}$$

$$\sigma_t^2 = y_0 + y_1\, \sigma_{t-1}^2 + y_2\, \mu_{t-1}^2 \quad \text{.............. (8)}$$

ARCH Asymmetrical Models

GARCH-M Model

GARCH-M model depends on adding the conditional variance to the average equation based on the fact that there is a direct relationship between return and risk and the risks and volatility can be measured by this model (Khalaf, 2015), it takes the following formula:

$$y_t = \alpha + \beta X_t + \theta \sigma_t^2 + \mu_t \quad \text{................. (9)}$$

As well as this model used to measure the risk by the standard deviation a follow:

$$y_t = \alpha + \beta X_t + \theta \sqrt{\sigma 2t} + \mu_t \quad \text{.............. (10)}$$

TGARCH Model

The main limitation faced by ARCH and GARCH models is that they are symmetrical models which take the absolute values and ignore the negative and positive sign which means that positive and negative shocks have the same effect in financial markets. Therefore, Glisten, Jaganathan, and Runkle (1993) suggested TGARCH model which addresses this problem by adding a dummy variable (Khalaf, 2015). This model is expressed in the following formula:

$$\mathrm{\sigma}_\mathrm{t}^2 = \mathrm{y}_0 + \mathrm{y}_1\, \mathrm{\sigma}_{\mathrm{t}-1}^2 + \mathrm{y}_2\, \mathrm{\mu}_{\mathrm{t}-1}^2 \mathrm{d}_{\mathrm{t}-1}\, \mathrm{y}_3\, \mathrm{\mu}_{\mathrm{t}-1}^2 \quad \text{........... (11)}$$

EGARCH Model

This model was proposed by Nelson (1991); the model includes the conditional variance which depends on the sign and range of the representations which precedes the error limits because the dependent variable is the logarithm of conditional variance (Laqawqi & Sheikh, 2017). This model is represented in the formula given below:

$$\log(\sigma_t^2) = \omega + \sum_{j=1}^{q} B_J \log(\sigma_{t-j}^2) + \sum_{j=1}^{p} \alpha_1 \left|\frac{\varepsilon_{t-i}}{\sigma_{t-1}}\right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \ldots\ldots\ldots\ldots (12)$$

RESULTS AND DISCUSSIONS

Identification and Stationary 'Test

The (p. d. q) ranks of ARIMA model are specified by autocorrelation function, partial autocorrelation function and correlogram.

Figure 1. Daily Close Indicator of Al Rajhi Bank Share 1/02/2018 to 9/23/2022

Table 1. Result of Unit Root Tests

Variables	Augmented Dickey-Fuller		Phillips-Perron	
	Level I(0)	Difference I(1)	Level I(0)	Difference I(1)
SP	-1.142680 (0.9201)	-33.24834 (0.0000)	-1.382955 (0.8657)	-33.47211 (0.0000)

Source: Prepared by the researcher based on Eviews 12

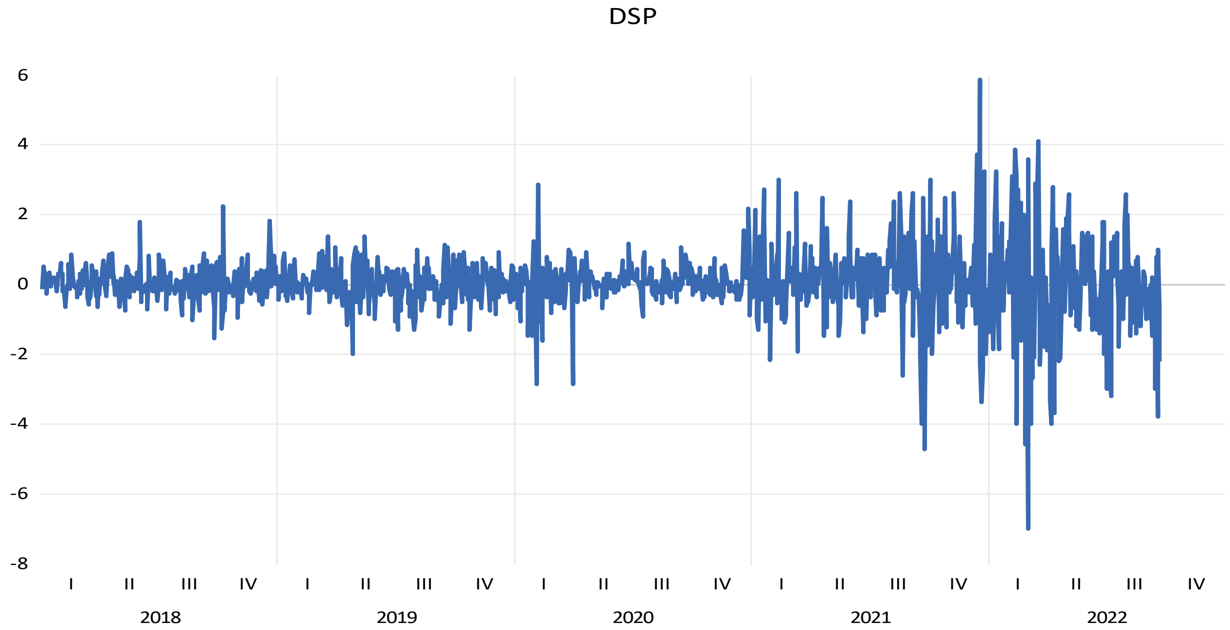

Figure 2. Daily Close Indicator of Al Rajhi Bank Share (DSP)

Table 1 shows the result of Augmented Dickey-Fuller and Phillips-Perron tests where the series becomes stationary at the first difference with p-value of 0.0000 and 0.0000 respectively, for that the model is SP ~ I (1). The autocorrelation and partial correlation pattern falls outside the confidence interval over 7 time gap which indicates series of SP is non-stationary, therefore the series tested at the first difference same the level at which the series is stationary as in table 1. Thus, the original series is an integral of order (d=1). When the first difference is taken, the series stationary obtained and the autocorrelation lay within confidence interval except 1,5,12,13,17,26 and 30 intervals as shown in Figure 2.

Date: 12/19/22 Time: 09:48
Sample (adjusted): 1/02/2018 9/23/2022
Included observations: 1234 after adjustments

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.051	0.051	3.2232	0.073
		2	0.024	0.021	3.9229	0.141
		3	0.035	0.033	5.4257	0.143
		4	0.032	0.029	6.7232	0.151
		5	0.061	0.056	11.283	0.046
		6	0.007	-0.001	11.337	0.078
		7	-0.012	-0.017	11.524	0.117
		8	-0.003	-0.007	11.539	0.173
		9	-0.025	-0.028	12.303	0.197
		10	-0.028	-0.029	13.309	0.207
		11	-0.009	-0.005	13.412	0.267
		12	0.037	0.043	15.098	0.236
		13	-0.043	-0.043	17.454	0.179
		14	-0.033	-0.026	18.836	0.171
		15	0.029	0.035	19.889	0.176
		16	-0.009	-0.010	19.985	0.221
		17	-0.064	-0.067	25.047	0.094
		18	0.002	0.013	25.054	0.123
		19	0.018	0.023	25.439	0.147
		20	-0.001	-0.005	25.439	0.185
		21	0.030	0.034	26.552	0.186
		22	0.028	0.034	27.572	0.190
		23	-0.022	-0.032	28.171	0.209
		24	-0.037	-0.047	29.936	0.187
		25	0.033	0.041	31.305	0.179
		26	0.088	0.083	41.116	0.030
		27	0.003	-0.017	41.127	0.040
		28	-0.040	-0.038	43.151	0.034
		29	0.010	0.023	43.269	0.043
		30	-0.057	-0.074	47.325	0.023
		31	0.001	-0.007	47.327	0.030
		32	-0.012	0.004	47.507	0.038
		33	0.002	0.008	47.510	0.049
		34	0.016	0.009	47.848	0.058
		35	-0.019	-0.000	48.328	0.066
		36	-0.022	-0.010	48.919	0.074

Figure 3. Autocorrelation and Partial Autocorrelation Function Graphs of SP Series.

Estimating Appropriate Model

The values of the partial correlation coefficient observed in figure 3 show the coefficient are located outside the confidence interval, for that the autoregressive model (MA) is tried using the ranks (1,5,12,13,17,26,30) included in MA(1), MA(5), MA(12), MA(13), MA(17), MA(26), MA(30), therefore the function formula is as follows:

$$Y_t = a_0 + \beta_1 Y_{t-1} + \beta_5 Y_{t-5} + \beta_{12} Y_{t-12} + \beta_{13} Y_{t-13} + \beta_{17} Y_{t-17} + \beta_{26} Y_{t-26} + \beta_{30} Y_{t-30} \text{ …. (13)}$$

In the case of moving average model AR (1), AR (5), AR (12), AR (13), AR (17), AR (26), AR (30), the formula is as given below:

$$Y_t = a_0 + \beta_1\mu_{t-1} + \beta_5\mu_{t-5} + \beta_{12}\mu_{t-12} + \beta_{13}\mu_{t-13} + \beta_{17}\mu_{t-17} + \beta_{26}\mu_{t-26} + \beta_{30}\mu_{t-30} \text{ ……. (14)}$$

The current study is estimating according to ARMA (p,q) model, The formula includes autoregressive AR and moving averages MA as follows:

AR (1,5,12,13,17,26,30) MA (1,5,12,13,17,26,30)

Table 2. Estimation of ARIMA Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.036920	0.028491	1.295867	**0.1953**
AR(1)	0.051240	0.014469	3.541408	**0.0004**
SIGMASQ	0.884443	0.016299	54.26234	**0.0000**
R-squared	0.002618	Mean dependent var		**0.037026**
Adjusted R-squared	0.000997	S.D. dependent var		**0.942063**
S.E. of regression	0.941593	Akaike info criterion		**2.719944**
Sum squared resid	1091.402	Schwarz criterion		**2.732386**
Log likelihood	-1675.205	Hannan-Quinn criter.		**2.724624**
F-statistic	1.615409	Durbin-Watson stat		**1.997642**
Prob(F-statistic)	0.199230	-		-
Inverted MA Roots	**.05**	-		-

Source: Prepared by the researcher based on Eviews 12

The appropriate model of SP sequence is AR (1) and equation of the model as given below:

D (SP) = 0.0369202880049 + 0.0512398147285 SPt-1

Therefore the value of the variance of the estimated corresponding error term of 0.941593

Dynastic Checking of Model

For checking and confirming that results obtained in table 2 are appropriated, the residuals of the same estimated model must be test and according to some of the coefficients of autocorrelation and partial correlation are obtained in figures 4 which lie out the limits of trust, the estimated ARMA model is not appropriate for describing the future data and conducting the forecasting, so ARCH model must be applied for estimating.

Date: 12/19/22 Time: 10:03
Sample (adjusted): 1/02/2018 9/23/2022
Q-statistic probabilities adjusted for 1 ARMA term

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.001	-0.001	0.0014	
		2	0.020	0.020	0.4755	0.490
		3	0.032	0.032	1.7447	0.418
		4	0.028	0.028	2.7184	0.437
		5	0.059	0.058	7.0151	0.135
		6	0.004	0.003	7.0397	0.218
		7	-0.012	-0.016	7.2333	0.300
		8	-0.002	-0.006	7.2361	0.405
		9	-0.023	-0.026	7.9119	0.442
		10	-0.027	-0.030	8.7972	0.456
		11	-0.010	-0.008	8.9115	0.541
		12	0.040	0.044	10.884	0.453
		13	-0.044	-0.040	13.283	0.349
		14	-0.033	-0.030	14.616	0.332
		15	0.031	0.034	15.845	0.323
		16	-0.007	-0.005	15.905	0.388
		17	-0.064	-0.067	20.965	0.180
		18	0.005	0.008	20.991	0.227
		19	0.017	0.023	21.374	0.261
		20	-0.003	-0.005	21.386	0.316
		21	0.028	0.032	22.407	0.319
		22	0.028	0.037	23.417	0.322
		23	-0.021	-0.027	23.996	0.347
		24	-0.038	-0.050	25.833	0.309
		25	0.030	0.034	27.001	0.304
		26	0.087	0.086	36.497	0.064
		27	0.001	-0.011	36.498	0.083
		28	-0.041	-0.040	38.617	0.069
		29	0.015	0.025	38.890	0.083
		30	-0.057	-0.072	43.060	0.045
		31	0.005	-0.010	43.089	0.058
		32	-0.012	0.003	43.277	0.070
		33	0.002	0.008	43.280	0.088
		34	0.017	0.010	43.661	0.102
		35	-0.019	0.001	44.136	0.114
		36	-0.017	-0.006	44.518	0.130

Figure 4. Autocorrelation and Partial Autocorrelation Function Graphs of the Residual Series

Figure 5 shows the actual values and data are given by red line and green line refer to the fitted the upper fitted values, while the blue line represents the residuals of model.

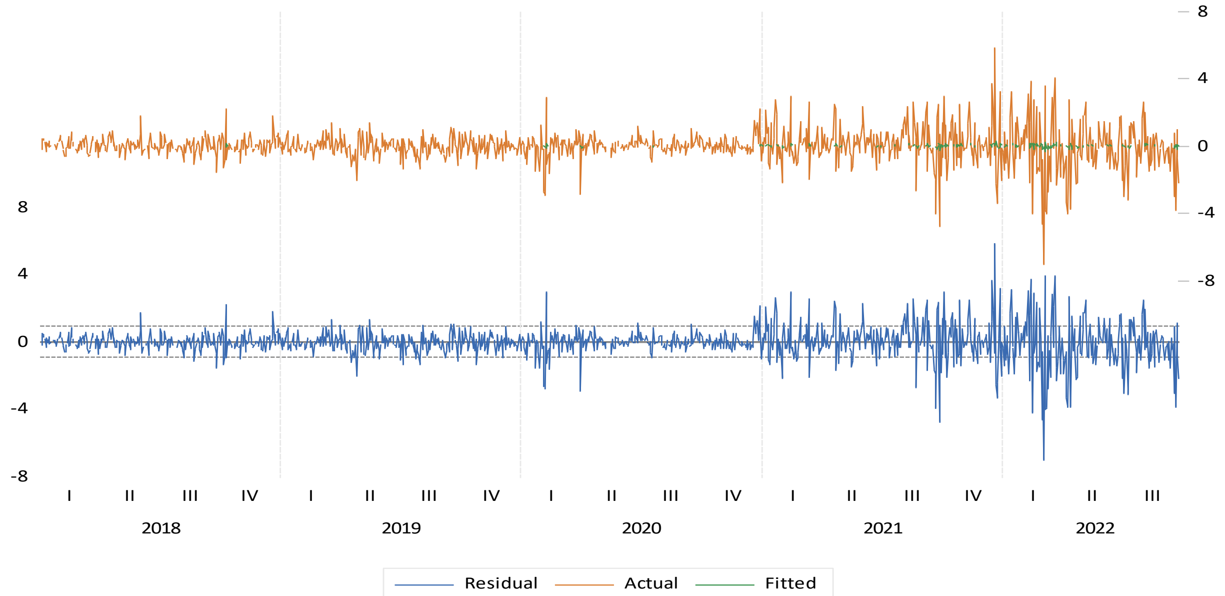

Figure 5. Actual Series, Fitted Series and Residual Series of SP Sequence

Estimating by ARCH Models

The estimation using ARCH and GARCH models are the basic methods for estimating time series data for financial variables.

ARCH Effect Test

The first step is to test ARCH effect to specify if the model includes ARCH effect or not as shown in table 3.

Table 3. Heteroskedasticity Test: ARCH

F-statistic	**99.61813**	**Prob. F(1,1231)**	**0.0000**
Obs*R-squared	**92.30985**	**Prob. Chi-Square(1)**	**0.0000**

Source: Prepared by the researcher based on Eviews 12

The results in table 3 show that model has ARCH effect according to Lagrange multiplier (T* R2) which amounted to 92.30985 with P- value less than 0.5. Therefore, the null hypothesis that a state that the homogeneity of variance is constant is rejected while the alternative hypothesis is accepted which means that model includes the heteroskedasticity and it is appropriate for estimating by ARCH method.

Estimating ARCH Model

Table 4. Estimating ARCH Model (ML ARCH)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.189150	0.054874	-3.446976	**0.0006**
SP(-1)	1.005773	0.000707	1422.773	**0.0000**
Variance Equation				
C	0.418389	0.011750	35.60838	**0.0000**
RESID(-1)^2	0.815609	0.050078	16.28678	**0.0000**
R-squared	0.998265	Mean dependent var		**54.40814**
Adjusted R-squared	0.998263	S.D. dependent var		**23.02890**
S.E. of regression	0.959658	Akaike info criterion		**2.514151**
Sum squared resid	1134.601	Schwarz criterion		**2.530741**
Log likelihood	-1547.231	Hannan-Quinn criter.		**2.520392**
Durbin-Watson stat	**1.836551**	-		-

Source: Prepared by the researcher based on Eviews 12

The results in table 4 show that RESID (-1) ^2 is 0.815609 with positive and statistically significant p-value is 0.0000 less than 0.05, but the residuals are not within the limits of confidence. So we can run the estimation by GARCH model.

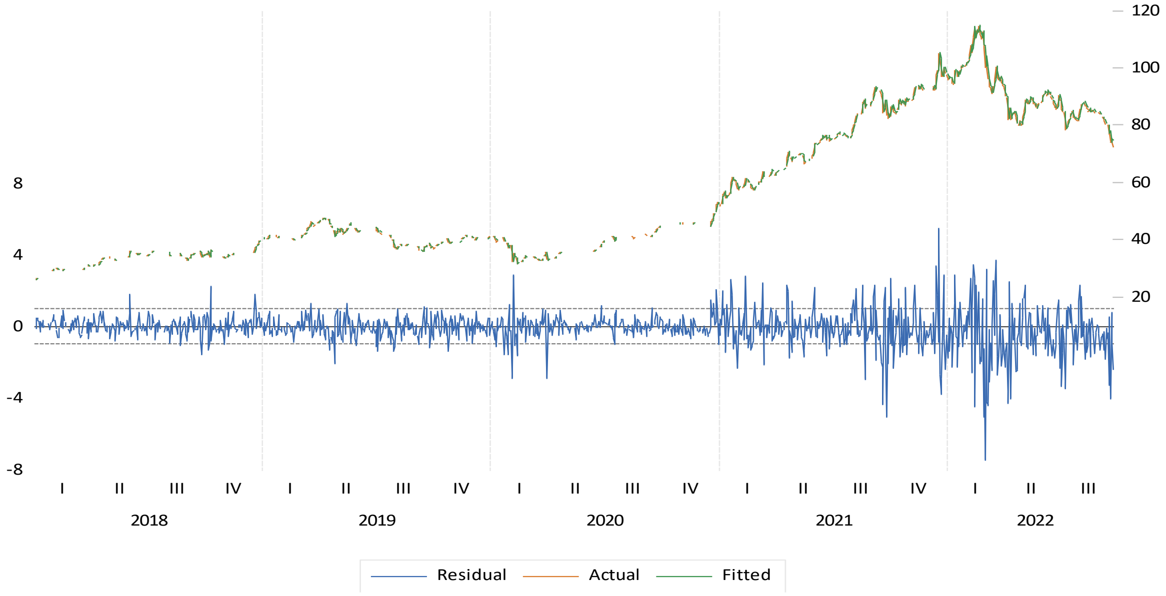

Figure 6. Residual Series of ARCH Model

Estimating GARCH Model

Table 5. Estimating GARCH Model (ML ARCH)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.026827	0.048365	0.554690	**0.5791**
SP(-1)	1.000352	0.001052	950.8649	**0.0000**
Variance Equation				
C	0.012273	0.002236	5.488349	**0.0000**
RESID(-1)^2	0.168856	0.016421	10.28318	**0.0000**
GARCH(-1)	0.830363	0.014449	57.46952	**0.0000**

R-squared	0.998325	Mean dependent var	**54.40814**
Adjusted R-squared	0.998324	S.D. dependent var	**23.02890**
S.E. of regression	0.942760	Akaike info criterion	**2.114376**
Sum squared resid	1094.997	Schwarz criterion	**2.135114**
Log likelihood	-1299.570	Hannan-Quinn criter.	**2.122177**
Durbin-Watson stat	**1.892710**	-	-

Source: Prepared by the researcher based on Eviews 12

The results in table 5 show that RESID (-1) ^2 of 0.168856 and GARCH (-1) of 0.830363 are statistically significant positive with p-value 0.0000 less than 0.05. But also the residuals are not within the limits of confidence. So the moving to run the estimation by GARCH-M model is required.

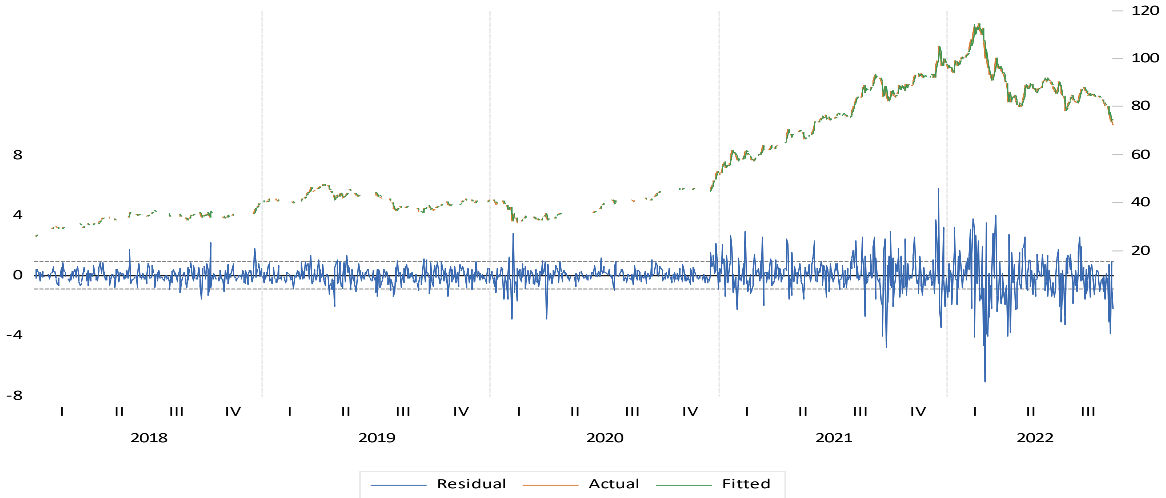

Figure 7. Residual Series of GARCH Model

Estimating GARCH-M Model

Table 6. Estimating GARCH-M Model (ML ARCH)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	0.014768	0.091454	0.161480	**0.8717**
C	0.025973	0.050386	0.515473	**0.6062**
SP(-1)	1.000176	0.001279	782.0402	**0.0000**
Variance Equation				
C	0.012406	0.002308	5.374431	**0.0000**
RESID(-1)^2	0.170527	0.016860	10.11437	**0.0000**
GARCH(-1)	0.828827	0.014860	55.77635	**0.0000**
R-squared	0.998323	Mean dependent var		**54.40814**
Adjusted R-squared	0.998321	S.D. dependent var		**23.02890**
S.E. of regression	0.943757	Akaike info criterion		**2.115978**
Sum squared resid	1096.423	Schwarz criterion		**2.140863**
Log likelihood	-1299.558	Hannan-Quinn criter.		**2.125339**
Durbin-Watson stat	**1.889554**	-		-

Source: Prepared by the researcher based on Eviews 12

The results in table 6 show that @SQRT (GARCH) is 0.014768 is not statistically significant with p-value 0.8717 more than 0.05 which means that the risks affect returns average. Also the residuals are not within the limits of confidence exactly. So we can run the estimation by TGARCH model.

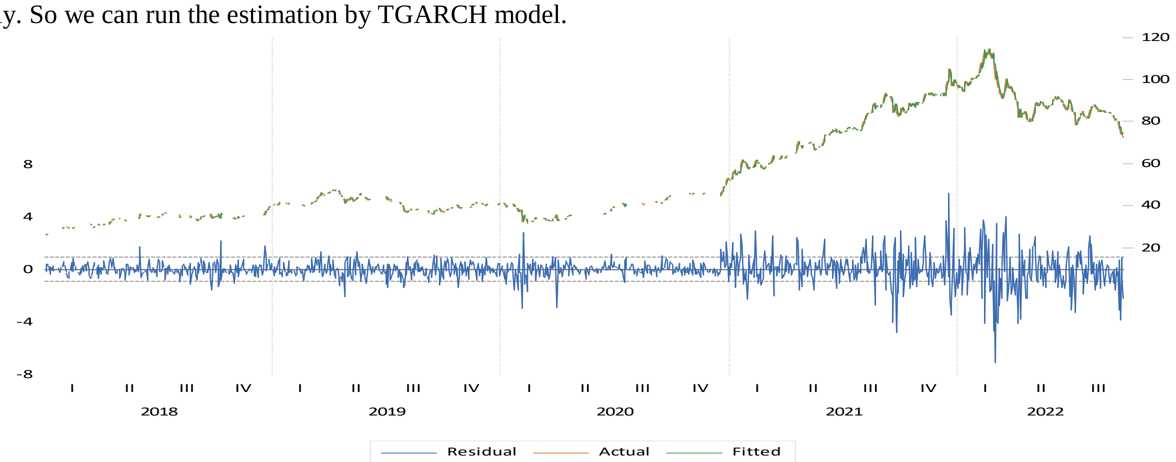

Figure 8. Residual Series of GARCH-M Model

Estimating Threshold TGARCH Model

Table 7. Estimating TGARCH Model (ML ARCH)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.031030	0.048366	0.641580	**0.5211**
SP(-1)	1.000287	0.001069	936.0949	**0.0000**
Variance Equation				
C	0.012474	0.002254	5.534054	**0.0000**
RESID(-1)^2	0.175878	0.020058	8.768451	**0.0000**
RESID(-1)^2*(RESID(-1)<0)	-0.012485	0.021335	-0.585180	**0.5584**
GARCH(-1)	0.829120	0.014632	56.66485	**0.0000**
R-squared	0.998326	Mean dependent var		**54.40814**
Adjusted R-squared	0.998324	S.D. dependent var		**23.02890**
S.E. of regression	0.942711	Akaike info criterion		**2.115862**
Sum squared resid	1094.884	Schwarz criterion		**2.140747**
Log likelihood	-1299.487	Hannan-Quinn criter.		**2.125223**
Durbin-Watson stat	**1.892783**	-		-

Source: Prepared by the researcher based on Eviews 12

The results in table 7 show that RESID (-1) ^2*(RESID (-1) <0) of -0.012485 is not statistically significant with p-value p-value of 0.5584 is more than 0.05 which means that the series is symmetric and no difference between the positive shocks and negative shocks, and EGARCH model must be applied to run the estimation.

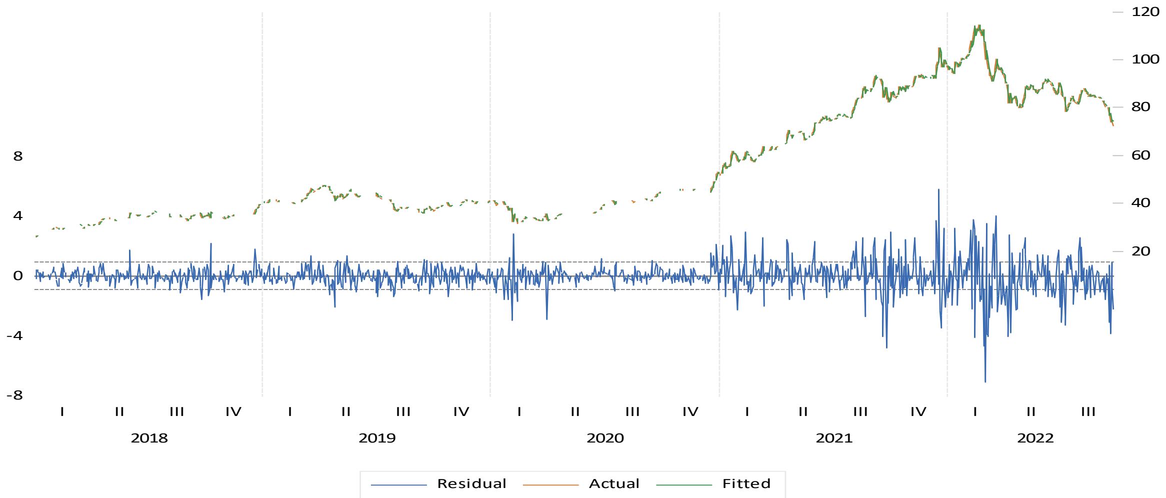

Figure 9. Residual Series of TGARCH Model

Estimating Exponential GARCH (EGARCH) Model

Table 8. Estimating Exponential EGARCH Model (ML ARCH)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.003365	0.045181	0.074483	**0.9406**
SP(-1)	1.001084	0.001011	989.9745	**0.0000**
Variance Equation				
C(3)	-0.255023	0.019429	-13.12589	**0.0000**
C(4)	0.326519	0.023935	13.64213	**0.0000**
C(5)	-0.001145	0.012043	-0.095039	**0.9243**
C(6)	0.972401	0.005138	189.2655	**0.0000**
R-squared	0.998322	Mean dependent var		**54.40814**
Adjusted R-squared	0.998320	S.D. dependent var		**23.02890**
S.E. of regression	0.943844	Akaike info criterion		**2.119591**
Sum squared resid	1097.516	Schwarz criterion		**2.144476**
Log likelihood	-1301.787	Hannan-Quinn criter.		**2.128952**
Durbin-Watson stat	**1.889744**	-		-

Source: Prepared by the researcher based on Eviews 12

The results in table 8 show that C(5) of -0.001145 is not statistically significant with p-value 0.9243 is more than 0.05 which means that the series is symmetric and no difference between the positive shocks and negative shocks and the negative shocks no affect share prices strongly.

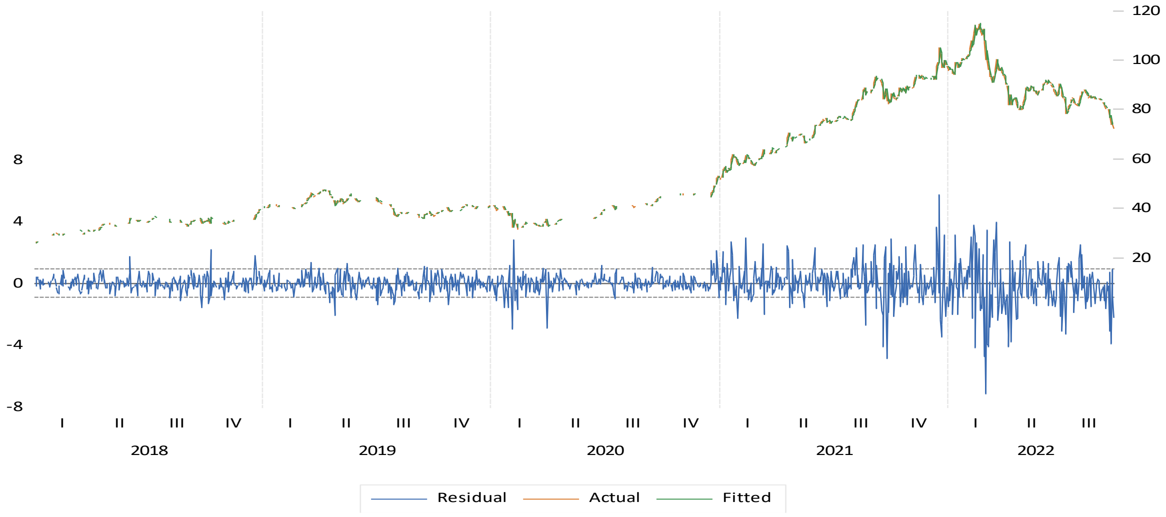

Figure 10. Residual Series of EGARCH Model

Selecting the Appropriate Model and Testing the Hypothesis

The values in table 9 shown that GARCH (1, 1) model is the appropriated model according to the lower values of Akaike, Schwarz and Hannan-Quinn which amounted 2.114376, 2.135114 and 2.122177 respectively, also the value of R-squared is 0.998323 closes to 1. As well as the p-value of heteroskedasticity tests of GARCH (1, 1) model is 0.6573 as shown in table 10 because the time series becomes homogeneous which means that the study's hypothesis rejected.

Table 9. Comparison of Models

Model	GARCH (1,1)	GARCH-M(1,1)	TARCH (1,1)	EARCH (1,1)
R-squared	0.998323	0.998323	0.998326	0.998322
Akaike	2.114376	2.115978	2.115862	2.119591
Schwarz	2.135114	2.140863	2.140747	2.144476
Hannan-Quinn	2.122177	2.125339	2.125223	2.128952

Source: Prepared by the researcher based on Eviews 12

Table 10. Heteroskedasticity Tests of ARCH Models

Model	F-statistic	Obs*R-squared	Prob. F(1,1231)	Prob. Chi-Square(1)
GARCH (1,1)	0.196512	0.196800	0.6576	0.6573
GARCH-M(1,1)	0.177657	0.177920	0.6735	0.6732
TARCH (1,1)	0.158968	0.159206	0.6902	0.6899
EARCH (1,1)	0.572707	0.573370	0.4493	0.4489

Source: Prepared by the researcher based on Eviews 12

CONCLUSIONS

Through this econometrics study, the daily closing share prices of Al-Rajhi Bank listed on Saudi stock exchange (Tadawul) within the banking and financial sector are modeled. Initially, the results obtained confirm that AR(1) model is considered the fitted model for representing the time series of share prices, but ARCH effect test of residuals refer that there is ARCH effect in the model's residual series, therefore, ARCH models were applied for the modeling. The results of heteroskedasticity tests, values of R-squared, Akaike, Schwarz and Hannan-Quinnshowed of ARCH models shown that GARCH (1, 1) model is appropriate for describing the conditional variance of the closing prices of Al-Rajhi Bank shares. The study concluded that the positive shocks synchronizing with favorable conditions cause less severe fluctuations than the negative shocks synchronizing with unfavorable conditions. Therefore, the bank's share prices were not affected by the negative shocks of covid-19 crisis which is included in the time series of study 1/02/2018 to 9/23/2022.

Author Contributions: Conceptualization, Y.S.A.A.; Methodology, Y.S.A.A.; Software, Y.S.A.A.; Validation, Y.S.A.A.; Formal Analysis, Y.S.A.A.; Investigation, Y.S.A.A.; Resources, Y.S.A.A.; Data Curation, M.M.A.A. and A.S.A.S.; Writing – Original Draft Preparation, Y.S.A.A.; Writing – Review & Editing, Y.S.A.A.; Visualization, Y.S.A.A.; Supervision, Y.S.A.A.; Project Administration, M.M.A.A. and A.S.A.S.; Funding Acquisition, Not applicable. Authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement: Ethical review and approval were waived for this study, due to that the research does not deal with vulnerable groups or sensitive issues.

Funding: The authors received no direct funding for this research.

Acknowledgments: I am incredibly thankful to Dr. Shakeel-Ul-Rehman, for valuable guidance for this article.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to restrictions.

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

Almonifi, Y.S.A., Rehman, S.U., & Gulzar, R. (2021). *The Covid-19 Pandemic Effect on the Performance of the Islamic Banking Sector in KAS: An Empirical Study of Al Rajhi Bank*. *International Journal of Management (IJM), 12*(4), 533-547. https://doi.org/10.34218/IJM.12.4.2021.045.

Albayan (24 August, 2022). *6 Saudi Banks in the List of the 100 Largest Banks in the World*. Retrieved December 21, 2022, from https://www.albayan.ae/economy/arab/2022-08-24-1.4500362

Arabish, S., Nakkar, O., & Ismail, R.S. (2011). *Applying ARCH Symmetrical and Non-Symmetrical Models for Modeling Returns Volatility in the Financial Market: A Case Study on the General Index of Amman Financial Market*. *Tishreen University Journal for Research and Scientific Studies -Economic and Legal Sciences Series, 33*(3), 59-79. Retrieved from http://journal.tishreen.edu.sy/index.php/econlaw/article/viewFile/7753/7493

Box, G.E.P., Jenkins, G.M., Reinsel, G.C. & Ljung, G.M. (2016). *Time Series Analysis Forecasting and Control (Fifth Edition).* Wiley & Sons, New Jersey, USA. Retrieved from http://www.wiley.com/go/permission

Engel, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica: Journal of the econometric society*, 987-1007. https://doi.org/10.2307/1912773

Engel, R. (1995). Photoproduction within the two-component Dual Parton Model: amplitudes and cross sections. *Zeitschrift für Physik C Particles and Fields*, *66*, 203-214. https://doi.org/10.1007/BF01496594

Ghassan, H. B., & Alhajhoj, H.R. (2012). *Effect of Capital Market Liberalization on Volatility of TASI*. Munich Personal repec Archive. Retrieved from https://mpra.ub.uni-muenchen.de/80623/

Gabo, S. (2012). *Analysis of The Movement of Share Prices In Stock Exchange: A Case Study Of Shares Traded In Amman Stock Exchange For The Period 2001-2010(Master Thesis)*. University of Kasdi Merbah Ouargla, Algeria. Retrieved from https://www.theses-algerie.com/3167293282246756/memoire-de-master/universite-

Glosten, L. R., Jagannathan, R., & Runkle, D. E. (1993). On the relation between the expected value and the volatility of the nominal excess return on stocks. *The journal of finance*, *48*(5), 1779-1801. https://doi.org/10.1111/j.1540-6261.1993.tb05128.x

Hyndman, R.J. & Athanasopoulos, G. (2013). *Forecasting: Principles And Practice (Second Edition).* Monash University, Australia. https://otexts.com/fpp2/

Hasan, A. (2014). *Analyzing Random Walk of Stock Prices In The Light of Stock Market Efficiency: Applied Studying In Amman Stock Market (Master Thesis).* Damascus University, Syria. Retrieved from http://mohe.gov.sy/master/Message/Mc/ali%20hasan.pdf

Khalaf, A. (2015). *Econometrics Applications Using Eviews Software*. Doctor's House for Administrative and Economic Sciences, Baghdad. ISBN: 978-9922-20-183-2. Retrieved from https://www.researchgate.net/publication/339933196_ttbyqat_alaqtsad_alqyasy

Laqawqi, F., & Sheikh, M. (2017). *Modeling Saudi Stock Market Volatility Using ARCH Models: Case Study of Etihad Etisalat Saudi Arabia*. Munich Personal RePEc Archive. Retrieved from https://mpra.ub.uni-muenchen.de/84263/

Mohamed, F. A., & Yadkar, A. S. (2015). *Using ARCH, GARCH Models In Prediction At Daily Closing Price For Iraqi Stock Exchange Index*. *Kirkuk University Journal of Administrative and Economic Sciences*, *5*(2), 237-266. Retrieved from https://www.iasj.net/iasj/download/888e025aa0081c2a

Ma, L., Hu, C., Lin, R., & Han, Y. (2018). *ARIMA Model Forecast Based on Eviews Software*. IOP Publishing. https://doi.org/10.1088/1755-1315/208/1/012017

Nelson, D. B. (1991). Conditional heteroskedasticity in asset returns: A new approach. *Econometrica: Journal of the econometric society*, 347-370. https://doi.org/10.2307/2938260

Rehman, S., Almonifi, Y.S.A., & Gulzar, R. (2021). *Impact of the Covid-19 Pandemic on Islamic Bank Indices of the GCC Countries*. *International Journal of Islamic Banking and Finance Research, 7*(1), 1-17. https://doi.org/10.46281/ijibfr.v7i1.1381

Yusof, R.M., & Majid, S.A. (2007). *Stock Market Volatility Transmission in Malaysia: Islamic Versus Conventional Stock Market*. Journal of King Abdulaziz University: *Islamic Economics, 20*(2), 17-35. Retrieved from https://www.researchgate.net/publication/285481772