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The GARCH Model Volatility of Sharia Stocks Associated Causality with Market Index

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Abstract

The purpose of this paper is to examine the volatility of Islamic stocks related to the causality of the composite stock price index (CSPI). The aim is to investigate the causality of several levels of stock returns with the movement of the CSPI, and determine its volatility as a measure of risk. To determine the causality relationship is done by using the granger causality test method, with Vector Autoregressive (VAR) modeling. Whereas to determine the volatility is done using the Generalized Autoregressive Conditional Heteroscedastisiy (GARCH) model approach. The results of the causality test show that there is a direct relationship that affects and is influenced by the CSPI, and the relationship that affects each other between the company's stock market and the movement of the CSPI. While the volatility follows the GARCH model (1, 1). Based on the results of this study are expected to be used as consideration in making investment decisions in the analyzed stocks.

Keywords: Stock Returns, Vrenger Causality, VAR Models, GARCH Models

1. Introduction

The capital market in Indonesia began to develop into an Islamic capital market since July 3, 1997, PT. Denareksa Investment Management launches Sharia Mutual Funds. Indonesia Stock Exchange in cooperation with PT. Denareksa Investment Management launched the Jakarta Islamic Index (JII) on July 3, 2000. The Islamic capital market aims to guide investors who want to invest their funds in a sharia manner. Of course, shares traded on the Islamic capital market are shares that do not conflict with Islamic regulations (Aziz and Kurniawan, 2007).

In investment theory, each share will produce a return and risk (kalfin et al, 2019). Return is the result obtained from the investment or the level of profit enjoyed by the investor, for an investment

made (Kalfin et al, 2019). The formation of stock prices occurs because of the demand and supply for these shares. In other words, the price is formed by the supply and demand of these stocks. The supply and demand occurs because of many factors, both specific to shares and macro factors such as interest rates, inflation, exchange rates and non-economic factors such as social and political conditions, and other factors (Aziz and Kurniawan, 2007).

Stocks are securities that have a high level of risk. Risk or loss cannot be eliminated in investing, and this risk can be seen from the high and low levels of fluctuations (volatility) of stock prices. Therefore, to find out the level of risk it is necessary to know the relationship of what factors influence it, and how much influence. Macro variables such as interest rates and exchange rates always affect systematic risk on every investment, especially investments in each stock, both ordinary shares and sharia shares (Chapakia and Sanrego, 2007; Constantinou et al, 2004).

Based on the description above, this research will analyze the level of stock price volatility that has a causal relationship between the price index of sharia stock prices with the Generalized Autoregressive Conditional Heteroscedastic (GARCH) model approach.

2. Methodology

The analytical method in this paper is outlined in the following stages:

Data transformation. For example X_t the closing value of the Composite Stock Price Index at time t where $t = 1,2,\ldots,T$ with T the amount of data observations. For example, also X_t closing return of JCI country *i* at time *t*, the return value can be calculated by equation (Tsay, 2005):

$$X_t = In\left(\frac{X_t}{X_{t-1}}\right) \quad (1)$$

Stationary Test Data. The time series data stationary testing for the sharia stock return variables of several large companies and the Composite Stock Price Index return used in this study uses the Augmented Dickey Fuller test (ADF) with the help of Eviews 8. The hypothesis used is $H_0: ADF_{test} >$ MacKinnon Critical Value (there is a unit root), and $H_1: ADF_{test} <$ MacKinnon Critical Value (no root unit). Where the test criteria are starting H_0 if the *t-statistic* value of the ADF test is smaller than the *p-value* at each percentage level (Deng, 2004; Tsay, 2005).

Granger causality test. After the data is declared stationary, a granger causality test is performed to see the causal relationship between the movement of the Composite Stock Price Index and several sharia stock prices of large companies in Indonesia using Eviews 8 software. The hypothesis used is that $H_0 : P_{it}$ does not affect X_t and H_1: P_{it} affects X_t. Test statistics seen from the value of the probability of the F test, where the criteria for testing results reject H_0 if the test probability $F < \alpha = 5\%$. If there is a direct but not simultaneous relationship then proceed to the next stage, and if there is a direct and simultaneous relationship then proceed to the VAR modeling stage (Constantinou et al, 2004; Wo´zniak, 2009).

Grouping data into regression models. Data were grouped from the results of the granger causality test for direct but not simultaneous relationships. Then proceed to the next stage.

Autocorrelation Test. To see the form of the relationship between the CSPI and the company an approach was made using a regression model to see patterns of relationships with the Jakarta CSPI movement. The hypothesis used is H_0: There is no serial correlation on residuals, and H_1: There is a serial correlation on residuals. The test statistic is seen from the Watson durbin value approaching 2, where the criterion of the result of testing is H_0 if the value is DW ≤ 2 (Tsay, 2005).

Heteroscedasticity Test. After autocorrelation testing, hetroskedastis testing is performed to analyze the variance of errors. The hypothesis used is H_0: Assumption of homoscedasticity of the error component is fulfilled, and H_1: error is heteroscedastic. Test statistics seen from the probability value *Obs * R-Squared* (*p-value*), where the criteria for testing results reject H_0 if $p - value \leq 5\%$.

ARCH / GARCH model estimation. To solve the heteroscedastic problem, an estimation is performed with the ARCH or GARCH models. In the GARCH model, the parameter values are estimated in the same way in estimating the regression model. In general, estimating a GARCH model cannot be done just once. A number of trials are needed in forming the GARCH model in such a way that a coefficient of parameters that meets the required and significant requirements is obtained (Deng, 2004; Wo´zniak, 2009).

Partial and Total Verification Test. After selecting the best variance model, just like the next model the variance model needs to be done *t-stat* test to determine the significance of each independent variable in influencing the dependent variable.

- **constant test α_0**, with hypotheses $H_0 : \alpha_0 = 0$ and $H_1 : \alpha_0 \neq 0$. Where the test statistics are

$$t_{rasio} = \frac{\alpha_0}{S.E\ \alpha_0} \tag{2}$$

  or prob value (t_{rasio}). The test criteria, reject H_0 if $t_{rasio} > t_\alpha$ or probability (t_{rasio}) $< \alpha$ (Tsay, 2005).
- **Coefficient Test α_i**, with hypotheses $H_0 : \alpha_i = 0$ and H_1: There is $\alpha_i \neq 0$ Where the test statistics are

$$t_{rasio} = \frac{\alpha_i}{S.E\ \alpha_i} \tag{3}$$

  or probability value (t_{rasio}). Test criteria, reject *H0* if $t_{rasio} > t_\alpha$ or (t_{rasio}) $< \alpha$ probability value (Tsay, 2005).

ARCH / GARCH model diagnostic test. To define the GARCH model properly, residuals must be standardized as follows:

$$Z_t = \frac{\varepsilon_t}{\sigma_t} \tag{4}$$

If the model is suitable, then the series $\{\varepsilon_t\}$ does not contain the ARCH effect and the squared residuals of $\{\varepsilon_t\}$ are white noise, which means the squared residuals of $\{\varepsilon_t\}$ must be independent (uncorrelated) and normally distributed with an average approaching ($\mu = 0$)and standards deviation σ. Meanwhile, to test whether the series $\{\varepsilon_t\}$ is white noise, it can be done by looking at the value of Q (m) *Ljung-Box* (Febrian and Herwany, 2009; Deng, 2004; Tsay, 2005).

VAR modeling. VAR model is an autoregressive (AR) model development. If the AR of the current observation is influenced by previous observations of the data, then the VAR mode of time observation is influenced by previous observations of the data and other data. The VAR model with the order P is denoted VAR (P) expressed in the following equation (Tsay, 2005; Wo´zniak, 2009).

$$Z_t = \phi_t Z_{t-1} + \ldots + \phi_p Z_{t-p} + a_t \tag{5}$$

where residual a_t is assumed to be white noise [4], (Tsay, 2005).

3. Results and Discussion

3.1 Analyzed Data

The data used in this study are secondary data taken from www.finance.yahoo.com. For closing prices of Astra Graphia (ASGR) sharia shares, Bank Central Asia (BBCA), Citra Development (CTRA), Jasa Marga (JSMR), Indonesian Telecommunications (TLKM), Unilever Indonesia (UNVR), and the Composite Stock Price Index (CSPI)). The data is daily data from January 4, 2010 to December 30, 2013.

3.2 Data Analysis

As explained in section 2, the analysis methodology is carried out in stages as follows:

Data transformation. Data transformation is performed to calculate the return value in each company stock, for example the JCI data which is denoted by variable x has a close price on January 4,2010 that is Rp.2575.41 and on January 5, 2010 that is Rp.2605.28 using the equation (1) the calculation results are:

$$x_1 = \ln \frac{2605{,}28}{2575{,}41} = 0{,}011531$$

And so on to calculate the JCI return until the last data and carried out the same way for the variable p_1 is the ASGR stock price return, p_2 is the BCA stock price return, p_3 is the CTRA stock price return, p_4 is the JSMR stock price return, p_5 is the TLKM stock price return, p_6 is the return of the UNVR stock price.

Stationary test results of the data. The results of the data return stationary test for each sham and CSPI are given in Table 1 as follows.

Tabel 1: Stationary Test Results of Stock Returns and CSPI

Variable	Critical Value at the level:			ADF_{test} value	Prob.	Conclusion
	1%	5%	10%			
x	-3,967547	-3,414458	-3,129363	-18,53363	0,0000	H_0 rejected
p_1	-3,967567	-3,414468	-3,129369	-20,55699	0,0000	H_0 rejected
p_2	-3,967518	-3,414444	-3,129355	-35,11327	0,0000	H_0 rejected
p_3	-3,967518	-3,414444	-3,129355	-31,58663	0,0000	H_0 rejected
p_4	-3,967547	-3,414458	-3,129363	-18,83595	0,0000	H_0 rejected
p_5	-3,967547	-3,414458	-3,129363	-19,37230	0,0000	H_0 rejected
p_6	-3,967528	-3,414448	-3,129358	-28,46386	0,0000	H_0 rejected

Based on the table above it can be seen that the results of MacKinnon Critical Value for all observations of data, then all observations of data used are stationary in levels at the significance level of 1%, 5%, and 10%. To test the data, a significance level of 5% is chosen for each data test.

Granger causality test results. The results of testing the relationship between granger causality to the returns of Islamic stocks with CSPI, which is done using Eviews 8 software are given in Table-2 as follows.

Based on the results of the table above, it is found that the variables p_1, p_2, p_3, are influenced by the variable *x*, for the variable p_4, p_5 affects the variable *x*, while for the variable p_6 has a simultaneous direct relationship with the variable *x*.

Table 2: Granger Causality Test Results

H_0	$F_{-Statistik}$	Prob.
x does not affect p_1	2,68344	0,0456
p_1 does not affect x	1,10896	0,3445
x does not affect p_2	7,63669	0,0005
p_2 does not affect x	0,35919	0,6983
x does not affect p_3	5,67384	0,0032
p_3 does not affect x	1,53225	0,2166
x does not affect p_4	1,38929	0,2446
p_4 does not affect x	2,65791	0,0472
x does not affect p_5	0,25045	0,8610
p_5 does not affect x	5,47552	0,0010
x does not affect p_6	3,57227	0,0285
p_6 does not affect x	3,81651	0,0223

The results of grouping data in a regression model. From the results of granger causality testing, the variables p1, p2, p3 can be grouped into the first group and the variables p4, p5 can be grouped into the second group, and both groups are modeled with a regression model.

3.3 The First Group Regression Model

Based on the causality test in which large companies do not have a simultaneous relationship with the movement of the Jakarta CSPI shares. The output of the regression model for the variables affected by the CSPI can be seen in Table-3 below.

Table 3: Output of Regression model output

Dependent Variable: X
Method: Least Squares
Date: 05/12/14 Time: 14:44
Sample: 1 973
Included observations: 973

Variable	Coefficient	Std. Error	t-Statistic	Prob.
P1	0.004009	0.001573	2.548110	0.0110
P2	0.435058	0.014452	30.10416	0.0000
P3	0.020427	0.007166	2.850658	0.0045

R-squared	0.493390	Mean dependent var	0.000521
Adjusted R-squared	0.492345	S.D. dependent var	0.012686
S.E. of regression	0.009039	Akaike info criterion	-6.571562
Sum squared resid	0.079244	Schwarz criterion	-6.556515
Log likelihood	3200.065	Hannan-Quinn criter.	-6.565836
Durbin-Watson stat	2.078638		

Based on the results of the above output the equation is obtained:

(a) Autocorrelation Test Results

Based on the Results Table of the regression model above, the Durbin Watson value of 2.078638> 2 means that there is no autocorrelation in the first group regression model.

(b) Heteroscedasticity Test Results

After autocorrelation testing, hetroskedastis testing is performed to analyze the variance of the error. To see the heteroscedasticity test results of each company can be seen in Table 4 below.
Based on the comparison of the standard error values for each method is different, but the coefficient test results with statistics show all the regression coefficients are significant, it can be concluded that heteroscedasticity is not a serious problem for this regression

Table 4: Comparison of Default Error Values

Method Variable	Method OLS	Method HC
p_1	0,001573	0,000817
p_2	0,014452	0,023649
p_3	0,007166	0,009672

(c) ARCH / GARCH Model Estimation

In the GARCH model, the parameter values are estimated in the same way in estimating the regression model. The results are given in Table 5 below.

Table 5: Estimation of the GARCH Model

GARCH model	AIC value	SIC value
GARCH (1,1)	-6,673605	-6,643510
GARCH (1,2)	-6,671646	-6,636535

Based on the results in Table 5 above, it can be concluded that the best model used to model stocks in the first group is GARCH (2.1) because it has the smallest AIC and SIC values.

(d) Partial and Total Verification Test (Parameter Hypothesis Test)

After selecting the best model, then the chosen model needs to be t-stat tested to determine the significance of each independent variable in influencing the related variable. After conducting a partial test it can be concluded that constant α_0, α_1 influences the related variable $(\sigma_t{}^2)$ but the constant α_2, β_1 does not affect the related variable $(\sigma_t{}^2)$.
Next, to find out whether or not there is a serial correlation in the model, re-testing the existence of the ARCH effect in the residual by using the ARCH-LM test. The results are given in Table 6 below.

Table 6: ARCH-LM Test Results GARCH model (1, 1)

Heteroskedasticity Test: ARCH

F-statistic		Prob. F(1,970)	0.5847
Obs*R-squared	0.299402	Prob. Chi-Square(1)	0.5843

Based on Table-6 the probability of Obs * R-squared is greater than the significance level of 0.05 (5%). So it can be concluded that there has been no ARCH effect in stock residuals in the first group.

(e) GARCH Model Diagnostic Test

In the diagnostic test, the analysis that will be used is to perform Ljung-Box statistical tests and standardized ACF / PACF squared residual corelogram plots in Table 1 to see whether there are serial correlations or not in residuals.
From Figure-1 above it can be seen that ACF and PACF are not significant, which is indicated by the probability value of the Ljung-Box statistic that is greater than the confidence level of 0.05 (5%) so that it can be concluded that the residuals of the model are white noise and not there is a serial correlation in residuals.

Table 7: Standardized Residual Squared Correlogram

Correlogram of Standardized Residuals Squared

Date: 05/13/14 Time: 15:21
Sample: 1 973
Included observations: 973

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.018	-0.018	0.3006	0.583
		2	0.014	0.014	0.5058	0.777
		3	0.042	0.043	2.2679	0.519
		4	-0.030	-0.029	3.1417	0.534
		5	-0.028	-0.030	3.8994	0.564
		6	-0.006	-0.008	3.9378	0.685
		7	0.063	0.066	7.7931	0.351
		8	0.005	0.009	7.8197	0.451
		9	0.006	0.003	7.8535	0.549
		10	0.003	-0.004	7.8607	0.642
		11	-0.008	-0.005	7.9223	0.720
		12	-0.024	-0.021	8.4992	0.745
		13	-0.044	-0.043	10.371	0.663
		14	0.011	0.007	10.482	0.726
		15	-0.019	-0.017	10.850	0.763
		16	-0.012	-0.012	11.002	0.809
		17	0.000	-0.004	11.002	0.856
		18	0.034	0.035	12.177	0.838
		19	-0.037	-0.033	13.528	0.811
		20	0.066	0.069	17.867	0.596
		21	-0.022	-0.023	18.331	0.628
		22	-0.058	-0.054	21.697	0.478
		23	-0.001	-0.007	21.699	0.538
		24	-0.033	-0.027	22.764	0.534

White noise test can also be done by testing the assumption of normality of residuals. The test was carried out with the help of Eviews 8 software, and the results are shown in Figure 1 as follows

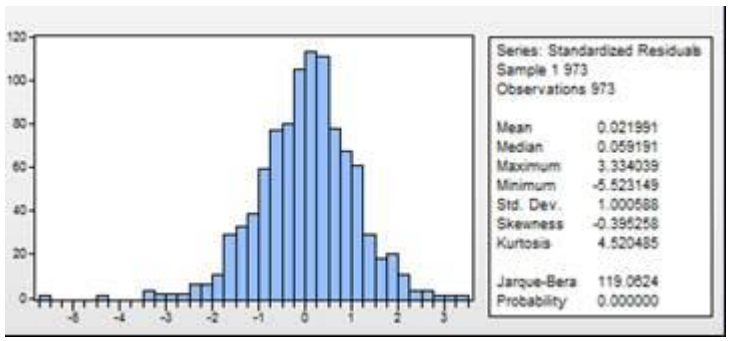

Figure 1: GARCH Model Residual Histogram (2, 1)

In Figure 1, the histogram shows that the residuals are normally distributed. This is shown by: (a) the graph that follows the bell curve, and (b) the statistical value of Jarque-Bera which has a very large probability.

So, from the diagnostic test it can be concluded that the GARCH model (2, 1) is white noise and normally distributed. So that the GARCH (2,1) model is good enough to be used in the modeling of stock data in the first group, with the GARCH (2,1) equation as follows:

$X_t = 0{,}005578 p_{1t} + 0{,}371095\, p_{2t} + 0{,}020058\, p_{3t} + e_t.$

$\sigma_t^2 = 0{,}00000421 + 0{,}096757 e_{t-1}^2 + 0{,}013481 e_{t-1}^2 + 0{,}839765 \sigma_{t-1}^2.$

3.4 Second Group Regression Model

Based on causality testing in which large companies do not have a simultaneous relationship with the JCI movement. The results of the regression model output for variables affected by the CSPI can be seen in Table 8 below.

Based on the above output results obtained equation: $X_t = \beta_1 p_{4t} + \beta_2\, p_{5t}$. Then do the research with the same steps for all stages in the second group, the GARCH equation (1,1) is obtained as the best model for modeling sharia stock data in the second group, with the GARCH model equation (1,1) as follows:

$X_t = 0{,}102165\, p_{4t} + 0{,}2843321\, p_{5t} + e_t.$

$\sigma_t^2 = 0{,}00000464 + 0{,}145702 e_{t-1}^2 + 0{,}817790 \sigma_{t-1}^2.$

Table 8: Results of Regression model output

Dependent Variable: X
Method: Least Squares
Date: 05/12/14 Time: 14:44
Sample: 1 973
Included observations: 973

Variable	Coefficient	Std. Error	t-Statistic	Prob.
P1	0.004009	0.001573	2.548110	0.0110
P2	0.435058	0.014452	30.10416	0.0000
P3	0.020427	0.007166	2.850658	0.0045

R-squared	0.493390	Mean dependent var	0.000521
Adjusted R-squared	0.492345	S.D. dependent var	0.012686
S.E. of regression	0.009039	Akaike info criterion	-6.571562
Sum squared resid	0.079244	Schwarz criterion	-6.556515
Log likelihood	3200.065	Hannan-Quinn criter.	-6.565836
Durbin-Watson stat	2.078638		

3.5 VAR Modeling Results

As has been proven in the causality test that between variables and have a two-way and simultaneous relationship, the model used to describe the relationship between the two capital markets uses the VAR model. The results are given in the following Table 9

Table 9: Estimation of the VAR Model

Vector Autoregression Estimates
Date: 03/26/14 Time: 08:15
Sample (adjusted): 3 973
Included observations: 971 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	X	P6
X(-1)	0.031558	-0.148022
	(0.03206)	(0.07351)
	[0.98436]	[-2.01350]
X(-2)	0.041050	-0.124549
	(0.03212)	(0.07365)
	[1.27806]	[-1.69112]
P6(-1)	0.020673	-0.313519
	(0.01389)	(0.03184)
	[1.48881]	[-9.84680]
P6(-2)	0.036679	-0.137784
	(0.01387)	(0.03180)
	[2.64514]	[-4.33324]
C	0.000424	0.001419
	(0.00041)	(0.00093)
	[1.04089]	[1.51946]

From Table 9 above, modeling can be carried out as follows:

$$x = 0{,}000424 + 0{,}031558x_{t-1} + 0{,}041050x_{t-2} + 0{,}020673p_{6\cdot t-1} + 0{,}036679p_{6\cdot t-2}$$

$$p_6 = 0{,}001419 - 0{,}148022x_{t-1} - 0{,}124549x_{t-2} - 0{,}313519p_{6\cdot t-1} - 0{,}137784p_{6\cdot t-2}$$

4. Conclusion

In this paper, a study of the volatility of sharia shares related to the causality of joint stock price index (CSPI) has been carried out. The results of the study showed that the equation model for the first group obtained the GARCH model (2.1), namely the upward movement of the JCI was influenced by the movement of PT.Astra Graphia Tbk companies by a point, the company PT Bank Central Asia Tbk by a point, and PT. Citra Development Tbk amounted to a point. For the second equation model, the GARCH model (1.1) is obtained, namely Jakarta's JCI movement increased by PT. Jasa Marga Tbk's influence by a point, and PT. Telekomunikasi Indonesia Tbk amounted to a

point. While Jakarta Composite Index and PT Unilever have simultaneous relationship with the proportional movement, if IHSG rises, PT. Unilever also experiences an increase and vice versa.

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