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MEASURING VOLATILITY OF DOW JONES SUKUK TOTAL RETURN INDEX USING GARCH MODEL

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Abstract

The aim of this study is to measure the performance of the selected Sukuk index, Dow Jones Sukuk Total Return Index (DJSTRI) in the presence of 2008 global financial crisiswith trade-off risk and return by measuring the volatility behavior as the proxy of risk for the period under study. The data of DJSTRI are collected from the Bloomberg database from the daily data of historical prices, 30/9/2005-12/5/2015 (2490 observations) excluding Saturdays and Sundays. The methodologies that are utilised in the study consisting of the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. The application of GARCH (1,1) model can give the empirical analysis to forecast the volatility of DJSTRI. The researcher advises policy makers to guide regulators, investors and issuers to the best Sukuk that remained stable during a crisis. This analysis will provide valuable information and guidelines to Sukuk issuers, policy makers, regulatory bodies and investors to Islamic bonds.

Keywords: *DJSTRI, Sukuk, Volatility, GARCH, Financial Crisis*

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MENGUKUR KETIDAKSEIMBANGAN 'DOW JONES SUKUK TOTAL RETURN INDEX (DJSTRI)' MENGGUNAKAN MODEL GARCH

Abstrak

Tujuan kajian ini adalah untuk mengukur prestasi Sukuk indek yang dipilih, iaitu Dow Jones Sukuk Total Return Index (DJSTRI) dengan kehadiran 2008 krisis kewangan global dengan risiko keseimbangan dan pulangan dengan mengukur tingkah laku turun naik sebagai proksi risiko bagi tempoh dalam kajian. Data DJSTRI dikumpulkan dari pangkalan data Bloomberg dari data harian harga sejarah, 30/9 / 2005-12 / 5/2015 (2490 pemerhatian) tidak termasuk hari Sabtu dan Ahad. Metodologi yang digunakan dalam kajian ini terdiri daripada model Generalized Autoregresif Conditional Heteroskedasticity (GARCH). Penggunaan GARCH (1,1) model boleh memberi analisis empirikal untuk meramal turun naik DJSTRI. Penyelidik menasihatkan pembuat dasar untuk membimbing pengawal selia, pelabur dan penerbit untuk Sukuk yang terbaik yang kekal stabil semasa krisis. Analisis ini akan memberikan maklumat dan garis panduan yang berharga kepada penerbit Sukuk, pembuat dasar, badan-badan kawal selia dan pelabur untuk bon Islam.

Katakunci : DJSTRI, Sukuk, Turun Naik, GARCH, Krisis Kewangan

INTRODUCTION

Global market sentiment and volatility have affected the mainstream fixed income markets and influenced the global Sukuk market, resulting in multiple sources of risk and high liquidity level. Approximately, a modest correlation between Sukuk and fixed-income markets determines the necessary development in global bond volatility, including Sukuk (Islamic Finance News, 2011). Volatility is an uncertainty that influences the performance of the financial sector and the entire economy. In this notion, higher volatility corresponds to the higher probability of a declining market (Rano, 2010; and Ahmed and Suliman, 2011).Volatility refers to the sharp fluctuations in the price of a financial asset or market in a short period. It illustrates the magnitude and speed of an asset's price change. In other words, an increment in volatility will lead to increasing risk and decreasing returns. As volatility increases, the market's performance tends to decrease (Okpara, 2011; Abu Orabi and Abed, 2015).

Bloomberg (2015) reports that the global Sukuk issuances in the first quarter of 2015 declined to USD18.7 billion from USD24.2 billion in the fourth quarter of 2014. The problem appears when the diminishing number of Sukuk issuances heightened the uncertainty in the worldwide economic system has touched on the

Sukuk market. The main motivation of this study arises from the deterioratedof returns on investment on Sukuk following the 2007/2008 global financial crisis. It suits the primary subject in this study where the higher the risk, the higher the volatility, the lower the returns on Sukuk investment.

This paper contributes in measuring an analysis of Sukuk market volatility following Sukuk issuances to contribute valuable information and guidelines to issuers, policy makers, regulatory bodies and investors to Islamic bonds. This paper adds to the literature since empirical work on the information content of Sukuk issues is relatively few. The rest of the paper is formed as follows. Section II discusses the related literature. Section III highlights the research methodology. Section IV discusses the findings, and the final section concludes the paper.

LITERATURE REVIEW

Definition of Sukuk

According to the Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI), Sukuk is defined as certificates of equal value that represent an undivided interest in the ownership of an underlying asset (both tangible and intangible), usufruct, services or investments in particular projects or special investment activities (AAOIFI, 2008). The Islamic Development Bank (IDB) defined the Sukuk as, “an asset-backed bond which was designed or structured in accordance with the Shari’ah and which might be traded in the market” (IDB, 2006). Sukuk is defined by the Securities Commission Malaysia (2011) as “certificates of equal value which evidence undivided ownership or investment in the assets using Shari’ah principles and concepts approved by the Shari’ah Advisory Council (SAC)”.

Volatility Market

Young and Johnson (2004) indicated the volatility clustering only in Swiss bond market returns, but further analysis using GARCH(1,1) modeling indicated volatility clustering in both the bond and stock markets. The 39-year trend in bond market volatility is positive and significant at the one percent level (t = 12.52). Jithendranathan and Gupta (2010) used the GARCH method to investigate stock futures listed on the National Stock Exchange of India and discovered single stock futures which reduced thevolatility of the underlying stock’s returns.Kosturov and Stock (2010)showed the evidence of strong weekday effects on the volatility of a corporate bond.They found positive and highly significant coefficient of the announcement dummies confirms that, controlling for day-of-week effects, announcement days have significantly higher volatility.Alam (2012) mentioned that the stock volatility is significantly correlated with the bond yield spread with an overall positive relationship between the two in the presence of the other two variables (credit rating and SGS rate/interest rate spread).

Rahman, Omar and Kassim (2013) also used the GARCH method to explore the influential factors of Sukuk spreads. They found a negative correlation between changes in the Sukuk spreads for both long-term and short-term Sukuk and interest rate variable, together with the yield curve slope. The price discovery and volatility spillover effects between the stock and bond markets in Malaysia were also investigated by applying the VAR-bivariate-GARCH model (Kim, 2013). The volatility linkages (during and after the recent financial crisis) between the stock and Sukuk markets in Malaysia were examined in the study. He found that during the financial crisis, a unidirectional volatility spillover to the Shari'ah stock market existed, and the Sukuk market had a substantial impact on the stock exchange, while the stock exchange did not have such impact on the Sukuk market.Rusgianto and Ahmad (2013) examined the volatility behavior of the Sukuk market in several manners; under the consideration of the structural breaks, utilising data from the year 2007 to 2011 of Dow Jones Citigroup Sukuk Index, and by using the EGARCH model. Their findings indicated that the volatility behavior of Sukuk was expressively modified by the structural breaks; illustrated by the fact that volatility during the pre-crisis and simultaneous period showed more sensitivity to market events that were related to the post-crisis period.

Apart from that, Omer and Masih (2014) investigated and predicted the conditional volatility and correlations between daily returns of seven nominated Dow Jones Islamic and conventional price indexes between the year 2003 and 2013 by using the Dynamic Multivariate GARCH approach. As the estimates implied gradual volatility decay by falling very close to unity, their investigation concluded the high significance of all volatility parameters.Bayraci (2015) used the VAR-BEKK model and BEKK-GARCH model showed the Turkish bond market is only correlated with Japanese and the US markets, there are strong ties between the returns and volatility of developed bond markets.Naifar (2016) investigated the dependence structure between Sukuk yields and the stock market (returns and volatility) in the case of Saudi Arabia. His researchshowed that the Sukuk yields exhibit significant dependence only with stock market volatility. In addition, the dependence structure between Sukuk yields and stock market volatility are symmetric and linked to the same intensity. According to Maghyereh and Awartani (2016), they used the Generalized Vector Autoregressive (GVAR model) and found that Sukuk are a net receiver of returns and volatility information from other equity and bond market.In terms of volatility, bond market is a net giver of information to other markets.

METHODOLOGY

Data Collection

This study uses the secondary data of Dow Jones Sukuk Total Return Index (DJSTRI) as a proxy for the global Sukuk market. The sample used in this inquiry is the daily data of the DJSTRI from 30th September 2005-12th May 2015 (2490 observations). The data source from the Bloomberg Database. The descriptive statistics of daily data are summarized as below:

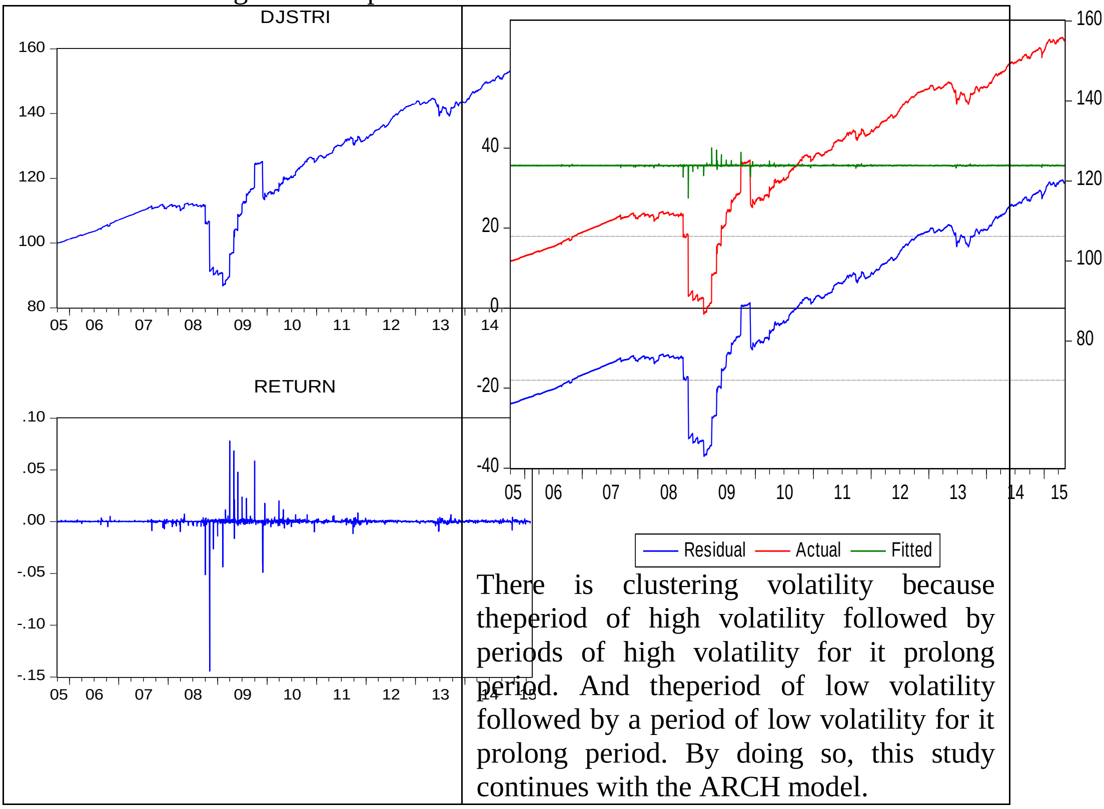
Table 1: The Statistics of DJSTRI (Daily Data), Sept. 2005- May 2015

	DJSTRI	RETURN_DJSTRI
Mean	123.8625	0.0002
Median	123.9300	0.0002
Maximum	155.9200	0.0781
Minimum	86.7400	-0.1442
Standard Deviation	17.9982	0.0046
Skewness	0.0580	-9.4441
Kurtosis	1.8568	472.0264
Jarque-Bera	136.9932	22851356
Probability	0.0000	0.0000
Sum	308417.7	0.4667
Sum Sq. Dev.	806273.4	0.0530
Observations	2490	2489

Source: Authors' calculation.

The results from descriptive statistics reported in Table 1 above indicate that during the sample period, the DJSTRI observed the highest mean daily return of 0.0002. The corresponding volatilities measured by standard deviation are0.0046for the DJSTRI. The higher the volatility offers the possibility of higher rates of returns, but also poses more risk (Islam, 2013). The return series shows the negative skewness suggesting that the distribution has long left tail. The excess values (that is, more the three) for kurtosis indicate fat tails characteristics of the asset returns distribution. The Jarque-Bera (JB) test of normality clearly rejects the null hypothesis of normality in all cases. The tests suggest that the distributions of the return series are non-normal.

Figure 1: Graph of DJSTRI and Return of DJSTRI



There is clustering volatility because theperiod of high volatility followed by periods of high volatility for it prolong period. And theperiod of low volatility followed by a period of low volatility for it prolong period. By doing so, this study continues with the ARCH model.

Source: Authors' calculation.

TESTING ARCH EFFECT

Before this study continues to apply the GARCH(1,1) model, it is necessary to check the existence of ARCH effect in the residuals. To test for ARCH effects in the conditional variance of u_1, this study considers the AR(1) model for the return series of each individual index as:

$$r_t = \beta_0 + \beta_1 r_{t-1} + u_1 \quad (1)$$

Then, this research runs a regression of squared OLS residuals (u_t^2) obtain from the equation (1) on q lags of squared residuals to test for ARCH of order q. "q" represents the number of autoregressive terms in the model. The ARCH (q) specification to σ_t^2 is denotes as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-2}^2 + \cdots \dots \dots . + \alpha_q u_{t-q}^2 (2)$$

The null hypothesis of "no ARCH effect" is:

$$H_0 : \alpha_1 = \alpha_2 = \cdots \dots = \alpha_q = 0$$

The alternative hypothesis is:

$$H_1: \alpha_1 \neq 0, \alpha_2 \neq 0, \ldots.., \alpha_q \neq 0$$

If the result of P-value is significant at a level 1 %, 5% or 10%, then this study will reject the null hypothesis.

GARCH (1, 1) MODEL

In financial markets, volatility is defined as a measure of uncertainty about the returns. The volatility of many economic time series, especially financial time series changes over time. In some periods, the daily returns exhibit high volatility while, in another period, they exhibit low volatility. The common phenomenon in financial time series, which refer to as volatility clustering. That is volatility comes in clusters. It is expected that a day of high volatility most likely to be replaced by another day of high volatility within a short period.

As such, linear models that assume homoscedasticity (constant variance) are inappropriate to explain such unique behavior of financial time series data. It is preferable to use models that examine the behavior of financial time series, allowing the variance to depend on upon its history. The GARCH (1,1) model is competent of capturing the volatility clustering effects in the financial time series data. The GARCH models are especially desirable for financial market data as the GARCH processes are 'fat-tailed' compared to the normal distribution.In GARCH model, the variance σ_t^2 is allowed to be dependent upon its past value as well as lags of the squared error terms. The general form of a GARCH (p,q) model is represented as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \cdots + \alpha_p u_{t-p}^2 + \beta_1 \sigma_{t-1}^2 + \cdots + \beta_q \sigma_{t-q}^2 \quad (3)$$

Where *p* is the order of the moving average ARCH terms and *q* is the order of the autoregressive GARCH terms. The simplest and, most commonly used GARCH model is the GARCH (1,1). This basic GARCH model is a reasonably good model for analyzing financial time series. It is important to estimate and forecast the time varying volatility of returns of financial assets, especially the high-frequency financial assets such as daily index returns.

FINDINGS AND DISCUSSION

This study has applied the standard Augmented Dickey-Fuller (ADF) test to check whether the financial time series (returns) are stationary or not. The results are presented in Table 2 as below:

	ADF test
Null Hypothesis ($\mathbf{H_0}$)	There is a unit root
Alternative Hypothesis ($\mathbf{H_1}$)	Data are stationary

Table 2: ADF test (unit root test) for the DJSTRI based on AIC onthe level.

	Augmented Dickey-Fuller (ADF)	
LevelI(0)	C	C+T
Return DJSTRI	-0.639478[3]	-2.163208[3]
First differentI(1)	C	C+T
Return DJSTRI	-27.9887[2]***	-27.9843[2]***

Note: *** denotes significant at the 1% level, respectively. Figure in the parenthesis represents the optimum lag length selected based on Akaike Info Criterion. Level "C" refer to Constant and "T" refer to Trend .Source: Author's calculation.

This study tests the stationary of data using Augmented Dickey-Fuller Test (ADF test). At level, I (0), there are the in significant result and the null hypothesis is not rejected in both tests, C and C+T test. It means that there is a unit root in the data. This study continues the test with the first different I(1) and both C and C+T test show the significant results. The null hypothesis is rejected, means the data is stationary at first different from ADF test. Because of these findings, ADF test proves that the data are stationary and will proceed to the ARCH and GARCH test.Table 3 indicates the result of ARCH effect:

F-statistic	930790.6	Prob. F(1,2486)		0.0000***
Obs*R-squared	2481.373	Prob. Chi-Square(1)		0.0000***
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.324796	0.456448	0.711572	0.4768
RESID^2(-1)	0.999513	0.001036	964.7749	0.0000***

Table 3: Heteroskedasticity Test (ARCH)
Note: *** denotes significant at the 1 % level, respectively.
Source: Author's calculation.

Null Hypothesis (H_0): There is no ARCH effect. **[REJECT]**
Alternative Hypothesis (H_1): There is ARCH effect.

The result of P-value show it is strongly significant, and the ARCH test rejects the null hypothesis that there is no ARCH effect. It means that there has the ARCH effect on the residual.This has all the validity to run the ARCH or GARCH model. GARCH (1,1) model meanings that there is 1 ARCH effect and 1 GARCH effect. It is essential to estimate GARCH(1,1) models as an alternative to high-order ARCH models because, with the GARCH(1,1), this study hasfewer parameters to estimate and therefore lose fewer degrees of freedom. The ARCH parameters correspond to α and the GARCH parameters to β.If the sum of the ARCH and

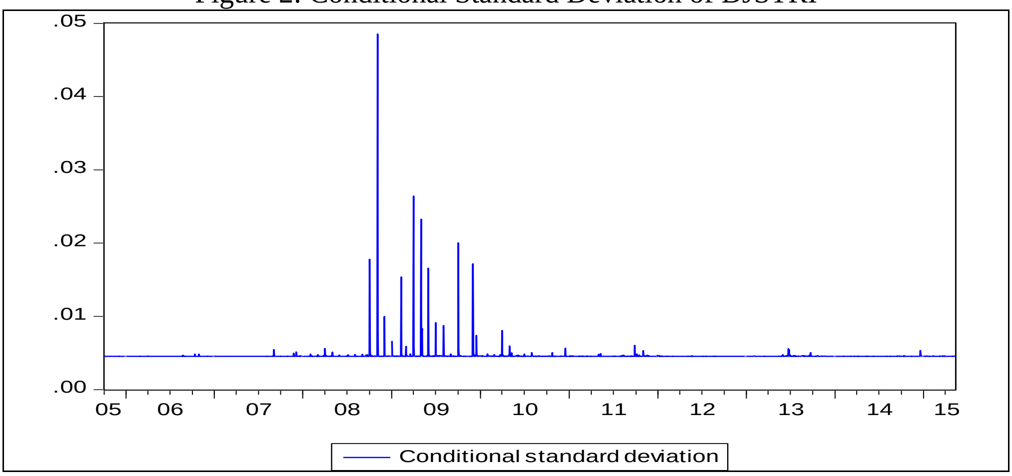
GARCH coefficients ($\alpha + \beta$) is very close to one, indicating that volatility shocks are quite persistent. This result is often observed in high frequency financial data. If the sum of the ARCH and GARCH coefficients ($\alpha + \beta$) is very close to one, indicating that volatility shocks are quite persistent. This result is often observed in high frequency financial data. The summation of coefficients ($\alpha + \beta$) is not close to one shows that the volatility of DJSTRI is not persistence.

Table 4: A GARCH(1,1) model for the DJSTRI

Variable	Coefficient	Std. Error	z-Statistic	Probability
C	124.5620	0.022426	5554.458	0.0000***
RETURN_DJSTRI(-1)	135.2712	1.953066	69.26099	0.0000***
		Variance Equation		
C	0.013036	0.004823	2.702755	0.0069
ARCH(1) α	0.111674	0.017363	6.431635	0.0000***
GARCH(1) β	0.020400	0.015029	1.357349	0.1747

Note: *** denotes significant at the 1 % level, respectively.
Source: Author's calculation.

Figure 2: Conditional Standard Deviation of DJSTRI

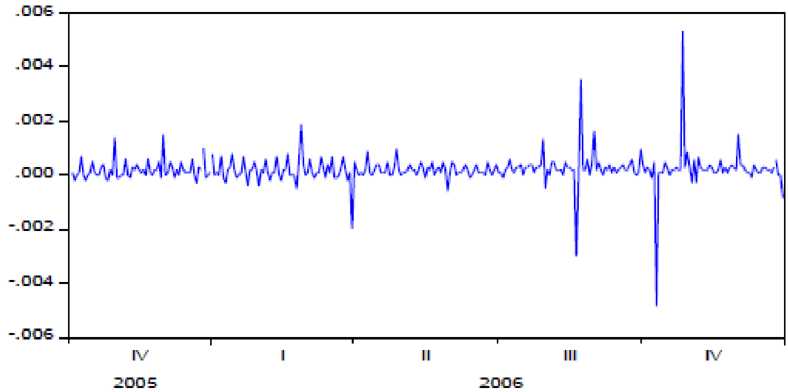


Source: Author.

Figure 3: Volatility of DJSTRI at Pre, During and After the 2007/2008 Global Financial Crisis

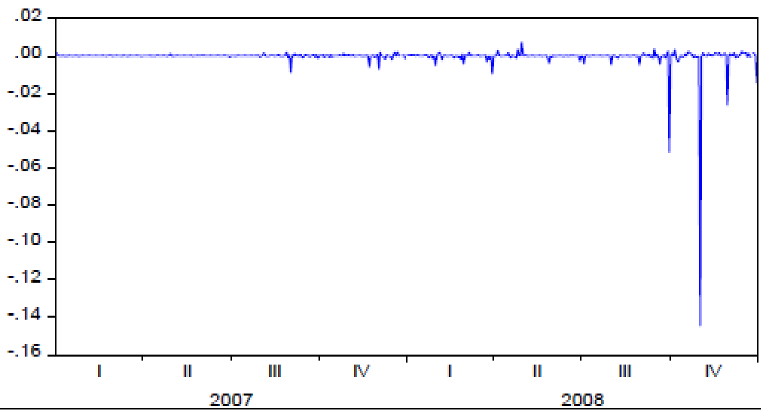
Before crisis: 2005-2006

Return



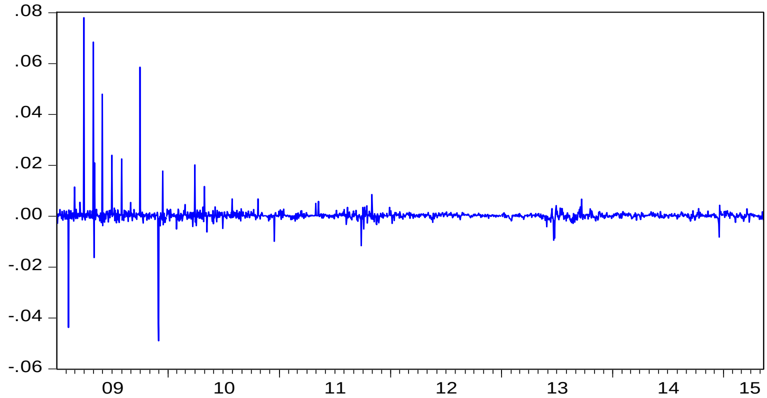
During crisis: 2007-2008

Return



After crisis: 2009-2015

Return



Source: Author.

The Figure 2 and Figure 3 record that there is volatility clustering between the periods of study, 2005-2015. In finance, volatility clustering refers to the observation, as noted as Mandelbrot (1963), that "large changes tend to be followed by large changes, of either sign, and small changes tend to be followed by small changes". The return of DJSTRI shows low volatility before the crisis. Then, the graph also indicates there ishigh volatility during the crisis and after the crisis around the year 2009 because of the long memory of volatility. The impact of the 2008 global financial crisis shows the high volatility in 2009 although after the crisis. After 2009, the memory of the crisis has recovered and shown low volatility after the crisis.The higher volatility indicates higher risk and the lower volatility indicates lower risk.

Besides, this study determines the serial correlation of DJSTRIdata and the reasons that the disturbances are serially correlated. The results show that in all probabilityis significant at the 1 % level. This study rejects the null hypothesis (H_0), and accept the alternative hypothesis, that support there is a serial correlation

Null Hypothesis (H_0): There is no serial correlation. **[REJECT]**

Alternative Hypothesis (H_1): There is aserial correlation.

Table 5: Results of Serial Correlation

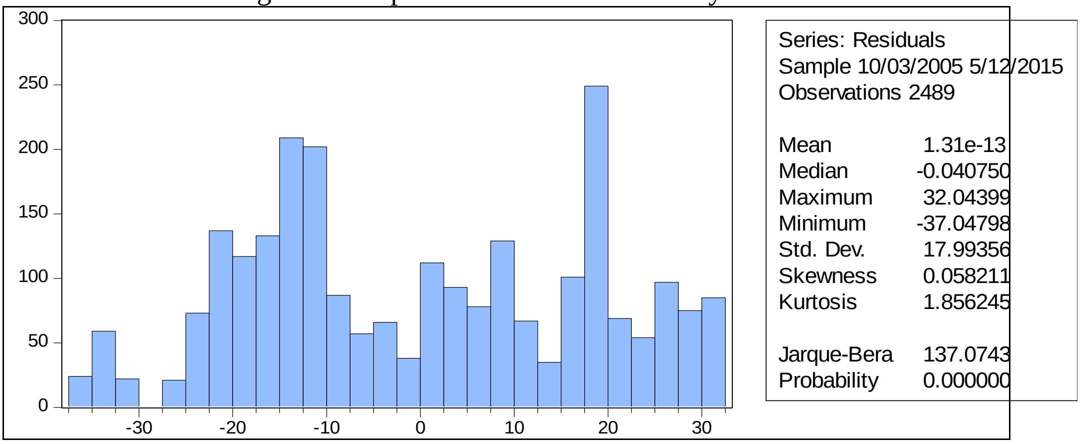
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Probability
|*******	|*******	1	0.998	0.998	2479.8	0.000***
|*******	**| |	2	0.994	-0.251	4942.4	0.000***

|*******	|* |	3	0.990	0.078	7388.2	0.000***
|*******	| |	4	0.987	-0.032	9817.1	0.000***
|*******	| |	5	0.983	-0.005	12229.	0.000***
|*******	| |	6	0.979	-0.001	14623.	0.000***
|*******	| |	7	0.976	-0.002	17001.	0.000***
|*******	| |	8	0.972	-0.002	19361.	0.000***
|*******	| |	9	0.968	-0.010	21704.	0.000***
|*******	| |	10	0.964	-0.008	24030.	0.000***
|*******	| |	11	0.961	0.001	26338.	0.000***
|*******	| |	12	0.957	0.006	28630.	0.000***
|*******	| |	13	0.953	-0.003	30905.	0.000***
|*******	| |	14	0.949	-0.001	33162.	0.000***
|*******	| |	15	0.946	0.009	35404.	0.000***
|*******	| |	16	0.942	0.003	37629.	0.000***
|*******	| |	17	0.938	-0.009	39837.	0.000***
|*******	| |	18	0.935	-0.008	42030.	0.000***
|*******	| |	19	0.931	0.004	44206.	0.000***
|*******	| |	20	0.927	-0.016	46365.	0.000***
|*******	| |	21	0.923	-0.058	48507.	0.000***
|*******	*| |	22	0.919	-0.068	50629.	0.000***
|*******	*| |	23	0.914	-0.096	52728.	0.000***
|*******	| |	24	0.908	-0.052	54803.	0.000***
|*******	| |	25	0.903	0.004	56854.	0.000***
|******|	| |	26	0.897	-0.005	58880.	0.000***
|******|	| |	27	0.891	-0.011	60881.	0.000***
|******|	| |	28	0.886	-0.006	62858.	0.000***
|******|	| |	29	0.880	-0.001	64810.	0.000***
|******|	| |	30	0.874	0.005	66738.	0.000***
|******|	| |	31	0.869	-0.001	68642.	0.000***
|******|	| |	32	0.863	0.002	70522.	0.000***
|******|	| |	33	0.858	0.003	72379.	0.000***
|******|	| |	34	0.852	-0.010	74212.	0.000***
|******|	| |	35	0.846	-0.005	76022.	0.000***
|******|	| |	36	0.841	0.032	77810.	0.000***

Note: *** denotes significant at the 1 % level, respectively
Source: Author's calculation.

The normality test shows the result of p-value is small and significant, means reject the null hypothesis.This study concludes that the data are not from a population with a normal distribution.

Figure 3: Graph and Results of Normality Test



Source: Authors' calculation.

Null Hypothesis (H_0): The population is normally distributed. **[REJECT]**
Alternative Hypothesis (H_1): The population is not normally distributed.

CONCLUSION

In this research, the author has utilized one of the GARCH family models which arethe symmetric GARCH (1,1) model. The primary aim of this study is to measure the volatility of global Sukuk index, DJSTRI. The results show the daily data of DJSTRI have the ARCH effect. The findings show that the GARCH (1,1)model finds adequately capable of capturing the dynamics of the financial time series, particularly in the respect to volatility clustering of the daily return series. In this respect, this study determines that the Sukuk market is volatile and risky for Sukuk investors, especially during and after the crisis show high volatility, but also promising of being covered by the higher return as proved by the empirical test. This research indicates that high volatility and risky to invest in Sukuk during global financial crisis compared to before and after the crisis. It concludes that the application of this symmetric GARCH (1,1) model can give the empirical analysis to forecast the volatility of DJSTRI.

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