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Aminah Shari, Fauziah Mahat, Nazrul Hisyam Ab Razak, Mohamed Hisham Dato' Hj. Yahya

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## Dynamic Interdependence Between Volatility of Shariah Stock and Bond

Aminah Shari<sup>a</sup>, Fauziah Mahat<sup>b</sup>, Nazrul Hisyam Ab Razak<sup>c</sup>,  
Mohamed Hisham Dato' Hj. Yahya<sup>d</sup>

<sup>a</sup>Labuan Faculty of International Finance, Universiti Malaysia Sabah, Kampus Antarabangsa Labuan, Labuan, <sup>b,c,d</sup>Department of Accounting and Finance, School of Business and Economics, Universiti Putra Malaysia, Selangor, Malaysia  
Corresponding Author's Email: aminah83@ums.edu.my

### Abstract

The purpose of this research is to investigate the correlation between bond yields and the Shariah equity index from 2007 to 2019. The Multivariate-GARCH Dynamic Conditional Correlation (DCC) model is applied to the daily data indices of five bond markets, namely conventional bond, corporate bond, corporate sukuk, government bond, and government sukuk, as well as the daily index of the Islamic equity market, which is represented by FTSE Bursa Malaysia EMAS Shariah. The empirical evidence reveals a substantial correlation between these sharia stock and sukuk indexes, demonstrating that investors' risk tolerance fluctuates over time. Co-movement power fluctuates throughout time, and the government bond is dominant.

**Keywords:** Interdependence, Stock, Bond, Multivariate-GARCH, Investment

### Introduction

In empirical finance, interconnectedness and contagion of financial markets are a subject of extensive investigation (Shahzad et al., 2017). Investors' primary concern is determining if the observed changes in financial markets are primarily due to contagion or fundamental factors. Evidence demonstrates that fundamentals are the primary determinant of market relationships linkages (Baele et al., 2010). Financial integration and globalisation are quantified by the interconnectivity of financial markets. During the previous several decades, for instance, many emerging nations have gradually eliminated financial and economic obstacles, resulting in increased financial integration (Hillier & Loncan, 2019). International investors have recently been attracted to global equities markets due to its correlation. Understanding the distinction between interdependence and contagion is crucial in empirical finance, namely in asset pricing, risk management, and hedging. The phenomena is referred to as fundamentals when the rising co-movement and fluctuation are likely to continue for an extended period. The effect is referred to as contagion when the growing volatility and intermarket links are expected to persist for a short period of time (a few days). In other words, the definition of the contagion effect is a sudden rise in short-term co-

movement. The research demonstrates that contagions have detrimental effects on the global economy (Yang et al., 2016). Because contagion involves events related to finance and the actual economy, it can spread across markets and have repercussions on the real economy (Chen et al., 2017).

Prior research concentrated mostly on conventional or traditional assets, such as stocks and bonds (Mehmet Balcilar Gozde Cerci Riza Demirer, 2016). Their primary field of research focuses on the implications of portfolio diversification views. They also discover a negative association between sukuk and equities during periods of more volatility Mehmet Balcilar Gozde Cerci Riza Demirer (2016); Hammoudeh et al (2014) demonstrate a strong relationship between Islamic stocks and the global equity market. In addition, research on the co-movement of financial assets within a single framework is lacking. In order for investors to diversify their financial assets, a significant gap must be filled, according to recent Islamic finance research. Therefore, this study would like to investigate the correlation between Shariah stock return and bond indices.

### Literature Review

In recent years, scholars have attempted to investigate bond markets and assess the time-varying correlation features of bond markets. Numerous recent empirical investigations demonstrate that the global bond market has no stable relationship; rather, it varies over time (Piljak & Swinkels, 2017). These findings are consistent with, for (Benlagha, 2014; Bhuiyan et al., 2019; Hassan et al., 2017, 2018; Naifar et al., 2017). Bhuiyan et al (2019), for instance, applied wavelet coherence and M-GARCH to the sovereign bond index returns of the United States, Canada, Germany, the United Kingdom, Australia, and Japan, as well as the Malaysia Sukuk Index. They discovered that the bond market exhibited substantial co-movement characteristics. In addition, they discovered a weaker relationship between sukuk and the bond market. These findings were consistent with a sukuk portfolio study undertaken by Najeeb et al (2017). Benlagha (2014), on the other hand, investigates the relationship between nominal and index-linked French market bonds. He utilised dynamic conditional correlation GARCH (DCC-GARCH) and a copula technique; the outcomes demonstrated considerable co-movement dynamics between bond returns.

Examining the dependence structure between sukuk and conventional bonds, Maghyereh and Awartani (2016) employed the Value-at-Risk (VaR) framework to analyse the impact of Sukuk price behaviour on the cost and risk structure of investment portfolios. Their findings revealed a dynamic interdependence between the markets in question. Additionally, they discovered that return spillovers between Sukuk and bonds are modest. In addition, they asserted the existence of information transfer from global equities.

Existing empirical research demonstrates a considerable correlation between bond and Islamic stock market fluctuations (Jawad et al., 2018; Tuysuz, 2020). Prior research indicates that the correlation between Islamic and conventional sector index pairs varies (Tuysuz, 2020). During a downward market trend, the Islamic bond index is proposed as a possible hedge/safe haven (Jawad et al., 2018). In order to demonstrate this, Ahmed and Elsayed (2018) demonstrated that conventional and Islamic markets are intimately intertwined. On the basis of empirical facts, we postulate the following relationship:

Hypothesis 1a: There is a significant co-movement between the conventional bond returns and the Shariah index

Hypothesis 1b: There is a significant co-movement between the corporate bond returns and the Shariah index

Hypothesis 1c: There is a significant co-movement between the corporate sukuk returns and the Shariah index

Hypothesis 1d: There is a significant co-movement between the government bond returns and the Shariah index

Hypothesis 1e: There is a significant co-movement between the government sukuk returns and the Shariah index

### Research methodology

The study utilised daily frequency data for the following reasons: first, more full information on dynamic conditional correlation than monthly data. Specifically, employing daily frequency data is more advantageous for investors seeking to construct optimal portfolios and make economic profits. On the other side, Mensi et al (2017) demonstrate that a daily data model is a stronger predictor of returns than a monthly data model. The equities sector return was calculated by multiplying the initial difference of the daily logarithmic indexes by 100. In other terms, the equity sector return formula can be expressed as follows:

$$R_t = 100 \times \log (P_t / P_{t-1}) \quad (1)$$

Where  $R_t$  indicates the stock returns and  $P$  represents stock index levels at the time ( $t$ ) and ( $t-1$ ).

The empirical analysis began with an examination of the co-movement patterns between stock sectors and the composite index, as well as their evolution through time. GARCH analysis can be utilised to detect stylised facts of financial time series, like volatility clustering and fat tails. It has been implemented in the modelling of volatility. Moreover, the Multivariate Generalized Autoregressive Conditional Heteroskedasticity (MGARCH) model is widely utilised for portfolio optimization, pricing of assets and derivatives, computation of the value at risk (VaR), futures hedging, volatility transmitting, and asset allocation (Minovi & Simeunovi, 2002).

Engle (2002) develops the dynamic conditional correlation (DCC)-GARCH model, which provides the flexibility to describe the multivariate conditional volatility of stock returns and their time-varying correlations simultaneously. The DCC is a multivariate GARCH model with an autoregressive specification for time-varying correlations. Engle (2002) establishes a two-step procedure, namely estimate of univariate GARCH models for each series and dynamic conditional correlations derived from standard residuals.

$$H_t = D_t R_t D_t \quad (2)$$

In equation 2,  $H_t$  is the  $n \times n$  conditional covariance matrix,  $R_t$  is the dynamic correlation matrix and  $D_t$  is a diagonal matrix with time-varying standard deviations.

$$D_t = \text{diag} (h_{11t}^{1/2}, \dots, h_{kk1t}^{1/2})$$

$$R_t = \text{diag} (q_{11t}^{-1/2}, \dots, q_{kk1t}^{-1/2}) Q_t \text{diag} (q_{11t}^{-1/2}, \dots, q_{kk1t}^{-1/2})$$

where  $Q_t$  is a symmetric positive definite matrix:

$$Q_t = (1 - \theta_1 - \theta_2) \bar{Q} + \theta_1 \varepsilon_{t-1} \varepsilon'_{t-1} + \theta_2 \theta_{t-1} \quad (3)$$

$\bar{Q}$  is the  $n \times n$  unconditional correlation matrix of the standardized residuals  $\varepsilon_{it}$ . The parameters  $\theta_1$  and  $\theta_2$  are non-negative with a sum of less than unity. The study calculate the conditional correlation at time t as:

$$\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t}q_{jj,t}}}, \forall i,j = 1, \dots, n, i \neq j \quad (4)$$

To estimate the model, the Quasi-Maximum Likelihood Estimation (QMLE) is utilised. This rich conditional correlation parameterization permits the examination of the co-movement of two markets and the inference of the dependence's evolution over time. Consequently, the least connected stock indices would provide investors with more diversification benefits.

### Results and discussion of findings

The descriptive statistics between bond indexes and the Shariah index are presented in Table 1. The corporate sukuk market was highest among the five bond market segments. As can be observed, the corporate sukuk index has better average returns than other bond indices.

Table 1  
*Summary of descriptive analysis*

Variable	Observation	Minimum	Maximum	Mean	Std. Deviation
Conventional	3158	-189.127	189.161	0.006	4.761
Corporate bond	3158	-16.078	14.387	0.007	0.385
Corporate Sukuk	3158	-5.956	5.979	0.008	0.154
Government bond	3158	-189.694	189.729	0.006	7.397
Government Sukuk	3158	-250.263	250.319	0.006	6.306

Table 2 presents simple pairwise correlations between bond index returns and Shariah index returns over the sample periods. In addition, they provided the daily return correlation matrix. Conventional bond, government bond, and government sukuk were the exceptions. Inferring a negative association between Shariah index returns and conventional bond, government bond, and government sukuk returns, the Shariah index returns coefficients were negative. During the study period, it is evident that the link between conventional bond and Shariah index return was minuscule and nonexistent (-0.011). This study suggests that conventional bonds may have the capacity to diversify a global bond portfolio and improve its risk-return profile. Similarly, conventional bonds appeared to have a weak correlation with the Shariah index, as shown in the table. Its correlation was comparable to that of government sukuk, which was modest and less than 0.01. The low correlation between conventional bonds and government sukuk and the Shariah index makes them suitable candidates for diversifying a global bond portfolio.

Table 2

*Correlation matrix*

Variable	Conventional	Corporate bond	Corporate Sukuk	Government bond	Government Sukuk	Shariah Index
Conventional	1					
Corporate bond	0.000	1				
Corporate Sukuk	0.977	0.007	1			
Government bond	0.646	-0.002	0.625	1		
Government Sukuk	0.999	-0.002	0.975	0.668	1	
Shariah	-0.011	0.001	0.006	-0.013	-0.011	1

This section addresses the empirical outcomes of the Multivariate GRACH models and the behaviour of the conditional correlation dynamics over time. The study begins with a discussion of the DCC-GARCH model's outcomes. The paper then addresses the conditional correlation patterns of equity based on the dynamics of the estimated correlations shown in Figures 1 and 2. The purpose of the study was to examine the co-movement of hazardous and non-risky assets on the Islamic market, on the one hand, and on conventional markets, on the other.

Figures 1 and 2 show empirical findings based on the conditional volatilities and correlations of bonds with the Shariah and KLCI indices. The numerical approach failed to converge for multivariate normal distribution and multivariate Student t-distribution. Consequently, Multivariate GARCH applied to OLS residuals yielded the best results, indicating that the model employs two-step estimating techniques. In the initial estimation stage, independent OLS regressions were conducted for each variable. The second estimating stage included the DCC model (Pesaran & Pesaran, 2010). Complete models such as the GARCH model and time-varying correlation model are described in the study. The reporting of this estimations model is essential, as it might reveal the maximum likelihood test estimations. Notably, the study is consistent with (Nagayev et al., 2016). According to Mimouni et al (2016), a multivariate Gaussian distribution might also be used in this investigation, as the data points to the same conclusions.

Table 3 displays the outcome of the MGARCH model applied to the OLS residuals of the return on bond prices and the return on the Shariah index. The maximum likelihood estimates for OLS residuals were 15189.5, and the degree of freedom for the OLS residuals model was 3.3309, which was less than 30, showing that the model was able to account for the fat-tailed structure of the pricing index distribution. Significant coefficients of volatility and correlations indicate that the parameter for bond prices is astonishingly near to zero.



Table 3

*Estimates  $\lambda_{i1}$  and  $\delta_1$  for bond variables under review with Shariah index*

Parameter		Estimate	SE	T-Ratio	[Prob]
Lamda 1 ( $\lambda_i$ )	Shariah Index	0.9572	0.0070	137.3565	[0.000]
	Conventional bond	0.6214	0.0071	87.2785	[0.000]
	Corporate bond	0.7890	0.0111	66.9904	[0.000]
	Corporate sukuk	0.7198	0.0105	68.3917	[0.000]
	Government bond	0.6096	0.0076	80.7366	[0.000]
	Government sukuk	0.6239	0.0094	66.3097	[0.000]
Delta 1 ( $\delta_1$ )		0.9490	0.0025	384.4254	[0.000]
Maximized likelihood	log-	15189.5000			
Degree of freedom (df)		3.3309			

Note:  $\lambda_{i1}$  are decay factors for variance and covariance, respectively.

The unconditional volatilities of the five types of bonds and Shariah index return are presented in Table 4. The unconditional volatilities of bond indexes and the Shariah index ranged from 0.2219 to 6.6930, representing a low range. These data suggested that there was less fluctuation in this relationship, but there was more volatility in the prices of government bonds and government sukuk. The volatilities of these two assets were, respectively, 6.6930 and 5.7059.

The connection between corporate sukuk and other types of bonds appeared to be the strongest at 0.0257. However, the positive correlation between corporate sukuk and Shariah index was only 2.5%. It was also determined that the association was weak and not too strong. Government sukuk and conventional bonds had the lowest connection with the Shariah index, both with a correlation of 0.0066. Except for government sukuk and conventional bond, all bond indices have a positive connection with the Shariah index.

Table 4

*Estimated unconditional volatility matrix for the bond prices return and Shariah index return*

Variable	Shariah Index	Conventional bond	Corporate bond	Corporate sukuk	Government bond	Government sukuk
Shariah Index	0.3340					
Conventional bond	-	4.3098				
Corporate bond	0.0105	0.0045	0.4437			
Corporate sukuk	0.0257	0.6137	0.0156	0.2219		
Government bond	0.0012	0.6456	-0.0039	0.3640	6.6930	
Government sukuk	-	0.9976	-0.0021	0.6098	0.6671	5.7059
	0.0066					

The findings of the DCC-GARCH model of bond indexes and the Shariah index are displayed in Figure 1. The analysis revealed that business sukuk had the lowest volatility, whereas government sukuk had the highest volatility. The remaining bonds, corporate bonds and conventional bonds, appeared to follow the same trajectory as corporate sukuk. Moreover, the data suggest that investing in the bond market could give investors with diversification benefits.

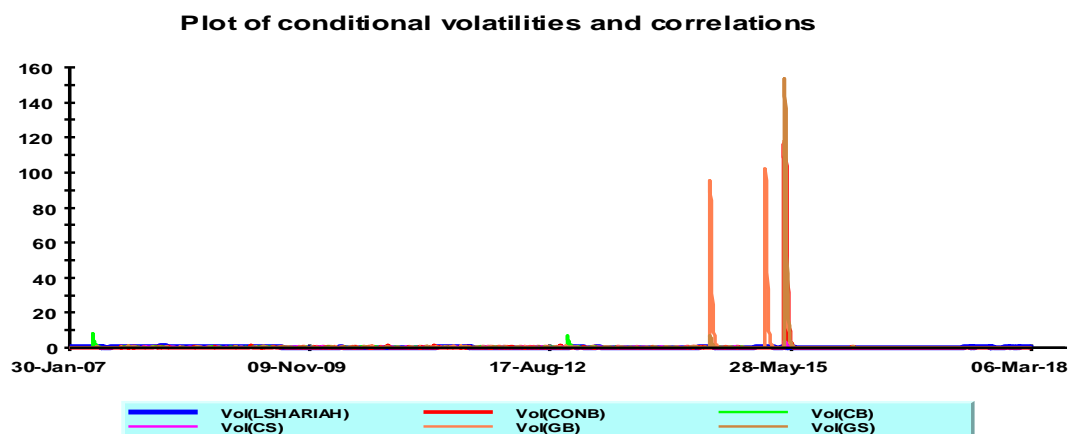


Figure 1: Conditional Volatilities of Bond Index Return with Shariah Index Return

Figure 2 displays the estimated average correlations between conventional bonds, corporate bonds, corporate sukuk, government bonds, and government sukuk and the Shariah index. The average correlation between bonds and the Shariah index was below 0.5, notwithstanding their volatility during the data period. For instance, the computed correlations revealed that the correlations between bond indexes were inversely correlated with their characteristic levels.

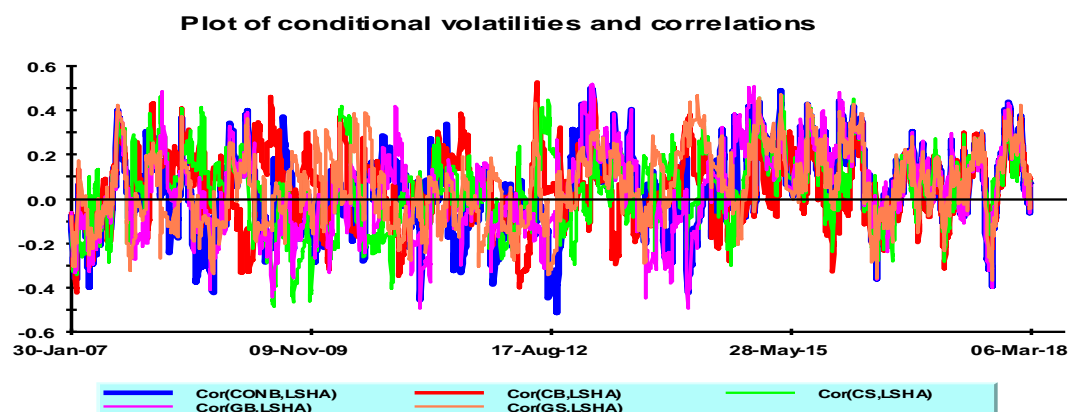


Figure 2: Conditional Correlation of Bond Index Return with Shariah Index

All calculated parameters for the temporal lag of the variable of the conventional bond return series were close to zero (-0.49920) but significant at the 5% significance level. Individual OLS estimations demonstrated that the estimated parameter for the variable's temporal lag was suitable. The underlying multivariate GARCH model was derived from the parameters LSHARIAH LSHARIAH(-1) C; CONB CONB(-1) C; CB CB(-1) C; CS CS(-1) C; GB GB(-1) C; and GS GS(-1) C of the t-DCC model on the OLS residuals. Table presents the estimation of the traditional bond equation (Appendix A).



## Conclusion

The time-frequency domain analysis undertaken in this study can benefit from the Malaysian sectoral index portfolio diversification. Rarely discussed in the realm of finance is the dynamic relationship between the return on Malaysian stocks and the comprehensive bond sector. This study sheds new light on the co-movement relationship between Malaysian bond indices between 2007 and 2019. Using MGARCH-DCC, this study distinguishes the time-frequency link between Shariah return in order to evaluate the issue in depth.

Due to their extremely low conditional correlation, conventional bonds, government sukuk, and corporate sukuk are excellent for fixed-income investors. In addition, the three types of bonds show a negative conditional correlation with the Shariah index, which is a positive sign for individual and institutional investors seeking diversification benefits. Furthermore, the MGARCH-DCC results reveal that all bond indices except government sukuk and conventional bonds have a positive association with the Shariah index. The analysis demonstrates that the conditional correlation between bonds and the Shariah index appears weaker than between bonds and the KLCI index. It implies that the bonds give investors with diversification benefits. Intriguingly, government sukuk is likely to result in more diversification benefits, and results pertaining to government sukuk indicate the lowest association with Shariah indices.

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