**Spillovers between the Islamic gold-backed cryptocurrencies and equity markets during COVID-19: A sectorial analysis**

**Abstract**

This study examines the return and volatility transmission between the Islamic gold-backed cryptocurrencies (Onegram and X8X) and global Islamic equity sectors during the pre-COVID and COVID-19 periods. We also estimate the optimal weights, hedge ratios, and hedging effectiveness for all pairs of markets. Our results suggest that the COVID-19 crisis intensified the spillover effect between the selected Islamic assets. We show that investors could increase their allocations in Onegram gold-backed cryptocurrency to reduce the risk of the equity sector portfolio during the COVID-19 pandemic. Moreover, the hedging costs for all pairs have increased during the COVID-19 period in comparison to the pre-pandemic level. Finally, the analysis of hedging effectiveness suggests that investors can reduce the risk of Islamic sectorial equity portfolios by adding the Islamic sharia-based cryptocurrencies during both sample periods.

**Keywords:** spillovers, stablecoins, Islamic cryptocurrencies, gold-backed cryptocurrencies, Islamic equity sectors, COVID-19, hedging effectiveness

**JEL code**: C58, F39, G11, G15.

1. **Introduction**

In presence of the high uncertainty amplified by the COVID-19 pandemic, investors are in search of new investment opportunities that can offer higher hedging effectiveness for their diversified portfolios. Islamic financial markets have been previously considered as a safe haven assets, since they were decoupled from traditional financial markets during past crises (Al-Yahyaee et al., 2020), however, the COVID-19 pandemic and social isolation negatively affected both Islamic and conventional markets (e.g., Sherif, 2020; Chowdhury et al., 2021; Yarovaya et al., 2021a; Bugan et al., 2021; Hung and Vo, 2021; Hasan et al., 2021). Thus, Islamic portfolio investors and managers need to adjust their portfolio allocation by adding other Sharia-compliant safe-haven assets and portfolio diversifiers. The most recent innovations in finance, cryptocurrencies, became a popular choice of portfolio managers during the COVID-19 crisis (e.g., Corbet et al., 2020a; Col Conlon et al., 2020; Goodell and Goutte, 2021; Iqbal et al., 2021; Mariana et al., 2021; Huang et al., 2021), however, whether these new assets are Sharia-compliant? In fact, the Islamic gold-backed cryptocurrencies have been recently introduced offering additional diversification potential for Islamic portfolio managers (Aloui et al., 2021), i.e. their value is pegged to gold and these assets seem to be Sharia compliant. The Sharia compliance resticts the Muslim investors from speculation; while the opportunity to exchange these assets to certain quantity of physical gold adds additional benefit of having intrinsic value (Aloui et al., 2021), which ultimately address price volatility and speculation. In this paper, we aim to assess whether Islamic gold-backed cryptocurrencies can be used as an effective hedge or diversifier during the COVID-19 pandemic.

Islamic finance industry is growing fast and the total worth of Islamic financial service industry (Takaful, Islamic capital markets, and Islamic banking) reached $2.7 trillion and 10.7 percent growth rate in 2020. Moreover, the growth rate and worth of Islamic capital markets reached 26.9 perecent and $0.83 trillion in the year of 2020, respectively.[[1]](#footnote-2) From an Islamic perspective, it is prohibited for Muslims to invest in non-Sharia compliant assets. Therefore only Shariah-compliant assets traditionally used to diversity the risk of Islamic equity portfolios (e.g., Aloui et al., 2015; Maghyereh et al., 2018; Maghyereh et al., 2019; Alahouel and Loukil, 2021; Trabelsi, 2019). Aloui et al. (2015) analyse the relationship between Sukuk and Islamic equity markets in Gulf Cooperation Countries (GCC) during the bull and bear states of economies. They find that the relationship is negative (positive) between the Sukuk and Islamic equities during the bear (bull)market, therefore Sukuk has been reported as a safe haven asset for Islamic equities during the turbulent periods. More recently, Alahouel and Loukil (2021) investigate the relationships between the Sukuk and Islamic equity markets, however, in contrast to earlier studies, the findings report the positive association between Sukuk and Islamic equity markets indicating diminishing benefits of portfolio diversification. However, the direction of the relationship changes for the short-run during the high financial uncertainty regimes.

Gold is undoubtedely the most commonly used hedge and diversifier during the crisis periods (Baur and McDermott, 2010; Bredin et al., 2015; Yousaf, 2021: Kinateder et al., 2021). Flight-to-safety behaviour and increased allocations in gold have been evident for many past crises. In Islamic finance, Maghyereh et al. (2018) report that the addition of gold in Islamic equity portfolios is useful for portfolio optimization and diversification, while Maghyereh et al. (2019) compared the linkages between gold and Islamic equity markets during different investment horizons confirming the hedging properties of gold. Trabelsi (2019) examines the integration between regional Islamic equity markets, crude oil, bonds, and gold markets showing only weak integration between different assets. These results suggest that the diversification benefits can be achieved by adding crude oil and gold in the Islamic equity portfolios. Hassan et al. (2021) explore the safe haven features of various assets (including gold) against Islamic financial markets during the global financial crisis and the COVID-19. They find that gold is found to be highly productive as safe haven against Islamic financial markets during the global financial crisis compared to the COVID-19 crisis. Based on the above-mentioned literature, we can see that only traditional Sharia-compliant assets (i.e., gold and Sukuk, etc.) were examined in the context of Sharia-compliant equity portfolios. However, Islamic cryptocurrencies, as a new Sharia-compliant assets, have not yet been examined, therefore this paper aims to adderess this literature gap.

The cryptocurrency markets have attracted a high attention of retail and institutional investors, big Tech companies, media, regulators, policy markets in the last few years, and especially, during the COVID-19 pandemic. Siwantoro et al. (2020) explored the suitability of cryptocurrency as money from the Islamic perspective and expressed scepticism regarding cryptocurrency adoption in Muslim countries. While other authors discussed some potential for cryptocurrency to become more suitable for Islamic Finance world (e.g. eddine Bedoui and Robbana, 2019; Abubakar et al., 2019; Kakkattil, 2019; Avedh et al., 2020)[[2]](#footnote-3). Apart from the Sharia-compliant cryptocurrencies assets, a few recent studies have also examined the role of non-Sharia-compliant cryptocurrencies (i.e., Bitcoin) in Islamic Sharia-compliant portfolios. Mensi et al. (2020) investigate the causal relationships between Bitcoin (conventional cryptocurrency) and the regional Islamic equity indices and find that Bitcoin affects the regional Islamic equity markets including the Asia Pacific and Japan. Rehman et al. (2020) examine the Islamic equity-Bitcoin nexus and report the volatility spillover between the Bitcoin and Islamic equity market. Thus, we contribute to this literature by providing a novel results important for Islamic investors and aim to answer the question: *Are Islamic digital assets able to diversify the risk of Islamic equity portfolios during the times of increased uncertainty?*

This study aims to examine the return and volatility spillover between the Islamic sharia complaint gold-backed cryptocurrencies and Islamic global equity sectorial markets before and during COVID-19 pandemic. Following Aloui et al., (2021), we use the two Sharia-compliant cryptocurrencies for analysis, namely Onegram and X8X. The Islamic global equity sectors include communication services, consumer discretionary, consumer staples, energy, financials, health care, industrials, information technology, materials, real estate, and utilities. Moreover, in order to provide insightful information to investors and portfolio managers regarding optimal portfolio allocation and optimal portfolio risk hedging, we also estimate the optimal weights, hedge ratios, and hedging effectiveness for the Islamic equity-cryptocurrency pairs during both sample periods.

The contributions of this study are twofolds. First, this study extends the literature of portfolio optimization and diversification by examining the role of Islamic gold-backed cryptocurrencies as an alternate new asset that can be used by Islamic investors. While cryptocurrencies are highly-speculative and risky assets, that are often associated with “*gambling*”, it is important to analyse what makes these new assets trully Sharia-compliant. To our best knowledge, to date only Aloui et al., (2021) examine the linkages of the Islamic and conventional gold-backed cryptocurrencies with the gold. They find that Sharia compliant (conventional) gold-backed cryptocurrencies are positively (negatively) correlated with the gold. In the Islamic finance literature, only a few Sharia-compliant assets were examined in the context of Islamic equity portfolios, like Sukuk, gold, and oil, however, this study explores the features of Islamic gold-backed cryptocurrencies against Islamic equity markets. For Islamic portfolio managers, this study provides useful insights regarding the features of Sharia complaint cryptocurrencies for Islamic equity portfolio diversification.

Second, this study extends the literature on the spillover effect during the COVID-19 pandemic by examining the spillovers between the Islamic equity-cryptocurrency pairs before and during COVID-19 offering insights not only for Islamic portfolio managers, but to any investor that wishes to hedge the pandemic risks. Several studies report that the return and/or volatility spillover is different during the pre-COVID-19 and the COVID-19 periods for the pairs of Islamic equity and other markets (Yarovaya et al., 2021a; Bahloul and Khemakhem, 2021; Adekoya et al., 2021; Hasan et al., 2021). More specifically, by considering gold-backed cryptocurrencies our paper adds to the literature on Stablecoins (Wang et al., 2020; Arner et al., 2020) and providing a novel empirical evidence on their behaviour during the pandemic.

The results of this study reveal that the return and volatility spillovers vary during the pre-COVID and the COVID-19 periods. We also estimate the optimal weights, hedge ratios, and hedging effectiveness for all pairs of markets during both sample periods. The optimal weights analysis suggests that investors should increase (decrease) their investment in Onegram (X8X) to reduce the risk of the equity sector-Onegram (equity sector- X8X) portfolio during the COVID-19. Moreover, the hedging cost for all pairs is highest during the COVID-19 compared to the pre-COVID-19 period. Lastly, the hedging effectiveness results suggest that investors can reduce the risk of Islamic sectorial equity portfolios by adding the Islamic sharia-based cryptocurrencies in their portfolios during both sample periods.

The structure of this study is as follows. Section 2 presents the methodology, Section 3 provides the data and preliminary analysis, Section 4 reports the results, and Section 5 concludes.

1. **Methodology**

We apply the VAR-BEKK-AGARCH model to estimate the return and volatility spillovers between the 11 Islamic equity sectors and 2 most-tradable Islamic gold-backed cryptocurrencies. Several studies have applied the VAR-BEKK-AGARCH model for the estimations of return and volatility spillover (e.g., Sadorsky, 2012; Salisu and Oloko, 2015; Symitsi and Chalvatzis, 2018; Yousaf and Ali, 2020; Yarovaya et al., 2021a; Yousaf and Ali, 2021). VAR-BEKK-GARCH model is better compared to other competitive models like VAR-DCC-GARCH and VAR-GARCH because of few reasons. Firstly, VAR-GARCH model is based on constant conditional correlations and does not provide the time-varying correlation. Secondly, VAR-DCC-GARCH and VAR-GARCH models encounter the convergence issues, especially in small data samples (Zhang and Choudhry, 2017; Yousaf and Ali, 2020). However, VAR-BEKK-GARCH model provides the time-varying correlations and this model can be estimated with comparatively lesser convergence issues (Chng, 2009; Yousaf, 2021). Apart from the comparative advantages, the main feature of BEKK-GARCH modle is the positive definiteness of the variance-covariance matrix. Moreover, the time-varying variance and covariance of BEKK-GARCH model is useful in estimating the optimal weights and hedge ratios.

Firstly, we focus on the return spillovers, that can be estimated through the vector autoregressive moving average specifications. The conditional mean equation is specified as:

|  |  |
| --- | --- |
|  | (1) |

*,* reprents the vector of the Islamic stock sector (x) and Islamic cryptocurrency (y) returns, respectively. denotes the 2 × 2 matrix of parameters, that estimate the two types of return spillover, (a) past own spillovers, (b) spillovers across x and y series. refers to the residual terms and indicates a sequence of identically and independently distributed random errors. . and are the conditional volatilities of x and y series, respectively. represents the covariance between both series. Besides, denotes the 2 × 2 symmetric positive definite matrix.

Secondly, we estimate the volatility spillovers using the full BEKK–AGARCH (1,1) specifications proposed by Kroner and Ng (1998), which necessitates positive definiteness restrictions for . The variance equations is defined as:

|  |  |
| --- | --- |
|  | (2) |

More specifically, A, B, C, and D matrices are presented as follows:

, , , (3)

Variable order is the Islamic equity sector (1) and Islamic cryptocurrency (2) in our analysis. C, A, B, and D indicate the constant, ARCH, GARCH, and asymmetric effect coefficients, respectively. More precisely, and capture the effect of past own shocks and volatility, respectively. () indicates the shocks (volatility) spillover from equity to cryptocurrency market. Lastly, show the asymmetric shock spillover within the equity market, whereas measures the asymmetric shock transmission from the equity sector to the cryptocurrency market. Using BFGS based algorithm, the maximum likelihood method is used to measure the parameters of the VAR-BEKK-AGARCH model.

Apart from return and volatility spillovers, this study also compute the optimal portfolio weights, hedge ratios, and hedging effectiveness using the conditional volatilities and covariance from the estimates of the VAR-BEKK-AGARCH model. Following Kroner and Ng (1998), the optimal portfolio weights between the equity sector and cryptocurrency are calculated as:

“ indicates the weight of Islamic stock() in a one-dollar portfolio of Islamic stock(x) and Islamic cryptocurrency() at time t”. Following Kroner and Sultan (1993), the hedge ratio can be measures though following formula:

, (5)

where denotes the optimal hedge ratio, showing that the cryptocurrency’s (y) short position is used to hedge the stock sector’s (x) long position

Finally, we estimate the hedging effectiveness (HE) score to compare the effectiveness of different portfolios. The higher score of HE indicates the higher risk reduction. According to the Ku et al. (2007), hedging effectiveness score can be calculated as:

, (6)

where denotes the unhedged portfolio (only x asset) return’s variance, and represents the variance of the x and y assets based portfolio’s returns..

1. **Data and Preliminary analysis**

We use the daily data of two gold-backed sharia-compliant cryptocurrencies, namely Onegram coin and X8X token. The data of Onegram coin and X8X coin are taken from the WorldCoinIndex.com and coinmarketcap.com, respectively. Both Onegram and X8X cryptocurrencies have Sharia compliant certifications. Each token of Onegram cryptocurrency is consisted of one gram gold and redeemable. Moreover, Onegram has low transaction fee, take few seconds in executing transaction, based on the proof of stake (PoS) blockchain technology which consume ten times less energy than its competitive proof of work (PoW) protocols.[[3]](#footnote-5) Onegram company sold the token of worth $400 million in its first year of launch (Vizcaino, 2018a). However, X8X is mainly backed by gold, as well as the eight fiat currencies (Vizcaino, 2018b). The market captalization of X8X is the $2.78 million on August 27, 2021.[[4]](#footnote-6) We choose these two Islamic cryptocurrencies because these are highly captalized and well known in Islamic world. Aloui et al. (2021) and Lahmiri and Bekiros (2019) also used the Onegram and X8X as representative of Islamic cryptocurrencies. Finally, the total cryptocurrency market captalization is the $2.035 trillion on August 27, 2021, it shows that Islamic cryptocurrency is comparatively small but has huge growth potential.

Moreover, the daily data of eleven S&P global Sharia-compliant sectoral equity indices are used, including communication services (S&P Global 1200 Shariah Communication Services) , consumer discretionary (S&P Global 1200 Shariah Consumer Discretionary), consumer staples (S&P Global 1200 Shariah Consumer Staples), Energy (S&P Global 1200 Shariah Energy), Financials (S&P Global 1200 Shariah Financials), Health care (S&P Global 1200 Shariah Health Care), Industrials (S&P Global 1200 Shariah Industrials), Information technology (S&P Global 1200 Shariah Information Technology), Materials (S&P Global 1200 Shariah Materials), Real estate (S&P Global 1200 Shariah Real Estate), and utilities (S&P Global 1200 Shariah Utilities). The data of Sharia-compliant sectoral equity indices are collected from S&P Global.[[5]](#footnote-7)

According to World Health Organization (WHO) the “unknown virus” was first reported on 31st December 2019,[[6]](#footnote-8) and since then the total number of confirmed COVID-19 cases and deaths are 120.91 million and 2.67 million, respectively, as per 18th March 2021[[7]](#footnote-9). Most of the financial markets have observed a huge decline during the different phases of the COVID-19 (Baker et al., 2020; Ramelli and Wagner, 2020; Zhang et al., 2020; Goodell, 2020; Corbet et al., 2020c; Ding et al., 2021; Yarovaya et al., 2021b), including Islamic financial markets (Damak, 2020). The returns of the Islamic equity sectors are also declined during the COVID-19 period compared to the pre-COVID-19 period (see. Table 1).

[Table 1 here]

In this paper, we use two sample periods for analysis, pre-COVID, i.e. from 15 February 2019 to 21 January 2020, and the COVID-19 period, 22 January 2020 to 26 February 2021[[8]](#footnote-10). Following Engelhardt et al. (2021) and Ashraf (2020), we start the sample period of the COVID-19 from the first day of Wuhan lockdown. Ramelli and Wagner (2020), and Goodell and Huynh (2020) report that the Coronavirus got the attention of corporate managers and the public after 21 January 2020, therefore we used this date instead of 31st December 2019 as in some other studies. The daily returns are calculated as: , where and denote the natural logarithm of closing price at day *t* and day *t-*1, respectively.

Table 1 provides the summary statistics of the Islamic Shariah-compliant cryptocurrencies and the global sectorial equity returns during the pre-COVID and during the COVID-19 periods. The summary statistics reveals that the average daily returns are highest in the financials equity sector, whereas lowest in the energy sector during the pre-COVID period. The unconditional volatility is the highest in Sharia-compliant cryptocurrencies, whereas the lowest in the consumer staples sector during the pre-COVID period. During the COVID-19, X8X cryptocurrency and the energy sector provide the highest and lowest returns, respectively. Moreover, the gold-backed cryptocurrencies are highly volatile and the Utilities sector is least volatile during the COVID-19.

Within cryptocurrencies, in terms of returns and unconditional volatilities, the Sharia-compliant cryptocurrencies perform better during the COVID-19 compared to the pre-COVID period. In contrast, within equity sectors, the returns (un-conditional volatilities) are low (high) in most equity sectors during the COVID-19 compared to the pre-COVID period. In addition to descriptive statistics, the time varying prices and returns are given in Figure 1 and 2, respectively, that shows the different patterns in almost all cryptocurrencies and equity sectors during the COVID-19 than the pre-COVID-19 period. Moreover, the skewness is negative in Islamic cryptocurrencies and stock sectors in both sample periods, showing the few large losses and frequent small gains in these markets. Kurtosis is greater than 3, indicating the higher investment risk in these markets. Al-Yahyaee et al. (2020) also report the negative skewness and greater than 4 kurtosis in Islamic equity sectors. Jarque-Bera statistics are significant in the majority of the markets during both sample periods, showing the normally distributed returns of Islamic cryptocurrencies and stock sectors.

The statistics of Augmented Dickey–Fuller test and Phillips–Perron test are significant in all markets during both sample periods, showing that all series are stationary. Lastly, the unconditional correlations are negative for the few pairs of Islamic cryptocurrency-equity sectors during the pre-COVID-19 period. However, these unconditional correlations become higher and positive during the COVID-19. Our results match with the findings of Corbet et al. (2020b), and Yousaf and Ali (2021), which find strong un-conditional correlations between cryptocurrency and stock markets during the COVID-19 compared to the pre-COVID-19 period, and we show that this is also evident for the selected gold-backed cryptocurrecncies.

[Figures 1 and 2 here]

1. **Results** 
   1. **Return and volatility spillovers**

We begin our empirical investigation by reporting the results of spillovers between Islamic equity sectors and Onegram cryptocurrency during pre-COVID-19 and the COVID-19 periods, as it shown in Tables 2 and 3. The findings presented in Panel A show that the lag returns of Islamic equity markets do not affect their current return in the majority of the cases during both sample periods, indicating that it is not possible to forecast future returns of Islamic equity markets through their past returns. However, the past returns of Onegram influence their current returns during both sample periods, suggesting the short-run predictive power of Onegram through their past returns. Our results match with the findings of Lahmiri and Bekiros (2019), which provide the evidence of multifratality in Onegram in non-crisis period, indicating the short term predictability of current return of Onegram through their past returns.

[Tables 2 and 3 here]

The cross-market return spillovers results reveal that the return spillover is unidirectional and negative from consumer services, consumer discretionary, information technology, and real estate sectors to the Onegram, and from Onegram to financials sector during the pre-COVID-19 period. The return transmission is unidirectional and negative from financials, industrials, information technology, materials, and real estate sectors to the Onegram during the COVID-19. The negative transmission shows that the decline in returns of Islamic equity sectors leads to the increase in search, demand, and ultimately prices for alternate assets like Onegram during the COVID-19. Moreover, it also implies that the returns of Islamic equity sectors are useful in forecasting the returns of Onegram during the COVID-19.

Panel B shows that past shocks affect the current volatility of the Islamic equity sectors and Onegram market during both sample periods. Ng et al. (2017), and Shahzad et al. (2018) also find that the past shocks of Islamic stock sectors and markets influence their current volatility. Moreover, lag volatility also influences the current volatility in Islamic sectorial equity and Onegram cryptocurrency market during both sample periods, implying the forecastibility of Islamic equity sectors and Onegram through their past returns. Ng et al. (2020) also find that the past volatility of Islamic equity sectors affects their current volatility. Lahmiri and Bekiros (2019) also report that volatility of Onegram can be forecasted through their past volatility. The results also reveal that the coefficients of past own volatility are higher compared to the past own shocks, suggesting that past volatility is a more important factor in forecasting the current volatility as compared to past shocks in Islamic sectorial equity and cryptocurrency markets. The cross-market shock spillover results reveal that the shock transmission is unidirectional from the communication services, energy, information technology, materials, and real estate sectors to the Onegram during the pre-COVID-19 period. During the COVID-19, the shock spillover is unidirectional from communication services, financials, and utilities sectors to the Onegram, and from Onegram to the consumer discretionary, industrials, and materials sectors.

The cross-market volatility spillovers are found to be unidirectional from Onegram to few equity sectors, like communication services, industrials, and materials sectors, during the pre-COVID-19 period. The volatility spillovers are not significant between Onegram and most equity sectors, therefore Onegram provides diversification opportunities for the portfolios of the majority of equity sectors during the pre-COVID-19. During the COVID-19, the volatility spillover is unidirectional from the consumer discretionary, consumer staples, health care, industrials, information technology, materials, and real estate sectors to the Onegram. Moreover, there is a bidirectional volatility transmission between the utilities sector and Onegram during the COVID-19. As volatility spillovers are not significant between the Onegram and few equity sectors (i.e., communication services, consumer staples, and energy) sectors during the COVID-19, suggesting that investors can get the maximum benefit of diversification by adding Onegram in the communication services, consumer staples, and energy Islamic sectorial equity portfolio during the COVID-19.

The asymmetric coefficients are found to be significant and positive during the pre-COVID-19, suggesting that negative own shocks increase the volatility more than the positive shocks in Islamic equity markets during the pre-COVID-19 period. During the COVID-19, the coefficients and are significant and positive, showing that the own negative shocks have a bigger effect than the positive shocks on the volatility of Islamic equity sectors and Onegram during the COVID-19. Lastly, the coefficient is also significant and positive in the majority of the cases during the COVID-19, showing that the negative shocks of most Islamic equity sectors increase the volatility more in Onegram compared to the positive shocks of Islamic equity markets during the COVID-19.

Similarly, Table 4 and 5 represents the return and volatility spillovers between the Islamic equity sectors and X8X during the pre-COVID and the COVID-19 periods. The results reveal that the past returns of Islamic equity sectors do not influence their current return during both sample periods, showing that past returns of Islamic equity sectors do not help forecast their future returns. However, the lag returns of X8X significantly and negatively affect their current returns during both sample periods, implying that past returns can be used to forecast the current return for the short run in X8X. Our results are in line with the findings of Lahmiri and Bekiros (2019), which provide the evidence of forecastibility X8X returns though their past returns. The results of cross-market return spillovers reveal that the return spillover is unidirectional and negative from the financial, materials, utilities sectors to X8X, and from X8X to consumer discretionary and industrials sectors during the pre-COVID-19 period. During the COVID-19, the return transmission in significant and positive from X8X to consumer discretionary, information technology, and material sectors, suggesting that X8X returns can be used to forecast the returns of these sectors during the COVID-19.

[Tables 4 and 5 here]

The effect of own past shocks is found to be significant (insignificant) on their current conditional volatility in X8X (Islamic equity sectors) during the pre-COVID-19 period. However, the coefficients of own past shocks are significant (insignificant) in Islamic equity sectors (X8X) during the COVID-19. The past volatility significantly influences the current volatility in Islamic equity sectors and X8X during both sample periods, implying the forecasting power of past volatility of Islamic equity sectors and X8X. Our results are similar to the findings of Rahim et al. (2009) and Chkili and Hamdi (2021), they report that lag volatility of Islamic equity markets affect their current volatility in crisis. Moreover, Lahmiri and Bekiros (2019) also find that past volatility of X8X is useful in forecasting their volatility. As the coefficients of past own volatility are higher compared to past own shocks, therefore the past own volatility is a more important factor in explaining current conditional volatility compared to the past own shocks in Islamic equity and cryptocurrency markets during both sample periods. Nazlioglu et al. (2015) also find the stronger impact of past volatility compared to past shocks on current volatility in Islamic equity markets in pre and during crises periods. The cross-market shock spillover analysis reveals that the shock spillover is significant from the majority of the sectors to X8X during the pre-COVID-19 period. In contrast, the past shock of X8X significantly affects the current conditional volatility of the consumer discretionary and financials sectors during the COVID-19.

The volatility spillover is found to be unidirectional from the health care and real estate to X8X, and from X8X to energy, materials, and utilities sectors during the pre-COVID-19 period. There is no volatility spillover between X8X, and communication services, consumer discretionary, consumer staples, financials, industrials, and information technology sectors, showing that the portfolio risk of these sectors can be reduced by adding X8X during non-crisis period. However, the volatility transmission unidirectional from X8X to energy, financials, information technology, materials, real estate, and utilities sectors during the COVID-19. Moreover, the volatility transmissions are not significant between X8X and communication services, consumer discretionary, consumer staples, health care, and industrials, proposing that X8X can be used to minimize the risk of few equity sectorial portfolios during the COVID-19.

The asymmetric coefficients , ,are significant and positive in the majority of the cases during the pre-COVID-19, suggesting that negative own shocks increase the volatility more than the positive shocks in Islamic equity sectors and X8X during the pre-COVID-19 period. Hassan et al. (2019) also find that the impact of bad news is higher compared to good news on the volatility of Islamic equity markets in non-crisis period. However, the coefficient is significant and positive in majority of the cases during the COVID-19. During both sample periods, the coefficients and are insignificant in majority cases, implying the no asymmetry exists across majority markets during the pre-COVID-19 and the COVID-19 periods.

* 1. **Time-varying correlations, optimal weights, hedge ratios, and hedging effectiveness**

At the next stage of our analysis we discuss th time-varying correlations, optimal weights, hedge ratios and hedging effectiveness of selected gold-backed cryptocurrencies in the context of Islamic equity sector portfolio. The average conditional correlations for the pairs of Islamic equity sector-Onegram and Islamic equity sector-X8X during pre-COVID and the COVID-19 periods are reported in Table 6. The average conditional correlations for the pairs of equity sector-Onegram and equity sector-X8X are negative in the majority of the cases during pre-COVID-19, implying that Islamic cryptocurrencies are strong hedge against the Islamic stock sectors in non-crisis period. During pre COVID-19, out of all pairs, X8X is strongly and negatively associated with the Information technology (-0.20) and Industrials (-0.18) sectors, showing that the addition of X8X in the portfolios of Information technology and Industrial sectors provide the highest benefit of diversification during the non-crisis period. However, these correlations between sectorial equity and cryptocurrency markets become positive during the COVID-19. We also illustrate the time-varying conditional correlations for the pairs of equity sector-Onegram and equity sector-X8X in Figures 3 and 4. These figures clearly reveal that the patterns of correlations for all pairs are different during the COVID-19 period compared to the pre-COVID-19 period, suggesting that investors should continuously adjust their portfolios, especially in transmission period from non-crisis to crisis, to make their portfolios resistant to the crisis episodes. The highest connectedness between Islamic cryptocurrency and most of the Islamic equity sectors is observed in the first quarter of 2020 (initial phase of the COVID-19), implying that the Islamic cryptocurrencies provides the lesser benefits of diversification against the portfolio of Islamic equity sectors during the peak of crisis. Ali et al. (2021) and Naeem et al. (2021) also provide the evidence of higher connectedness between Islamic markets during the COVID-19 pandemic compared to the pre COVID-19 period.

[Table 6 here]

[Figure 3 & 4 here]

Table 7 represents the optimal weights, hedge ratios, and hedging effectiveness for the pairs of equity sector-Onegram and equity sector-X8X during pre-COVIDand the COVID-19 periods. For the pairs of equity sector-Onegram, the optimal weights are found to be lower during the COVID-19 compared to the weights in the pre-COVID-19 period, suggesting that, for the portfolio of equity sector-Onegram, investors should increase their investment in Onegram during the COVID-19 period. For most of the pair of equity sector-X8X, the optimal weights are higher during the COVID-19 than the pre-COVID-19 period, implying that investors should increase (decrease) their investment in Islamic equity sectors (X8X) to diversify the risk of equity sector-X8X based portfolio during the COVID-19 period. For an instance, in case of energy sector-X8X pair, the optimal weights are lower during the COVID-19 (0.974) compared to the pre-COVID-19 (0.981), proposing that investors should increase their investment in X8X by 0.7 percent for the portfolio of energy sector-X8X during the COVID-19.

[Table 7 here]

Next, we discuss about the results of hedge ratios. The hedge ratio is financial sector-onegram pair is 0.069 during the COVID-19, indicates that $1 long position in financial sector can be hedged for 6.9 cents with a short position in Onegram cryptocurrency in the COVID-19. The interpretation of all pairs are not mentioned here for the purpose of brevity. Howere the hedge ratio for all pairs of equity sector-Onegram and equity sector-X8X are reported to be higher during the COVID-19 period compared to the pre-COVID-19 period, implying that the hedging cost is higher during the COVID-19. Lastly, we estimate the hedging effectiveness scores to compare the effectiveness (in terms of risk reduction) of all pairs of equity sector-cryptocurrency portfolios during both sample periods. The results show that the hedging effectiveness is positive in all pairs of equity sector-Onegram and equity sector-X8X during pre-COVID-19 and the COVID-19 periods, showing that the investors can reduce the portfolio risk using optimal portfolio weights during both sample periods. For all pair of equity sector-Onegram, the hedging effectiveness scores are higher during the COVID-19 compared to the pre-COVID-19. In contrast, the hedging effectiveness score is found to lower during the COVID-19 compared to the pre-COVID-19 period for all pairs of equity sector-X8X. Out of all pairs of equity sector-Onegram and equity sector-X8X, the highest hedgeding effectiveness is observed for the Information Technology sector-X8X portfolio (10.52%) during the pre-COVID-19 period, whereas the highest hedging effectiveness score is noticed for the energy sector-Onegram portfolio (33.5%) during the COVID-19. Hence, the addition of X8X (Onegram) in the portfolio of Information technology (energy) sector is suggested during the pre-COVID-19 (the COVID-19) to get maximum benefit of risk reduction. Overall, these hedging effectiveness scores suggest that investors can reduce maximum portfolio risk through adding Onegram in their portfolios of Islamic equity sectors during the COVID-19 period.

1. **Conclusion**

This study examines the return and volatility spillovers between the Islamic Sharia-compliant cryptocurrencies (Onegram and X8X) and eleven Islamic global equity sectors during pre-COVID and the COVID-19 periods using the VAR-BEKK-AGARCH model. The results reveal that the return and volatility spillovers for the pairs of equity sectors-Onegram and equity sectors-X8X vary in the pre-COVID and COVID-19 periods, suggesting that investors should rebalance their portfolios in response to the COVID-related uncertainty to maximise the diversification benefits.

We also assess the hedging properties of new Islamic gold-backed cryptocurrencies in the context of Islamic equity portfolios. The portfolio analysis reveals that the optimal weights are higher (lower) for the pairs of equity sector-X8X (equity sector-Onegram) during the COVID-19 compared to the pre-COVID-19. It implies that investors should increase (decrease) their investment in Onegram (X8X) to reduce the risk of the equity sector-Onegram (equity sector- X8X) portfolio during the COVID-19. The optimal hedge results reveal that hedging might be costly during the COVID-19 for all pairs of equity-cryptocurrency. Lastly, the hedging effectiveness results suggest that investors can reduce the risk of Islamic sectorial equity portfolios by adding the Islamic sharia-based cryptocurrencies in their portfolios during both sample periods.

Overall, this study extends the literature in the area of Islamic FinTech and Sharia alternate assets, providing a novel empirical evidence from Sharia-compliant gold-backed stablecoins. These results are useful for faith-based investors and portfolio managers who are interested in finding alternate Sharia complaint assets to reduce the risk of Islamic equity-based portfolios. Apart from the faith-based investors, these findings are also useful for the non-faith-based investors who invest in Islamic equity sectors or in gold-backed digital assets. The sharia compliance and gold-backup features make the Islamic cryptocurrencies effective alternate assets, therefore Islamic enterprenuers and Islamic Fintech organizations are suggested to introduce new Islamic gold backed cryptocurrencies. Major Islamic countries have gold reserve, therefore these countries are suggested to issue their own Islamic gold backed cryptocurrencies. Regulators are suggested to continuously monitor the Islamic cryptocurrency markets in addition to the Islamic equity markets, because the connectedness is observed to be higher between Islamic cryptocurrency and Islamic equity markets during the initial phase of the COVID-19. Policymakers are also suggested to consider the addition of Islamic gold back cryptocurrencies in their financial systems especially in Islamic countries, as these are effective alternate assets and; becoming stable with the passage of time, i.e., the unconditional volatility of Onegram declined from 36.2 in pre-COVID-19 to 4.5 in the COVID-19 period (See. Table 1). Further, in case of permissibility of Islamic gold-backed cryptocrrency in any country, the regulators should watch and ensure the backup (of gold) of these Islamic cryptocurrencies, and inform to their local customers in case of any deficiency. Sharia boards and advisors should promote and design new standards and models of Islamic sharia based cryptocurrecies to expand the market size of Islamic Fintech, as it has huge growth potential.

Our study uses the data of only two major Islamic gold backed cryptocurrencies, whereas future studies are suggested to add Hellogold (Islamic gold backed cryptocurrency) in analysis. Moreover, our study only explore the effectiveness of Islamic gold backed cryptocurrencies against the Islamic equity sectors, whereas future studies can examine the effectiveness of Islamic gold backed cryptocurrencies against the other Islamic (i.e., Sukuk, countrywise Islamic equity indices) and coneventional markets (i.e., stocks, bonds, cryptocurrencies, commodities, real estate, among others).

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**Table 1.** Summary Statistics

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| This Table provides the summary statistics of Islamic gold backed cryptocurrencies and Islamic equity sectors. Panel A and Panel B represent the summary statistics during pre-COVID-19 period and the COVID-19 period, respectively. a,b,c denote the level of significance at 1%, 5%, and 10%, respectively. Following are the full forms of different acronyms used in table: Com. services-communication services, consumer disc.-consumer discretionary, consumer stap-consumer staples, Information tech.-Information technology. Std. Dev.-standard deviation, JB-Jarque Berra, ADF-Augmented Dicky Fuller test, PP- Phillips–Perron test, Corr.-correlation. Q-stat refers to the Ljung-Box Q-statistics. | | | | | | | | | | | | | | | | | |
|  | | Mean | Maximum | Minimum | Std. Dev. | Skewness | Kurtosis | JB | Q-stat | | | ADF | | PP | Corr. with  Onegram | Corr. with  X8X |
|  | **Panel A. Pre-COVID-19** | | | | | | | | | | | | | | | | |
| Onegram | | -0.390 | 150.275 | -160.165 | 36.222 | -0.100 | 11.412 | 710.962a | 92.006a | | | -9.456a | | -62.711a | 1.000 | 0.053 |
| X8X | | -0.309 | 60.657 | -59.393 | 13.382 | 0.185 | 7.189 | 177.590a | 59.323a | | | -17.164a | | -27.119a | 0.053 | 1.000 |
| Com. Services | | 0.101 | 3.797 | -4.244 | 0.980 | -0.690 | 6.128 | 117.322a | 48.685a | | | -14.626a | | -14.618a | -0.034 | -0.157 |
| Consumer disc. | | 0.067 | 2.162 | -2.407 | 0.673 | -0.572 | 4.641 | 40.209a | 34.958a | | | -13.922a | | -13.867a | -0.002 | -0.107 |
| Consumer stap. | | 0.068 | 1.414 | -2.159 | 0.591 | -0.443 | 3.951 | 16.966a | 50.588a | | | -12.607a | | -15.909a | 0.050 | 0.011 |
| Energy | | -0.046 | 3.343 | -3.953 | 1.107 | -0.206 | 3.797 | 8.077b | 31.618a | | | -15.072a | | -15.066a | 0.018 | -0.149 |
| Financials | | 0.170 | 3.411 | -4.504 | 1.148 | -0.712 | 4.628 | 46.956a | 51.070a | | | -15.656a | | -16.668a | 0.039 | -0.093 |
| Health Care | | 0.067 | 1.731 | -2.567 | 0.666 | -0.809 | 4.414 | 46.337a | 39.644 | | | -13.692a | | -13.602a | -0.035 | -0.168 |
| Industrials | | 0.055 | 1.688 | -2.389 | 0.705 | -0.594 | 4.286 | 30.766a | 42.363b | | | -13.595a | | -13.601a | -0.008 | -0.106 |
| Information Tech. | | 0.140 | 2.557 | -3.840 | 0.953 | -0.680 | 4.887 | 54.341a | 40.247c | | | -15.318a | | -15.337a | 0.051 | -0.175 |
| Materials | | 0.045 | 1.915 | -1.964 | 0.684 | -0.340 | 3.561 | 7.813b | 40.218b | | | -12.917a | | -12.925a | 0.057 | -0.055 |
| Real Estate | | 0.045 | 1.984 | -2.393 | 0.674 | -0.205 | 3.415 | 3.413 | 33.939 | | | -14.881a | | -15.225a | 0.012 | 0.009 |
| Utilities | | 0.010 | 2.660 | -2.575 | 0.717 | -0.064 | 4.018 | 10.566a | 41.533b | | | -15.056a | | -15.468a | 0.005 | -0.014 |
|  | **Panel B. The COVID-19** | | | | | | | | | | | | | | | | |
| Onegram | | -0.001 | 15.171 | -21.805 | 4.520 | -0.366 | 6.124 | 123.093a | | 87.459a | -11.048a | |  | -42.851a | 1.000 | 0.137 |
| X8X | | 0.155 | 73.941 | -84.630 | 14.782 | -0.431 | 10.253 | 638.030a | | 34.677c | -18.926a | |  | -19.102a | 0.137 | 1.000 |
| Com. Services | | 0.110 | 6.228 | -10.807 | 1.882 | -0.726 | 8.102 | 336.503a | | 105.500a | -11.260a | |  | -20.175a | 0.127 | 0.186 |
| Consumer disc. | | 0.063 | 10.473 | -13.040 | 1.927 | -1.305 | 16.642 | 2306.995a | | 100.810a | -8.947a | |  | -17.753a | 0.137 | 0.175 |
| Consumer stap. | | -0.014 | 6.200 | -8.868 | 1.365 | -0.691 | 12.527 | 1108.187a | | 111.340a | -10.610a | |  | -18.852a | 0.190 | 0.180 |
| Energy | | -0.068 | 15.021 | -19.038 | 3.456 | -0.631 | 9.180 | 475.759a | | 76.121a | -18.953a | |  | -18.863a | 0.115 | 0.132 |
| Financials | | 0.062 | 14.827 | -15.139 | 2.768 | -0.383 | 11.400 | 850.877a | | 186.660a | -6.390a | |  | -23.031a | 0.152 | 0.153 |
| Health Care | | 0.025 | 5.969 | -7.591 | 1.437 | -0.376 | 8.748 | 401.871a | | 121.510a | -10.383a | |  | -19.631a | 0.169 | 0.153 |
| Industrials | | 0.025 | 10.429 | -10.732 | 1.907 | -0.677 | 12.069 | 1005.370a | | 85.827a | -5.310a | |  | -16.968a | 0.151 | 0.188 |
| Information Tech. | | 0.112 | 9.588 | -13.011 | 2.216 | -0.673 | 10.547 | 702.765a | | 171.109a | -23.823a | |  | -23.126a | 0.162 | 0.171 |
| Materials | | 0.059 | 9.408 | -9.914 | 1.712 | -0.885 | 12.067 | 1020.463a | | 74.327a | -9.892a | |  | -17.578a | 0.201 | 0.198 |
| Real Estate | | -0.010 | 7.927 | -14.609 | 2.108 | -0.798 | 12.832 | 1186.485a | | 108.400a | -9.618a | |  | -20.734a | 0.089 | 0.189 |
| Utilities | | 0.010 | 3.952 | -6.183 | 1.285 | -0.319 | 5.651 | 88.932a | | 27.480 | -15.698a | |  | -15.771a | 0.080 | 0.034 |

**Figure 1.** Prices



**Figure 2.** Returns



**Table 2.** Estimates of VAR-BEKK-AGARCH between Islamic equity sectors and Onegram during pre-COVID-19 crisis.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| This table provides the estimations of return and volatility spillovers between Islamic equity sectors and Onegram during pre-COVID-19 period. The mean equation in Panel A provides the results of returns spillovers, whereas the variance equation in panel B provides the results of shock and volatility spillovers. Panel C presents the diagnostic tests, including log-likelihood ratio, AIC test, BIC test, and Ljung-Box Q statistics. Following are the full forms of different acronyms used in the table:Com. services-communication services, consumer disc.-consumer discretionary, consumer stap-consumer staples, Information tech.-Information technology. Coeff-coefficient, p-val.-p-value.AIC and SIC criterias are used for the selection of number of lags. Q (20), and Q2(20) denotes Ljung-Box Q statistics of order 20 for autocorrelation applied to the standardized residuals and squared standardized residuals, respectively. Variable order is the Islamic sectoral equity market (1) and Onegram (2). denotes the returns spillover from Islamic sectoral equity market to Onegram. means the shock spillover from Islamic sectoral equity market to Onegram. refers to the volatility spillover from Islamic sectoral equity market to Onegram. | | | | | | | | | | | | | | | | | | | | | | | |
|  | **Com. services** | | **Consumer disc.** | | **Consumer stap.** | | **Energy** | | **Financials** | | **Health Care** | | **Industrials** | | **Information Tech.** | | **Materials** | | **Real Estate** | | **Utilities** | |
|  | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. |
| **Panel A. Mean Equation** | | | | | | | | | | | | | | | | | | | | | | | |
|  | 0.154 | 0.002 | 0.036 | 0.362 | 0.070 | 0.065 | -0.082 | 0.228 | 0.200 | 0.003 | 0.081 | 0.036 | 0.029 | 0.502 | 0.154 | 0.007 | 0.056 | 0.172 | 0.022 | 0.643 | 0.002 | 0.965 |
|  | 0.029 | 0.647 | 0.159 | 0.015 | 0.009 | 0.887 | -0.022 | 0.766 | 0.031 | 0.667 | 0.105 | 0.109 | 0.133 | 0.030 | 0.031 | 0.640 | 0.206 | 0.000 | 0.053 | 0.376 | 0.047 | 0.457 |
|  | -0.882 | 0.081 | -1.274 | 0.024 | 0.428 | 0.511 | -0.605 | 0.118 | -0.467 | 0.275 | -0.902 | 0.272 | -0.606 | 0.416 | -0.908 | 0.052 | -0.874 | 0.327 | -1.100 | 0.040 | -0.645 | 0.164 |
|  | -0.528 | 0.476 | -0.489 | 0.538 | -0.579 | 0.438 | -1.006 | 0.196 | -0.737 | 0.187 | -0.583 | 0.331 | -0.556 | 0.399 | -0.490 | 0.505 | -0.655 | 0.315 | -0.667 | 0.197 | -0.616 | 0.376 |
|  | 0.001 | 0.709 | -0.001 | 0.396 | 0.000 | 0.865 | -0.001 | 0.427 | -0.002 | 0.099 | -0.001 | 0.532 | -0.001 | 0.309 | -0.001 | 0.184 | -0.002 | 0.185 | 0.000 | 0.866 | -0.001 | 0.235 |
|  | -0.407 | 0.000 | -0.413 | 0.000 | -0.432 | 0.000 | -0.420 | 0.000 | -0.377 | 0.000 | -0.390 | 0.000 | -0.420 | 0.000 | -0.418 | 0.000 | -0.418 | 0.000 | -0.475 | 0.000 | -0.410 | 0.000 |
| **Panel B. Variance Equation** | | | | | | | | | | | | | | | | | | | | | | | |
|  | 0.016 | 0.063 | 0.148 | 0.000 | 0.030 | 0.123 | 0.061 | 0.405 | 0.209 | 0.009 | 0.008 | 0.314 | 0.188 | 0.004 | 0.232 | 0.000 | 0.417 | 0.000 | 0.478 | 0.000 | 0.176 | 0.000 |
|  | 2.845 | 0.098 | -0.040 | 0.865 | 2.803 | 0.003 | -2.763 | 0.033 | -0.044 | 0.888 | -2.847 | 0.003 | -0.332 | 0.316 | -0.043 | 0.885 | -0.527 | 0.093 | -1.912 | 0.005 | 0.182 | 0.537 |
|  | 0.005 | 1.000 | 2.929 | 0.002 | 0.000 | 1.000 | 0.000 | 1.000 | 2.761 | 0.001 | 0.000 | 1.000 | 2.905 | 0.001 | 2.901 | 0.000 | 2.944 | 0.008 | 0.000 | 1.000 | 2.888 | 0.002 |
|  | -0.040 | 0.173 | -0.355 | 0.019 | -0.168 | 0.003 | -0.325 | 0.034 | -0.340 | 0.000 | -0.223 | 0.071 | -0.048 | 0.217 | -0.268 | 0.001 | -0.453 | 0.004 | 0.373 | 0.000 | -0.041 | 0.745 |
|  | 0.668 | 0.006 | 0.015 | 0.949 | 0.911 | 0.137 | 0.570 | 0.022 | -0.179 | 0.401 | -0.185 | 0.613 | 0.248 | 0.344 | 0.570 | 0.031 | 1.231 | 0.064 | 1.223 | 0.002 | -0.126 | 0.643 |
|  | 0.001 | 0.264 | -0.001 | 0.225 | -0.001 | 0.220 | 0.000 | 0.926 | -0.003 | 0.040 | -0.001 | 0.317 | -0.001 | 0.249 | -0.002 | 0.121 | -0.004 | 0.185 | 0.001 | 0.242 | 0.000 | 0.705 |
|  | 0.450 | 0.000 | 0.438 | 0.000 | 0.433 | 0.000 | 0.459 | 0.000 | 0.404 | 0.002 | 0.413 | 0.000 | 0.440 | 0.000 | 0.438 | 0.000 | 0.436 | 0.000 | 0.500 | 0.000 | 0.431 | 0.000 |
|  | 0.993 | 0.000 | 0.910 | 0.000 | 0.967 | 0.000 | 0.981 | 0.000 | 0.921 | 0.000 | 0.984 | 0.000 | 0.904 | 0.000 | 0.855 | 0.000 | 0.561 | 0.004 | 0.612 | 0.000 | 0.937 | 0.000 |
|  | -0.034 | 0.508 | -0.001 | 0.995 | -0.113 | 0.350 | 0.171 | 0.264 | 0.211 | 0.019 | -0.054 | 0.523 | -0.137 | 0.615 | 0.043 | 0.685 | 1.031 | 0.186 | 2.202 | 0.009 | 0.023 | 0.871 |
|  | -0.001 | 0.323 | 0.001 | 0.158 | 0.001 | 0.008 | 0.000 | 0.953 | 0.001 | 0.004 | 0.001 | 0.189 | 0.001 | 0.167 | 0.001 | 0.172 | 0.003 | 0.033 | 0.000 | 0.816 | 0.000 | 0.524 |
|  | 0.891 | 0.000 | 0.892 | 0.000 | 0.894 | 0.000 | 0.888 | 0.000 | 0.900 | 0.000 | 0.899 | 0.000 | 0.892 | 0.000 | 0.893 | 0.000 | 0.885 | 0.000 | 0.876 | 0.000 | 0.896 | 0.000 |
|  | 0.122 | 0.089 | 0.456 | 0.000 | 0.235 | 0.027 | 0.260 | 0.001 | 0.023 | 0.898 | 0.189 | 0.039 | 0.436 | 0.000 | 0.543 | 0.001 | 0.293 | 0.042 | 0.000 | 0.997 | 0.339 | 0.000 |
|  | -0.033 | 0.712 | -0.398 | 0.463 | -0.351 | 0.498 | -0.354 | 0.253 | 0.109 | 0.635 | 0.348 | 0.304 | 0.174 | 0.811 | -0.399 | 0.257 | -0.557 | 0.612 | 0.000 | 0.996 | 0.197 | 0.742 |
|  | -0.003 | 0.040 | 0.001 | 0.419 | -0.001 | 0.311 | -0.002 | 0.234 | 0.001 | 0.512 | 0.001 | 0.110 | 0.002 | 0.087 | 0.001 | 0.606 | 0.006 | 0.093 | 0.000 | 0.996 | -0.001 | 0.276 |
|  | 0.046 | 0.539 | -0.093 | 0.630 | -0.110 | 0.495 | -0.055 | 0.595 | -0.197 | 0.617 | -0.125 | 0.487 | -0.051 | 0.749 | -0.035 | 0.778 | -0.194 | 0.280 | 0.000 | 0.998 | -0.024 | 0.925 |
| **Panel C: Diagnostic Tests** | | | | | | | | | | | | | | | | | | | | | | | |
| LogL | -1,329 |  | -1,232 |  | -1,215 |  | - |  | -1,369 |  | - |  | -1,252 |  | -1,315 |  | -1,245 |  | - |  | -1,260 |  |
| AIC | 12.75 |  | 12.08 |  | 11.90 |  | 13.07 |  | 13.13 |  | 11.98 |  | 12.14 |  | 12.77 |  | 12.00 |  | 12.12 |  | 12.29 |  |
| SIC | 13.85 |  | 13.18 |  | 13.00 |  | 14.21 |  | 14.23 |  | 13.08 |  | 13.24 |  | 13.86 |  | 13.10 |  | 13.22 |  | 13.39 |  |
| [20] | 31.86 | 0.04 | 19.49 | 0.49 | 23.87 | 0.25 | 18.70 | 0.54 | 23.05 | 0.29 | 19.59 | 0.48 | 15.46 | 0.75 | 12.36 | 0.90 | 10.46 | 0.96 | 25.05 | 0.20 | 26.15 | 0.16 |
| [20] | 33.91 | 0.03 | 35.00 | 0.02 | 35.94 | 0.02 | 35.55 | 0.02 | 32.67 | 0.04 | 35.13 | 0.00 | 35.45 | 0.02 | 35.31 | 0.02 | 35.81 | 0.02 | 33.26 | 0.03 | 34.85 | 0.02 |
| [20] | 14.23 | 0.82 | 30.60 | 0.06 | 27.09 | 0.13 | 19.36 | 0.50 | 14.93 | 0.78 | 25.68 | 0.18 | 17.61 | 0.61 | 20.49 | 0.43 | 28.50 | 0.10 | 18.09 | 0.58 | 19.87 | 0.47 |
| [20] | 1.40 | 0.98 | 1.68 | 0.99 | 1.70 | 0.99 | 1.63 | 0.98 | 1.61 | 0.99 | 1.70 | 0.99 | 1.68 | 0.98 | 1.67 | 0.98 | 1.80 | 0.98 | 3.32 | 0.99 | 1.65 | 0.97 |

**Table 3.** Estimates of VAR-BEKK-AGARCH between Islamic equity sectors and Onegram during the COVID-19 period.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| This table provides the estimations of return and volatility spillovers between Islamic equity sectors and Onegram during the COVID-19 period. The mean equation in Panel A provides the results of returns spillovers, whereas the variance equation in panel B provides the results of shock and volatility spillovers. Panel C presents the diagnostic tests, including log-likelihood ratio, AIC test, BIC test, and Ljung-Box Q statistics. Following are the full forms of different acronyms used in the table: Com. services-communication services, consumer disc.-consumer discretionary, consumer stap-consumer staples, Information tech.-Information technology. Coeff-coefficient, p-val.-p-value.AIC and SIC criterias are used for the selection of number of lags. Q (20), and Q2(20) denotes Ljung-Box Q statistics of order 20 for autocorrelation applied to the standardized residuals and squared standardized residuals, respectively. Variable order is the Islamic sectoral equity market (1) and Onegram (2). denotes the returns spillover from Islamic sectoral equity market to Onegram. means the shock spillover from Islamic sectoral equity market to Onegram. refers to the volatility spillover from Islamic sectoral equity market to Onegram. | | | | | | | | | | | | | | | | | | | | | | |
|  | **Com. services** | | **Consumer disc.** | | **Consumer stap.** | | **Energy** | | **Financials** | | **Health Care** | | **Industrials** | | **Information Tech.** | | **Materials** | | **Real Estate** | | **Utilities** | |
|  | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. |
| **Panel A. Mean Equation** | | | | | | | | | | | | | | | | | | | | | | |
|  | 0.068 | 0.472 | 0.133 | 0.019 | 0.004 | 0.939 | 0.053 | 0.725 | -0.006 | 0.949 | 0.037 | 0.530 | 0.071 | 0.000 | 0.153 | 0.021 | 0.101 | 0.105 | -0.026 | 0.663 | 0.044 | 0.504 |
|  | 0.030 | 0.684 | 0.068 | 0.194 | -0.095 | 0.044 | -0.010 | 0.880 | -0.162 | 0.021 | -0.096 | 0.134 | 0.067 | 0.356 | -0.201 | 0.000 | 0.042 | 0.477 | -0.111 | 0.019 | -0.016 | 0.807 |
|  | -0.157 | 0.373 | -0.161 | 0.131 | 0.001 | 0.996 | -0.087 | 0.319 | -0.265 | 0.006 | -0.160 | 0.195 | -0.176 | 0.055 | -0.122 | 0.000 | -0.276 | 0.027 | -0.223 | 0.000 | -0.138 | 0.469 |
|  | 0.161 | 0.508 | -0.157 | 0.524 | 0.112 | 0.703 | -0.072 | 0.794 | 0.035 | 0.881 | -0.010 | 0.968 | -0.123 | 0.643 | 0.083 | 0.000 | -0.059 | 0.774 | -0.001 | 0.996 | 0.027 | 0.899 |
|  | -0.009 | 0.664 | 0.000 | 0.980 | -0.007 | 0.744 | -0.040 | 0.269 | -0.029 | 0.257 | 0.005 | 0.696 | -0.014 | 0.383 | -0.003 | 0.872 | -0.007 | 0.652 | 0.002 | 0.916 | 0.012 | 0.475 |
|  | -0.358 | 0.000 | -0.415 | 0.000 | -0.366 | 0.000 | -0.379 | 0.000 | -0.391 | 0.000 | -0.340 | 0.000 | -0.400 | 0.000 | -0.311 | 0.000 | -0.391 | 0.000 | -0.404 | 0.000 | -0.400 | 0.000 |
| **Panel B. Variance Equation** | | | | | | | | | | | | | | | | | | | | | | |
|  | 0.491 | 0.000 | 0.132 | 0.081 | 0.245 | 0.510 | 0.703 | 0.065 | 0.266 | 0.475 | 0.239 | 0.007 | 0.178 | 0.055 | 0.457 | 0.000 | 0.057 | 0.419 | 0.293 | 0.000 | 0.251 | 0.188 |
|  | -0.233 | 0.787 | -1.779 | 0.000 | 1.531 | 0.020 | -1.226 | 0.203 | -1.230 | 0.653 | -0.322 | 0.657 | -0.498 | 0.534 | -0.034 | 0.946 | 1.817 | 0.000 | 0.271 | 0.611 | 0.351 | 0.793 |
|  | 2.562 | 0.000 | 0.000 | 1.000 | 2.336 | 0.021 | 1.108 | 0.350 | 1.906 | 0.221 | 1.844 | 0.000 | 1.654 | 0.001 | 1.914 | 0.000 | 0.000 | 1.000 | 1.808 | 0.000 | 1.589 | 0.000 |
|  | 0.319 | 0.095 | 0.281 | 0.002 | -0.219 | 0.074 | 0.216 | 0.014 | 0.451 | 0.000 | 0.253 | 0.010 | 0.311 | 0.000 | 0.329 | 0.000 | -0.192 | 0.062 | 0.388 | 0.000 | 0.226 | 0.002 |
|  | 1.033 | 0.000 | 0.105 | 0.563 | -0.023 | 0.963 | 0.208 | 0.131 | 0.290 | 0.086 | 0.291 | 0.226 | 0.029 | 0.851 | 0.057 | 0.600 | 0.011 | 0.949 | -0.041 | 0.735 | -0.387 | 0.064 |
|  | -0.038 | 0.352 | -0.075 | 0.000 | -0.007 | 0.913 | -0.069 | 0.345 | 0.035 | 0.294 | 0.017 | 0.393 | -0.033 | 0.068 | -0.028 | 0.120 | 0.049 | 0.007 | 0.024 | 0.152 | -0.014 | 0.472 |
|  | 0.337 | 0.002 | 0.161 | 0.088 | 0.358 | 0.044 | -0.191 | 0.303 | -0.238 | 0.049 | -0.337 | 0.000 | 0.173 | 0.053 | -0.315 | 0.001 | -0.205 | 0.015 | -0.143 | 0.053 | -0.158 | 0.107 |
|  | 0.843 | 0.000 | 0.865 | 0.000 | 0.886 | 0.000 | 0.893 | 0.000 | 0.833 | 0.000 | 0.885 | 0.000 | 0.883 | 0.000 | 0.878 | 0.000 | 0.928 | 0.000 | 0.878 | 0.000 | 0.905 | 0.000 |
|  | -0.069 | 0.489 | -0.109 | 0.055 | -0.300 | 0.224 | -0.013 | 0.786 | -0.108 | 0.078 | -0.202 | 0.059 | -0.073 | 0.156 | -0.089 | 0.051 | -0.088 | 0.163 | -0.024 | 0.632 | 0.442 | 0.158 |
|  | 0.015 | 0.838 | 0.045 | 0.000 | 0.003 | 0.975 | 0.066 | 0.160 | 0.089 | 0.054 | 0.031 | 0.140 | 0.023 | 0.028 | 0.013 | 0.455 | 0.026 | 0.032 | 0.022 | 0.060 | -0.050 | 0.000 |
|  | 0.556 | 0.001 | 0.817 | 0.000 | 0.576 | 0.001 | 0.847 | 0.000 | 0.731 | 0.000 | 0.762 | 0.000 | 0.827 | 0.000 | 0.763 | 0.000 | 0.812 | 0.000 | 0.818 | 0.000 | 0.820 | 0.000 |
|  | 0.436 | 0.012 | 0.444 | 0.000 | 0.579 | 0.014 | 0.424 | 0.049 | -0.259 | 0.335 | 0.368 | 0.000 | 0.471 | 0.000 | 0.339 | 0.000 | 0.333 | 0.000 | 0.184 | 0.295 | 0.407 | 0.009 |
|  | -0.012 | 0.976 | 0.780 | 0.029 | 1.271 | 0.045 | -0.022 | 0.912 | 0.433 | 0.309 | 1.312 | 0.033 | 0.719 | 0.035 | 0.926 | 0.014 | 0.730 | 0.058 | -0.679 | 0.072 | 1.346 | 0.056 |
|  | -0.030 | 0.541 | -0.017 | 0.705 | -0.065 | 0.256 | -0.008 | 0.895 | 0.020 | 0.761 | -0.024 | 0.269 | -0.016 | 0.618 | -0.041 | 0.106 | -0.026 | 0.434 | -0.018 | 0.632 | -0.113 | 0.004 |
|  | 0.368 | 0.014 | 0.599 | 0.000 | 0.176 | 0.868 | 0.387 | 0.001 | 0.474 | 0.062 | 0.537 | 0.008 | 0.552 | 0.001 | 0.497 | 0.009 | 0.573 | 0.001 | 0.517 | 0.002 | 0.074 | 0.781 |
| **Panel C: Diagnostic Tests** | | | | | | | | | | | | | | | | | | | | | | |
| LogL | -1,338 |  | -1,277 |  | -1,186 |  | -1,512 |  | -1,385 |  | -1,220 |  | -1,278 |  | -1,349 |  | -1,267 |  | -1,306 |  | -1,247 |  |
| AIC | 9.98 |  | 9.94 |  | 9.22 |  | 11.16 |  | 10.57 |  | 9.35 |  | 10.09 |  | 10.15 |  | 9.66 |  | 10.15 |  | 9.37 |  |
| SIC | 11.02 |  | 10.98 |  | 10.21 |  | 12.16 |  | 11.57 |  | 10.34 |  | 11.01 |  | 11.15 |  | 10.66 |  | 11.14 |  | 10.36 |  |
| [20] | 28.75 | 0.09 | 33.12 | 0.03 | 38.24 | 0.01 | 11.31 | 0.94 | 38.97 | 0.01 | 39.31 | 0.01 | 26.86 | 0.14 | 33.24 | 0.03 | 32.00 | 0.04 | 26.82 | 0.14 | 15.07 | 0.77 |
| [20] | 46.17 | 0.00 | 47.42 | 0.00 | 46.41 | 0.00 | 48.30 | 0.00 | 47.95 | 0.00 | 43.60 | 0.00 | 48.37 | 0.00 | 45.00 | 0.00 | 48.16 | 0.00 | 49.52 | 0.00 | 52.63 | 0.00 |
| [20] | 20.52 | 0.43 | 23.79 | 0.25 | 12.69 | 0.89 | 13.11 | 0.87 | 11.45 | 0.93 | 18.06 | 0.58 | 22.45 | 0.32 | 7.60 | 0.99 | 9.82 | 0.97 | 18.80 | 0.53 | 24.90 | 0.21 |
| [20] | 13.48 | 0.86 | 12.88 | 0.88 | 18.75 | 0.54 | 14.92 | 0.78 | 18.65 | 0.54 | 15.41 | 0.75 | 13.46 | 0.86 | 18.42 | 0.56 | 13.69 | 0.85 | 15.06 | 0.77 | 13.61 | 0.85 |

**Table 4.** Estimates of VAR-BEKK-AGARCH between Islamic equity sectors and X8X during pre-COVID-19 crisis.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| This table provides the estimations of return and volatility spillovers between Islamic equity sectors and X8X during the pre-COVID-19 period. The mean equation in Panel A provides the results of returns spillovers, whereas the variance equation in panel B provides the results of shock and volatility spillovers. Panel C presents the diagnostic tests, including log-likelihood ratio, AIC test, BIC test, and Ljung-Box Q statistics. Following are the full forms of different acronyms used in the table: Com. services-communication services, consumer disc.-consumer discretionary, consumer stap-consumer staples, Information tech.-Information technology. Coeff-coefficient, p-val.-p-value.AIC and SIC criterias are used for the selection of number of lags. Q (20), and Q2(20) denotes Ljung-Box Q statistics of order 20 for autocorrelation applied to the standardized residuals and squared standardized residuals, respectively. Variable order is the Islamic sectoral equity market (1) and X8X (2). denotes the returns spillover from Islamic sectoral equity market to X8X. means the shock spillover from Islamic sectoral equity market to X8X. refers to the volatility spillover from Islamic sectoral equity market to X8X Onegram. | | | | | | | | | | | | | | | | | | | | | | |
|  | **Com. services** | | **Consumer disc.** | | **Consumer stap.** | | **Energy** | | **Financials** | | **Health Care** | | **Industrials** | | **Information Tech.** | | **Materials** | | **Real Estate** | | **Utilities** | |
|  | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. |
| **Panel A. Mean Equation** | | | | | | | | | | | | | | | | | | | | | | |
|  | 0.158 | 0.007 | 0.037 | 0.309 | 0.078 | 0.033 | -0.042 | 0.561 | 0.203 | 0.002 | 0.049 | 0.257 | 0.041 | 0.344 | 0.174 | 0.000 | 0.019 | 0.635 | 0.035 | 0.378 | 0.014 | 0.718 |
|  | 0.085 | 0.233 | 0.160 | 0.025 | 0.012 | 0.879 | -0.029 | 0.665 | 0.029 | 0.717 | 0.238 | 0.001 | 0.156 | 0.055 | 0.062 | 0.312 | 0.186 | 0.002 | 0.060 | 0.304 | 0.045 | 0.549 |
|  | -0.851 | 0.297 | 1.055 | 0.502 | -0.870 | 0.677 | -0.735 | 0.190 | -1.412 | 0.059 | -0.638 | 0.729 | 1.685 | 0.302 | -0.688 | 0.460 | -2.111 | 0.056 | 0.335 | 0.748 | 1.357 | 0.000 |
|  | -0.592 | 0.426 | -0.820 | 0.237 | -0.501 | 0.708 | -0.795 | 0.252 | -0.407 | 0.554 | -0.501 | 0.500 | -0.594 | 0.415 | -0.453 | 0.508 | -0.557 | 0.294 | -1.040 | 0.172 | -0.683 | 0.000 |
|  | -0.006 | 0.248 | -0.006 | 0.003 | -0.003 | 0.398 | 0.001 | 0.866 | -0.004 | 0.482 | 0.000 | 0.969 | -0.008 | 0.013 | -0.002 | 0.683 | -0.002 | 0.565 | -0.005 | 0.155 | -0.004 | 0.106 |
|  | -0.234 | 0.000 | -0.278 | 0.000 | -0.348 | 0.065 | -0.317 | 0.000 | -0.297 | 0.000 | -0.293 | 0.000 | -0.275 | 0.000 | -0.301 | 0.000 | -0.323 | 0.000 | -0.280 | 0.000 | -0.322 | 0.000 |
| **Panel B. Variance Equation** | | | | | | | | | | | | | | | | | | | | | | |
|  | 0.124 | 0.324 | 0.149 | 0.027 | 0.158 | 0.850 | 0.095 | 0.152 | 0.243 | 0.071 | 0.322 | 0.057 | 0.210 | 0.006 | 0.211 | 0.014 | 0.022 | 0.218 | 0.626 | 0.000 | 0.045 | 0.537 |
|  | -7.113 | 0.000 | -4.217 | 0.127 | -3.284 | 0.924 | -5.747 | 0.000 | -0.970 | 0.752 | 5.121 | 0.001 | -1.571 | 0.620 | -3.863 | 0.210 | -7.890 | 0.000 | 0.550 | 0.643 | -6.758 | 0.000 |
|  | 0.000 | 1.000 | 7.489 | 0.000 | 8.138 | 0.623 | 0.000 | 1.000 | 6.785 | 0.000 | 0.000 | 1.000 | 6.874 | 0.000 | 5.371 | 0.014 | 0.000 | 1.000 | 0.000 | 1.000 | 4.420 | 0.002 |
|  | 0.347 | 0.001 | -0.030 | 0.715 | 0.241 | 0.171 | -0.001 | 0.987 | 0.362 | 0.000 | 0.097 | 0.179 | 0.086 | 0.624 | 0.405 | 0.004 | -0.070 | 0.118 | 0.315 | 0.012 | -0.151 | 0.006 |
|  | 1.374 | 0.155 | 6.068 | 0.008 | 3.913 | 0.556 | 3.642 | 0.002 | 2.006 | 0.110 | 10.570 | 0.000 | 8.299 | 0.000 | 4.896 | 0.026 | 3.034 | 0.103 | 2.829 | 0.009 | 3.002 | 0.117 |
|  | -0.008 | 0.356 | -0.010 | 0.007 | -0.012 | 0.291 | -0.004 | 0.632 | 0.003 | 0.775 | -0.007 | 0.273 | -0.005 | 0.604 | 0.003 | 0.668 | -0.008 | 0.011 | -0.003 | 0.645 | -0.001 | 0.538 |
|  | 0.334 | 0.089 | 0.466 | 0.000 | 0.300 | 0.014 | 0.356 | 0.000 | 0.321 | 0.056 | 0.570 | 0.001 | 0.569 | 0.057 | 0.494 | 0.000 | 0.338 | 0.003 | 0.263 | 0.144 | 0.378 | 0.000 |
|  | 0.908 | 0.000 | 0.912 | 0.000 | 0.857 | 0.000 | 0.973 | 0.000 | 0.903 | 0.000 | 0.815 | 0.000 | 0.891 | 0.000 | 0.847 | 0.000 | 0.967 | 0.000 | -0.058 | 0.618 | 0.936 | 0.000 |
|  | 0.835 | 0.264 | -0.200 | 0.790 | 0.003 | 0.980 | -0.365 | 0.273 | -0.354 | 0.464 | 6.254 | 0.033 | -0.252 | 0.848 | -0.305 | 0.700 | -0.192 | 0.753 | 13.347 | 0.000 | 0.354 | 0.663 |
|  | -0.003 | 0.846 | 0.010 | 0.239 | 0.011 | 0.854 | 0.014 | 0.010 | -0.002 | 0.904 | 0.005 | 0.514 | 0.001 | 0.928 | -0.002 | 0.803 | 0.006 | 0.000 | -0.005 | 0.124 | 0.007 | 0.025 |
|  | 0.497 | 0.000 | 0.342 | 0.109 | 0.471 | 0.317 | 0.610 | 0.000 | 0.489 | 0.000 | 0.220 | 0.108 | 0.385 | 0.055 | 0.428 | 0.000 | 0.486 | 0.024 | 0.425 | 0.000 | 0.477 | 0.000 |
|  | 0.246 | 0.061 | 0.430 | 0.000 | 0.169 | 0.862 | 0.313 | 0.000 | 0.197 | 0.108 | 0.379 | 0.057 | 0.430 | 0.005 | 0.373 | 0.008 | 0.269 | 0.000 | 0.229 | 0.239 | 0.348 | 0.000 |
|  | 6.556 | 0.038 | 0.406 | 0.830 | 1.201 | 0.758 | 2.834 | 0.027 | 4.421 | 0.077 | 0.972 | 0.568 | 2.622 | 0.790 | -4.378 | 0.016 | 2.048 | 0.438 | 1.061 | 0.514 | 6.467 | 0.177 |
|  | -0.012 | 0.065 | -0.006 | 0.566 | -0.007 | 0.411 | -0.003 | 0.800 | -0.009 | 0.530 | -0.004 | 0.550 | -0.005 | 0.615 | 0.008 | 0.098 | -0.007 | 0.099 | -0.009 | 0.123 | -0.003 | 0.405 |
|  | 0.546 | 0.001 | 0.571 | 0.043 | 0.531 | 0.098 | 0.612 | 0.000 | 0.645 | 0.000 | 0.728 | 0.001 | 0.522 | 0.081 | 0.623 | 0.003 | 0.731 | 0.026 | 0.647 | 0.006 | 0.450 | 0.017 |
| **Panel C: Diagnostic Tests** | | | | | | | | | | | | | | | | | | | | | | |
| LogL | -1,244 |  | -1,146 |  | -1,132 |  | -1,280 |  | -1,278 |  | -1,150 |  | -1,162 |  | -1,222 |  | -1,162 |  | -1,168 |  | -1,172 |  |
| AIC | 11.14 |  | 10.48 |  | 10.28 |  | 11.50 |  | 11.50 |  | 10.46 |  | 10.57 |  | 11.16 |  | 10.57 |  | 10.47 |  | 10.62 |  |
| SIC | 12.24 |  | 11.62 |  | 11.42 |  | 12.60 |  | 12.60 |  | 11.60 |  | 11.67 |  | 12.26 |  | 11.71 |  | 11.61 |  | 11.72 |  |
| [20] | 27.58 | 0.12 | 17.94 | 0.59 | 24.47 | 0.22 | 18.46 | 0.56 | 21.49 | 0.37 | 21.60 | 0.36 | 15.98 | 0.72 | 11.21 | 0.94 | 9.92 | 0.97 | 25.24 | 0.19 | 25.88 | 0.17 |
| [20] | 17.37 | 0.63 | 17.60 | 0.61 | 19.47 | 0.49 | 17.57 | 0.62 | 16.02 | 0.72 | 14.81 | 0.79 | 17.47 | 0.62 | 17.28 | 0.63 | 19.03 | 0.52 | 19.60 | 0.48 | 17.74 | 0.60 |
| [20] | 5.96 | 0.98 | 21.72 | 0.36 | 23.90 | 0.25 | 21.53 | 0.37 | 11.69 | 0.93 | 41.40 | 0.00 | 13.08 | 0.87 | 22.56 | 0.31 | 23.99 | 0.24 | 20.20 | 0.45 | 22.19 | 0.33 |
| [20] | 9.20 | 0.98 | 6.40 | 0.99 | 5.36 | 0.98 | 4.95 | 0.99 | 4.05 | 0.99 | 8.92 | 0.98 | 8.48 | 0.99 | 8.74 | 0.99 | 5.70 | 0.98 | 4.53 | 0.99 | 6.21 | 0.99 |

**Table 5.** Estimates of VAR-BEKK-AGARCH between Islamic equity sectors and X8X during the COVID-19 period.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| This table provides the estimations of return and volatility spillovers between Islamic equity sectors and X8X during the COVID-19 period. The mean equation in Panel A provides the results of returns spillovers, whereas the variance equation in panel B provides the results of shock and volatility spillovers. Panel C presents the diagnostic tests, including log-likelihood ratio, AIC test, BIC test, and Ljung-Box Q statistics. Following are the full forms of different acronyms used in the table: Com. services-communication services, consumer disc.-consumer discretionary, consumer stap-consumer staples, Information tech.-Information technology. Coeff-coefficient, p-val.-p-value.AIC and SIC criterias are used for the selection of number of lags. Q (20), and Q2(20) denotes Ljung-Box Q statistics of order 20 for autocorrelation applied to the standardized residuals and squared standardized residuals, respectively. Variable order is the Islamic sectoral equity market (1) and X8X (2). denotes the returns spillover from Islamic sectoral equity market to X8X. means the shock spillover from Islamic sectoral equity market to X8X. refers to the volatility spillover from Islamic sectoral equity market to X8X Onegram. | | | | | | | | | | | | | | | | | | | | | | |
|  | **Com. services** | | **Consumer disc.** | | **Consumer stap.** | | **Energy** | | **Financials** | | **Health Care** | | **Industrials** | | **Information Tech.** | | **Materials** | | **Real Estate** | | **Utilities** | |
|  | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. | coeff. | p-val. |
| **Panel A. Mean Equation** | | | | | | | | | | | | | | | | | | | | | | |
|  | 0.086 | 0.274 | 0.123 | 0.031 | -0.026 | 0.596 | -0.073 | 0.603 | 0.084 | 0.274 | 0.014 | 0.767 | 0.049 | 0.000 | 0.179 | 0.029 | 0.061 | 0.000 | -0.029 | 0.714 | -0.004 | 0.950 |
|  | 0.022 | 0.790 | 0.062 | 0.307 | -0.104 | 0.201 | -0.027 | 0.638 | -0.190 | 0.005 | -0.101 | 0.147 | 0.048 | 0.000 | -0.139 | 0.050 | 0.042 | 0.000 | -0.113 | 0.114 | 0.014 | 0.832 |
|  | 0.816 | 0.126 | 0.305 | 0.484 | -0.332 | 0.594 | 0.110 | 0.664 | -0.184 | 0.425 | -0.117 | 0.829 | 0.139 | 0.736 | 0.134 | 0.722 | 0.001 | 0.998 | 0.264 | 0.526 | 0.248 | 0.665 |
|  | 0.204 | 0.836 | 0.437 | 0.637 | 0.263 | 0.765 | 0.288 | 0.788 | 0.325 | 0.691 | 0.343 | 0.730 | 0.284 | 0.722 | 0.472 | 0.547 | 0.492 | 0.602 | 0.081 | 0.930 | 0.477 | 0.601 |
|  | 0.007 | 0.201 | 0.008 | 0.067 | 0.003 | 0.290 | 0.012 | 0.183 | 0.007 | 0.175 | 0.004 | 0.199 | 0.003 | 0.513 | 0.011 | 0.062 | 0.003 | 0.000 | 0.008 | 0.112 | 0.002 | 0.622 |
|  | -0.129 | 0.039 | -0.139 | 0.019 | -0.100 | 0.307 | -0.146 | 0.028 | -0.131 | 0.044 | -0.118 | 0.047 | -0.126 | 0.059 | -0.128 | 0.041 | -0.127 | 0.120 | -0.118 | 0.109 | -0.153 | 0.043 |
| **Panel B. Variance Equation** | | | | | | | | | | | | | | | | | | | | | | |
|  | 0.546 | 0.008 | 0.356 | 0.032 | 0.259 | 0.001 | 0.776 | 0.014 | -0.060 | 0.359 | 0.272 | 0.042 | 0.281 | 0.016 | 0.005 | 0.967 | 0.267 | 0.123 | 0.242 | 0.060 | 0.217 | 0.432 |
|  | -2.680 | 0.756 | 1.388 | 0.590 | -3.511 | 0.319 | -7.080 | 0.000 | -13.019 | 0.000 | -1.718 | 0.806 | -3.917 | 0.123 | -6.620 | 0.000 | -6.586 | 0.029 | -7.404 | 0.003 | 7.643 | 0.007 |
|  | 7.640 | 0.105 | 8.919 | 0.000 | 1.915 | 0.726 | 0.000 | 0.998 | -0.001 | 0.999 | 8.396 | 0.009 | 0.000 | 0.999 | 10.66 | 0.000 | 0.000 | 1.000 | 0.001 | 0.999 | 0.000 | 0.999 |
|  | 0.289 | 0.266 | 0.278 | 0.000 | 0.099 | 0.737 | 0.151 | 0.114 | 0.518 | 0.000 | -0.055 | 0.833 | 0.262 | 0.019 | 0.405 | 0.000 | 0.117 | 0.158 | 0.285 | 0.026 | 0.190 | 0.041 |
|  | 0.909 | 0.477 | 0.699 | 0.362 | -0.130 | 0.889 | 0.660 | 0.208 | 0.583 | 0.128 | -0.718 | 0.468 | 0.262 | 0.574 | 0.482 | 0.299 | 0.983 | 0.339 | 0.464 | 0.290 | -0.280 | 0.675 |
|  | -0.001 | 0.958 | -0.017 | 0.010 | -0.003 | 0.885 | -0.029 | 0.332 | -0.024 | 0.037 | -0.007 | 0.380 | 0.001 | 0.966 | 0.012 | 0.313 | -0.012 | 0.288 | -0.012 | 0.135 | 0.004 | 0.499 |
|  | 0.322 | 0.339 | 0.421 | 0.009 | 0.218 | 0.188 | 0.379 | 0.112 | -0.210 | 0.059 | 0.390 | 0.077 | 0.210 | 0.233 | 0.216 | 0.485 | 0.331 | 0.189 | 0.264 | 0.243 | 0.326 | 0.047 |
|  | 0.822 | 0.000 | 0.833 | 0.000 | 0.885 | 0.000 | 0.859 | 0.000 | 0.740 | 0.000 | 0.906 | 0.000 | 0.848 | 0.000 | 0.792 | 0.000 | 0.892 | 0.000 | 0.866 | 0.000 | 0.931 | 0.000 |
|  | -0.121 | 0.698 | -0.208 | 0.269 | -0.080 | 0.753 | -0.006 | 0.966 | 0.333 | 0.281 | -0.067 | 0.804 | -0.215 | 0.481 | 0.785 | 0.178 | 0.041 | 0.916 | -0.032 | 0.857 | 0.083 | 0.923 |
|  | 0.012 | 0.636 | 0.004 | 0.588 | 0.006 | 0.363 | 0.041 | 0.039 | 0.044 | 0.000 | 0.007 | 0.545 | 0.006 | 0.474 | 0.038 | 0.003 | 0.015 | 0.032 | 0.016 | 0.004 | 0.012 | 0.000 |
|  | 0.758 | 0.001 | 0.662 | 0.000 | 0.935 | 0.000 | 0.783 | 0.000 | -0.089 | 0.319 | 0.716 | 0.000 | 0.938 | 0.000 | -0.002 | 0.989 | 0.821 | 0.000 | 0.817 | 0.000 | 0.792 | 0.000 |
|  | 0.439 | 0.100 | 0.582 | 0.002 | 0.498 | 0.000 | 0.485 | 0.066 | 0.286 | 0.036 | 0.439 | 0.000 | 0.626 | 0.000 | 0.188 | 0.131 | 0.388 | 0.000 | 0.409 | 0.000 | 0.343 | 0.007 |
|  | 1.102 | 0.497 | 2.065 | 0.058 | 1.465 | 0.071 | 0.514 | 0.125 | 3.284 | 0.022 | 2.061 | 0.126 | 1.385 | 0.152 | 3.962 | 0.001 | 0.898 | 0.338 | 0.640 | 0.255 | 1.371 | 0.182 |
|  | 0.009 | 0.331 | -0.010 | 0.180 | -0.003 | 0.564 | -0.023 | 0.207 | -0.014 | 0.215 | -0.005 | 0.303 | 0.001 | 0.928 | -0.015 | 0.068 | -0.002 | 0.678 | 0.002 | 0.846 | -0.002 | 0.565 |
|  | -0.090 | 0.447 | -0.209 | 0.349 | -0.146 | 0.222 | 0.038 | 0.666 | 0.184 | 0.622 | -0.088 | 0.550 | -0.132 | 0.279 | 0.241 | 0.328 | -0.054 | 0.347 | -0.094 | 0.474 | -0.122 | 0.308 |
| **Panel C: Diagnostic Tests** | | | | | | | | | | | | | | | | | | | | | | |
| LogL | -1,704 |  | -1,650 |  | -1,556 |  | -1,877 |  | -1,752 |  | -1,597 |  | -1,645 |  | -1,706 |  | -1,643 |  | -1,676 |  | -1,621 |  |
| AIC | 12.72 |  | 12.68 |  | 12.02 |  | 13.93 |  | 13.31 |  | 12.11 |  | 12.67 |  | 12.85 |  | 12.45 |  | 12.88 |  | 12.10 |  |
| SIC | 13.72 |  | 13.68 |  | 13.01 |  | 14.93 |  | 14.30 |  | 13.11 |  | 13.67 |  | 13.84 |  | 13.44 |  | 13.88 |  | 13.10 |  |
| [20] | 25.90 | 0.17 | 29.45 | 0.08 | 31.87 | 0.04 | 9.41 | 0.98 | 38.23 | 0.01 | 35.49 | 0.02 | 22.07 | 0.34 | 33.81 | 0.03 | 26.55 | 0.15 | 24.51 | 0.22 | 13.18 | 0.87 |
| [20] | 22.46 | 0.32 | 25.89 | 0.17 | 20.05 | 0.45 | 25.73 | 0.18 | 19.47 | 0.49 | 24.63 | 0.22 | 20.51 | 0.43 | 18.06 | 0.58 | 23.63 | 0.26 | 21.70 | 0.36 | 21.70 | 0.36 |
| [20] | 19.63 | 0.48 | 27.57 | 0.12 | 15.04 | 0.77 | 19.89 | 0.46 | 17.64 | 0.61 | 12.18 | 0.91 | 26.64 | 0.15 | 9.45 | 0.98 | 10.19 | 0.96 | 18.03 | 0.59 | 22.14 | 0.33 |
| [20] | 15.83 | 0.31 | 19.21 | 0.24 | 11.03 | 0.37 | 14.23 | 0.34 | 14.70 | 0.55 | 13.50 | 0.17 | 12.49 | 0.24 | 29.08 | 0.10 | 12.17 | 0.46 | 18.42 | 0.24 | 15.21 | 0.17 |

**Table 6. Conditional correlations**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| This table provides the average time-varying correlations between the pairs of Islamic sector-Onegram and Islamic sector-X8X during the two sample period, including the pre-COVID-19 period and the COVID-19 period. Following are the full forms of different acronyms used in the table: Com. services-communication services, consumer disc.-consumer discretionary, consumer stap-consumer staples, Information tech.-Information technology. | | | | | | | | |
|  | Pre-COVID-19 |  | COVID-19 | |  | Pre-COVID-19 |  | COVID-19 |
| Com. services/Onegram | -0.05 |  | 0.08 |  | Com. services/X8X | -0.19 |  | 0.14 |
| Consumer disc./Onegram | -0.05 |  | 0.13 |  | Consumer disc./ X8X | -0.15 |  | 0.10 |
| Consumer stap. /Onegram | 0.05 |  | 0.17 |  | Consumer stap. / X8X | 0.01 |  | 0.13 |
| Energy/Onegram | -0.01 |  | 0.05 |  | Energy/ X8X | -0.11 |  | 0.08 |
| Financials/Onegram | -0.03 |  | 0.14 |  | Financials/ X8X | -0.11 |  | 0.12 |
| Health care/Onegram | -0.02 |  | 0.15 |  | Health care/ X8X | -0.12 |  | 0.10 |
| Industrials/Onegram | -0.07 |  | 0.12 |  | Industrials/ X8X | -0.18 |  | 0.14 |
| Information Tech. /Onegram | -0.05 |  | 0.13 |  | Information Tech. / X8X | -0.20 |  | 0.14 |
| Materials/Onegram | 0.00 |  | 0.24 |  | Materials/ X8X | -0.05 |  | 0.14 |
| Real Estate/Onegram | -0.02 |  | 0.13 |  | Real Estate/ X8X | -0.02 |  | 0.15 |
| Utilities/Onegram | 0.00 |  | 0.06 |  | Utilities/ X8X | -0.11 |  | 0.03 |

**Table 7. Optimal weights, hedge ratios, and hedging effectiveness**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| This table provides the optimal weights, hedge ratios, and hedging effectiveness for the pairs of Islamic sector-Onegram and Islamic sector-X8X during the two sample period, including the pre-COVID-19 period and the COVID-19 period. Following are the full forms of different acronyms used in the table: Com. services-communication services, consumer disc.-consumer discretionary, consumer stap-consumer staples, Information tech.-Information technology. | | | | | | | | | | | | | | | | | | | |
|  | Pre-COVID-19 | | |  |  | COVID-19 | | |  |  | Pre-COVID-19 | | |  | | COVID-19 | | | |
|  |  |  | HE (%) |  |  |  |  | HE (%) |  |  |  |  | HE (%) |  |  | |  |  | HE (%) |
| Com. services/Onegram | 0.988 | -0.001 | 2.20 |  |  | 0.874 | 0.043 | 11.84 |  | Com. services/X8X | 0.976 | -0.009 | 10.08 |  |  | | 0.998 | 0.022 | 0.34 |
| Consumer disc./Onegram | 0.990 | -0.001 | 1.63 |  |  | 0.908 | 0.047 | 7.44 |  | Consumer disc./ X8X | 0.989 | -0.011 | 5.13 |  |  | | 0.996 | 0.023 | 2.18 |
| Consumer stap. /Onegram | 0.994 | 0.000 | 1.26 |  |  | 0.960 | 0.040 | 3.77 |  | Consumer stap. / X8X | 0.994 | 0.003 | 1.79 |  |  | | 0.996 | 0.012 | 0.31 |
| Energy/Onegram | 0.993 | -0.001 | 1.59 |  |  | 0.653 | 0.051 | 33.50 |  | Energy/ X8X | 0.981 | -0.014 | 6.02 |  |  | | 0.974 | 0.027 | 3.75 |
| Financials/Onegram | 0.981 | -0.001 | 3.77 |  |  | 0.829 | 0.069 | 14.32 |  | Financials/ X8X | 0.982 | -0.011 | 6.00 |  |  | | 0.991 | 0.016 | 0.89 |
| Health care/Onegram | 0.999 | 0.000 | 0.99 |  |  | 0.937 | 0.036 | 5.38 |  | Health care/ X8X | 0.990 | -0.007 | 4.69 |  |  | | 0.999 | 0.010 | 0.40 |
| Industrials/Onegram | 0.996 | -0.001 | 2.04 |  |  | 0.892 | 0.049 | 8.99 |  | Industrials/ X8X | 0.986 | -0.010 | 6.52 |  |  | | 0.998 | 0.015 | 0.39 |
| Information Tech. /Onegram | 0.992 | -0.010 | 3.45 |  |  | 0.866 | 0.062 | 12.09 |  | Information Tech / X8X | 0.984 | -0.021 | 10.52 |  |  | | 0.998 | 0.019 | 0.16 |
| Materials/Onegram | 0.985 | -0.001 | 2.95 |  |  | 0.941 | 0.075 | 4.67 |  | Materials/ X8X | 0.992 | 0.002 | 2.22 |  |  | | 0.997 | 0.024 | 0.84 |
| Real Estate/Onegram | 0.992 | -0.001 | 3.39 |  |  | 0.889 | 0.050 | 9.39 |  | Real Estate/ X8X | 0.993 | 0.000 | 1.91 |  |  | | 0.998 | 0.016 | 0.43 |
| Utilities/Onegram | 0.999 | 0.000 | 0.45 |  |  | 0.932 | 0.018 | 7.34 |  | Utilities/ X8X | 0.991 | -0.006 | 4.61 |  |  | | 0.994 | 0.001 | 1.58 |

Notes: Com. services-communication services, consumer disc.-consumer discretionary, consumer stap-consumer staples, Information tech.-Information technology. w-weights, -hedge ratio, HE-Hedging effectiveness.

Figure 3. Time-varying correlations between Islamic equity sectors and Onegram



**Figure 4. Time-varying correlations between Islamic equity sectors and X8X**



1. ISLAMIC FINANCIAL SERVICES INDUSTRY STABILITY REPORT 2021 [↑](#footnote-ref-2)
2. For more detailed assessment of Fintech and Islamic world see the book by Alam et al. (2019) “Fintech and Islamic Finance: Decentralization, Development and Disruption”. [↑](#footnote-ref-3)
3. https://onegram.org/ [↑](#footnote-ref-5)
4. https://coinmarketcap.com/currencies/x8x-token/ [↑](#footnote-ref-6)
5. https://www.spglobal.com/spdji/en/index-family/equity/shariah/sp-shariah/#indices [↑](#footnote-ref-7)
6. https://www.who.int/news/item/27-04-2020-who-timeline---covid-19 [↑](#footnote-ref-8)
7. https://covid19.who.int/ [↑](#footnote-ref-9)
8. For other statistics of COVID-19 pandemic please see: <https://ourworldindata.org/coronavirus> [↑](#footnote-ref-10)