

THE INTERCONNECTEDNESS PATTERN OF CRYPTOCURRENCIES AND ISLAMIC INVESTMENT CLASSES

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ABSTRACT

This study explores the dynamic co-movement of Islamic asset classes and cryptocurrencies for the period 01 March, 2017 to 15 June, 2022 by employing Wavelet methodology. The Islamic investment classes are represented by Islamic equities, Islamic Socially responsible investments, Real estate investment trusts and Sukuk. The results reveal that in normal times, there is negligible co-movement of both the asset classes. By contrast, both the investment classes exhibit significant spillover effect during the health crisis period. An important implication from these findings is that both the asset classes offer diversification opportunity during normal times but not during extreme times.

Keywords: Cryptocurrencies, Islamic investments, Hedge, Portfolio management.

JEL classification: F31; G11; G24.

Article history:

Received : October 14, 2022

Revised : January 8, 2023

Accepted : May 12, 2023

Available online : May 31, 2023

<https://doi.org/10.21098/jimf.v9i2.1600>

I. INTRODUCTION

The interesting resemblance between Tulip Mania (1637) and exorbitant values of cryptocurrencies has led central banks to adopt precautions regarding usage of digital assets (Mahomed and Mohd, 2018). The regulators across the globe are consistently endeavouring to make consumers aware of the high-risk nature of these investments. In addition, with the exception of a few, a wide majority of Islamic *Shariah* scholars have declared the usage of cryptocurrency impermissible owing to its excessive risk and lack of transparency (*gharar*), speculative nature, no regulatory control and violations of objectives of *Shariah* (Adam, 2017). Nevertheless, cryptocurrency remains a highly risky investment class with a capacity of extraordinary profiteering. Therefore, without indulging into the debate of *Shariah* position of these investments, this study intends to evaluate the hedging potential of cryptocurrencies vis-à-vis Islamic assets.

The motivation of this work stems from the fact that portfolio managers, in their quest for diversification, always keep looking for the assets that exhibit low correlation (Bodie, Kane, and Marcus, 2014). In view of the *Shariah* rulings deeming cryptocurrency investments impermissible, the digital assets become non-preferred investment habitats for *Shariah* compliant investors. Consequently, there is high probability that Islamic assets do not exhibit co-movement with cryptocurrencies. If indeed that is the case, both the investment classes can serve as hedge against each other. It is important to point out that this hedging opportunity will be available only to conventional portfolios as *Shariah* compliant investors are unlikely investing in cryptocurrencies. Nevertheless, as conventional portfolios constitute a major proportion of global investment industry, this finding will be beneficial for portfolio managers. This study contributes to the existing literature by exploring the dynamic co-movement of Islamic assets and cryptocurrencies by using Continuous Wavelet Transmission (CWT).

To conduct this study, the daily data of seven global indices belonging to Islamic and Cryptocurrency asset classes, from 01 March, 2017 to 15 June, 2022 are used. The estimation is performed using CWT as it not only captures the pairwise dynamic co-movement but also identifies the direction of causality. The results reveal that both the asset classes do not exhibit any relationship during normal times. Nevertheless, during COVID19 pandemic, there is significant co-movement between them. However, the co-movement during the period disappears when the controls for global market risk and investors' sentiments are added in the model. The results remain robust to the choice of investment class, indexing methodologies and different proxies of cryptocurrencies.

The study contributes to the literature in different ways. First, there is lack of research on the linkages between Islamic assets and cryptocurrencies. In recent literature, we come across studies that have explored the linkage between gold backed Islamic cryptocurrencies and other assets (Ali et al., 2022; Rizvi and Ali, 2022; Yousaf and Yarovaya, 2022). Nevertheless, to the best of our knowledge, no study has explored the interconnectedness of cryptocurrencies and Islamic assets and the present study fills this gap. Second, most of the existing studies on the topic utilize only Bitcoin to document the relationship between cryptocurrencies and investable asset classes ignoring other cryptocurrencies. However, this study considers a wide range of cryptocurrencies. Third, the study takes a time-frequency

perspective to investigate the time-varying connections between cryptocurrencies and Islamic assets employing wavelet coherence approach. This methodology effectively captures linear and non-linear effects.

The rest of the work is as follows: Section 2 offers review of literature and hypothesis development. Section 3 provides details of research framework. Section 4 includes results and discussion. Section 5 concludes the study.

II. BRIEF REVIEW OF LITERATURE AND RESEARCH QUESTIONS

In existing Shariah literature, we find contradicting opinions about the permissibility of Bitcoin and other Cryptocurrencies (Abu-Bakar, 2018). For example, Grand Mufti of Egypt Shaykh Shawki Allam declares cryptocurrencies as impermissible owing to its intangibility, ease of use for illegal activities and money laundering and lack of any central authority that may regulate cryptocurrencies. The religious authority of Turkish government and Fatwa Centre of Palestine also endorse this opinion. The dissenting view is made by South African Islamic seminary, Darul Uloom Zakariyya that deems cryptocurrencies as permissible. They are of the opinion that cryptocurrencies carry all the properties of good money, provided they are regulated by a central authority. Evidently, the legal opinion (fatwa) stating cryptocurrency as Haram is backed by renowned Shariah scholars and government bodies and seems more popular among the *Shariah* compliant investors. It can be argued that these investors prefer investing in Shariah compliant assets, i.e., Shariah compliant equities, Real estate investment trusts and Sukuk, and abstain from investing in cryptocurrencies. We further argue that reputable conventional investors choosing Islamic assets for the purpose of better returns or diversification may avoid cryptocurrencies, or keep their very low proportions, owing to their highly volatile and speculative nature. It is understandable because the higher proportions may lead to increase in overall volatility of the portfolios. Hence, the first hypothesis states that:

H1: There is no dynamic co-movement between Islamic assets and cryptocurrencies.

In addition to Shariah issues, cryptocurrencies are widely criticized due to their excessive usage of conventional energy and resulting bad impact on the environment. For example, Bitcoin is estimated to consume 150 terawatt-hours of electricity emitting 65 megatons of CO₂ in the air¹. Moreover, the recent incidents like massive decline of 14 % in Bitcoin prices, cybercrimes and legal disorientation have raised concerns regarding sustainability of these investments. These issues make cryptocurrencies ineligible investment class for socially responsible investment (SRI) portfolios. In recent studies (Anwer et al., 2023; Naeem and Karim, 2021), the authors provide evidence favoring this argument. They show that there is little co-movement between cryptocurrencies and socially responsible as well as clean energy assets. Furthermore, the objectives (*Maqasid*) of *Shariah* also discourage investment in such assets/ avenues that are harmful to the environment and may cause damage to humanity. This has led to efforts on building circular economy models (like Dubai Clean Energy Strategy 2050) for Muslim economies (Campura et al., 2021). We come across several instruments that are an outcome of the

1 <https://news.climate.columbia.edu/2021/09/20/bitcoins-impacts-on-climate-and-the-environment/>

integration of sustainable investments with Islamic assets, like green Sukuk, green Islamic equities etc. There is plethora of literature that discusses these instruments in the light of *Maqasid* (Abdullah, 2021; Alam, Duygun, and Ariss, 2016; Laldin and Djafri, 2021; Musari and Hidayat, 2023). Consequently, cryptocurrencies may not be suitable avenues for socially responsible *Shariah* compliant investors. Therefore, the second hypothesis states that:

H2: There is no dynamic co-movement between Islamic socially responsible assets and cryptocurrencies.

Finally, although both the asset classes are hypothesized to be detached from each other, it may be possible that during crisis periods, they demonstrate dynamic co-movement. There is a rich body of literature that points to the spillover of Islamic assets with other investment classes during crisis periods (Billah et al., 2022; Hassan et al., 2020; Yarovaya et al., 2021; Yousaf & Yarovaya, 2022 to name a few). For example, Umar et al. (2022) study the interconnectedness pattern of Islamic equities and US yield curve components and find them connected during crisis periods. Trichilli and Boujelbéne (2023) find evidence of spillover between Islamic gold-backed cryptocurrencies, Dow Jones Islamic Market World Index and halal chain during the COVID-19 pandemic. Hassan et al. (2020) observe significant volatility connectedness among crude oil, conventional and Islamic stock during crisis periods. Thus, it may be construed that like other conventional assets, Islamic assets exhibit dynamic co-movement with cryptocurrencies during the crisis periods. So, the third hypothesis states that:

H3: There is no dynamic co-movement between Islamic assets and cryptocurrencies during crisis periods.

Unlike the preceding two hypotheses, we expect H3 to be rejected on the basis of existing literature documenting spillover effects between various asset classes during crisis episodes.

III. DATA AND METHODOLOGY

To address the research question, suitable proxies for Islamic and cryptocurrency assets are required. To conduct this study, the daily data of seven global indices (as detailed in table 1), belonging to Islamic and Cryptocurrency asset classes, from 01 March, 2017 to 15 June, 2022 are used. The selection of the sample period is dictated by data availability. The Islamic assets class is represented by four indices namely S&P Global REIT Shariah (GRS), S&P Global 1200 ESG Shariah (ESGS), Dow Jones Sukuk Total Return (SUK), and Dow Jones Islamic Market World (IMW). ESGS represents socially responsible *Shariah* compliant investments. The cryptocurrency asset class is represented by S&P Cryptocurrency LargeCap (CLC), S&P Cryptocurrency MegaCap (MGC) and S&P Cryptocurrency Broad Digital Market (BDM). The sampled indices are developed by S&P Dow Jones Indices that offers indices belonging to both the asset classes. The sample selection is restricted to S&P as no other vendor is offering adequate coverage of both the asset classes. The daily prices are converted into returns to perform the estimations. The data are sourced from Yahoo Finance.

To achieve the research objectives, this study captures the co-movements of Islamic and Cryptocurrency asset classes in time–frequency space. The wavelet

decomposition of the return series (Grinsted, Moore, and Jevrejeva, 2004) is made by applying wavelet coherency in shape of the continuous wavelet transform (CWT). Following In & Kim (2013), CWT can be defined as an integral over whole duration of the signal multiplied by scaled, shifted versions of the wavelet function ' λ '.

$$H(\text{scale}, \text{position}) = \int_{-\infty}^{\infty} x_t \lambda(\text{scale}, \text{position}, \text{time}) dt \quad (1)$$

CWT estimates several wavelet coefficients H , that are functions of scale and position and may assume any values compatible with location of the time series x_t . The variances of the wavelet coefficients of the random process, computed within each scale, formulate the *Wavelet spectrum* (Li and Oh, 2002). In the first step, we will estimate Wavelet spectrum for all the time series. This approach maps the original time series and separates the original times series (for example, function of one variable 'time') into the function of two different variables (like 'time and frequency'). CWT itself generates the number of wavelet time scales based on the data length and enables easy identification and interpretation of patterns by mapping the series correlations in a two dimensional figure. We define our CWT model, in line with Rua & Nunes (2009), as:

$$W_x(u, s) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{s}} \overline{\psi}\left(\frac{t-u}{s}\right) dt \quad (2)$$

Where 'u' reflects the position of the wavelet in the time domain and 's' shows the position in the frequency domain. From this equation, we can simultaneously obtain information on time and frequency by mapping the original time series into a function of u and s in the wavelet transform.

Moving forward, CWT maps the correlation among two series in the form of *Wavelet power spectrum (Coherency)*, displayed through a two-dimensional figure, to easily identify and interpret the patterns or hidden information. Hence, we need a bivariate framework known as wavelet coherence to examine the interaction of two different time series. More precisely, in our case, we are investigating how environmentally sustainable indices and cryptocurrency indices are related by a linear transformation. We can define the wavelet coherence as the squared absolute value of the smoothed cross wavelet spectra, normalized by the product of the smoothed individual wavelet power spectra of each selected time series. The squared wavelet coefficient (Torrence and Webster 1999) can be defined as

$$R^2(u, s) = \frac{|s(s^{-1}W_{xy}(u, s))|^2}{s(s^{-1}|W_x(u, s)|^2)s(s^{-1}|W_y(u, s)|^2)} \quad (3)$$

In equation 3, 's' represents the smoothing parameter. In the instances when there is no smoothing, the wavelet coherence will be equal to one. The squared wavelet coherence coefficient falls in the range $0 \leq R^2(u, s) \leq 1$. Consequently,

the contour plot of the above specification can help in spotting i) the regions in time–frequency space where the two-time series move together and evaluate the features of their co-movement. In wavelet coherence plots, the Black arrows highlight phases. When the phase difference is zero, it suggests that the time series move together. When the arrows point to the right (left), it signifies that time series manifest positive (negative) correlation. When the arrow points upward (downward), it signifies that the first time series leads (lags) the second.

Table 1.
Summary Statistics

Index	Symbol	mean	SD	p25	p75	max	min	Skew	kurt	ADF
Dow Jones Islamic Market World	IMW	8.37	0.22	8.20	8.59	8.78	8.03	0.44	1.78	-29.03***
S&P Global 1200 ESG Shariah	ESGS	7.69	0.23	7.50	7.91	8.13	7.35	0.43	1.78	-30.88***
S&P Global REIT Shariah	GRS	5.00	0.18	4.84	5.09	5.43	4.70	0.62	2.32	-27.45***
Dow Jones Sukuk Total Return	SUK	5.21	0.08	5.12	5.29	5.32	5.09	0.01	1.37	-20.77***
S&P Cryptocurrency LargeCap	CLC	6.35	0.93	5.73	7.25	8.17	4.41	0.36	2.09	-30.48***
S&P Cryptocurrency MegaCap	MGC	6.90	0.97	6.30	7.81	8.73	4.59	0.17	2.37	-30.47***
S&P Cryptocurrency Broad Digital Market	BDM	6.98	1.03	6.37	8.07	8.90	4.57	0.16	2.34	-30.48***

IV. RESULTS AND DISCUSSIONS

The summary statistics are reported for sampled indices in table 1. It is observed that IMW manifests highest return. The lowest (P25) and highest (P75) returns are not very far from the mean, especially in case of Islamic assets. The cryptocurrency assets exhibit higher risk (SD) in comparison to Islamic indices. The return series are found to be positively skewed. We do not see any outliers in the data, as evident from maximum and minimum values. Finally, all the return series are stationery at first difference showing the suitability of the data for applying time series techniques.

The comparison of historical performance of both the asset classes is shown in figure 1. Evidently, there is lesser volatility in case of Islamic asset classes. The cryptocurrencies, nevertheless, remained volatile and experienced peaks (December 2017 and December 2020) and troughs (December 2018, March 2021, and April 2022) over the sample period. Moving forward, the sampled indices exhibit a visible downward trend at the emergence of COVID pandemic (March 2020). Therefore, there is a spillover of both the asset classes. It can be inferred from this comparison that both the asset classes demonstrate very little co-movement except during the pandemic. To assess if these asset classes are a hedge against each other, a formal analysis is conducted.

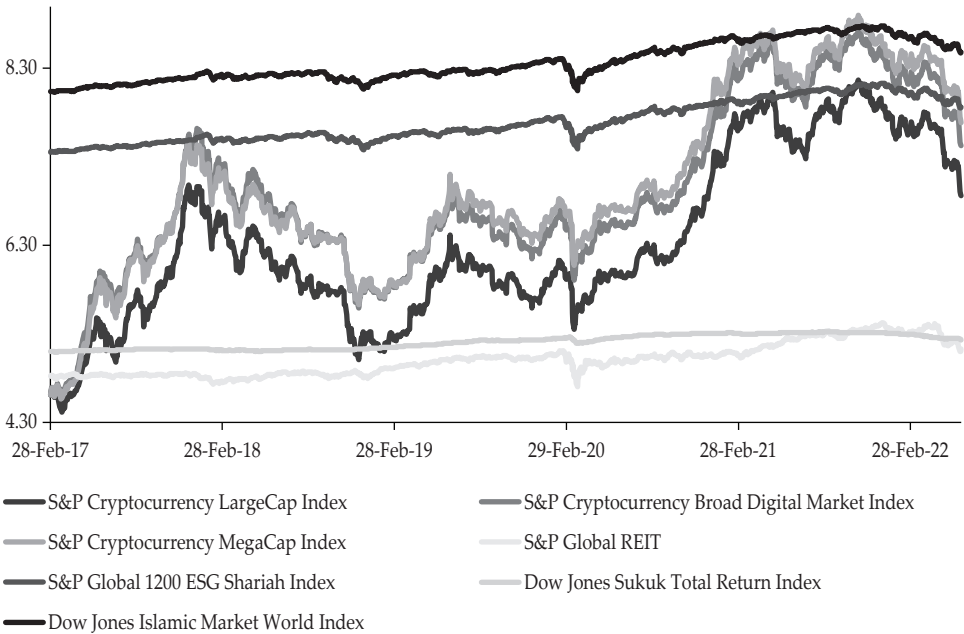


Figure 1.
Historical Performance of Indices

In the first step of the analysis, the movement of each index in the time scales and frequency bands on Wavelet spectrum plots is shown in figure 2. Here, the horizontal axis displays the time component (the years from March 2017 to May 2022). As it will be helpful for the readers to relate the dates with the time scale, the relevant dates with respect to the frequencies are mentioned in the subsequent lines: 200 = 01/12/2017, 400 is 07/09/2018, 600 is 14/06/2019, 800 is 20/03/2020, 1000 is 25/12/2020, and 1200 is 01/10/2021. The vertical axis display frequency component where the values range from scale 1 (a day) up to scale 260 (One year). The higher scale represents the low-frequency nature of the data and vice versa. The thick black contours in the figures show the statistical significance of wavelet power (95% confidence level), estimated by Monte Carlo simulations using phase randomized surrogate series. The cone of influence (COI) signals distortion of the picture by edge effects. As evident from the scale, the range of power is from blue (low power) to red (high power). The wavelet spectrum graphs for Islamic asset class (all the indices) show a high-volatility regime starting from February 2020 and lasting till April, 2020. However, for cryptocurrency asset class, no volatility regions are observed. Therefore, cryptocurrencies do not manifest significant dynamic volatility and may be reckoned as safe havens during the crisis periods.

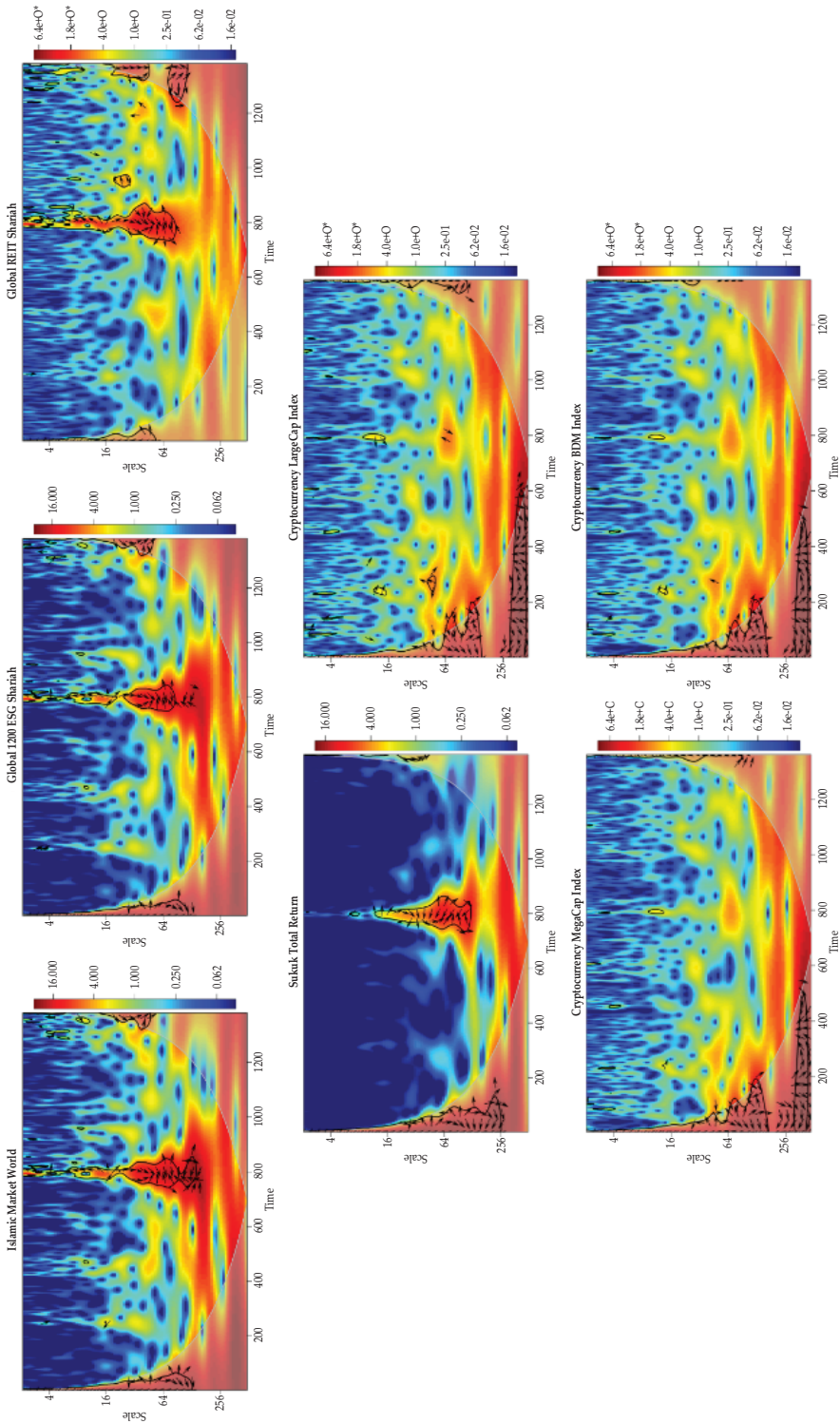


Figure 2.
Wavelet Spectrum

In the next step, to comprehend if both the asset classes exhibit co-movement with each other or remain detached, the volatility of both the asset classes is assessed for each pair of both the asset classes estimating wavelet power spectrum (coherences). The degree of correlation is highlighted by the color bar on the right side of each chart. The red color represents extremely high absolute correlation values for $R^2(u,s)$ and the blue color indicates extremely low correlation. The lead-lag relationship and the direction of causality by virtue of the phase-differences are also identified. The black arrows on the charts represent phases. The horizontal arrow signifies that both the asset classes move together. The arrows pointing towards the left (right) reflect negative (positive) association between the asset classes. In case of arrows pointing upward-left or downward-right, it implies that the first variable (in our case, Islamic assets) leads the second variable (i.e., cryptocurrencies). Likewise, the second variable leads and the first variable follows when the arrows point to upward-right or downward-left direction.

Figure 3 shows the dynamic co-movement of Islamic assets with CLC. It may be observed that both the categories of indices exhibit significant co-movement at the beginning of pandemic for 10-120 days and ends in August 2020 pointing to a contagion of both the asset classes during the crisis period. Interestingly, there is divergence in the direction of causality between the asset classes. In case of IMW Vs. CLC, both the indices are moving together. This finding is intuitive as equity markets also faced following the same direction. For ESGs Vs. CLC and GRS Vs. CLC, there is no clear pattern as the causality follows multiple directions across the frequency bands. However, in case of SUK Vs. CLC, we observe that SUK leads during contagion period. Except for contagions during COVID19, Islamic assets remain detached from CLC.

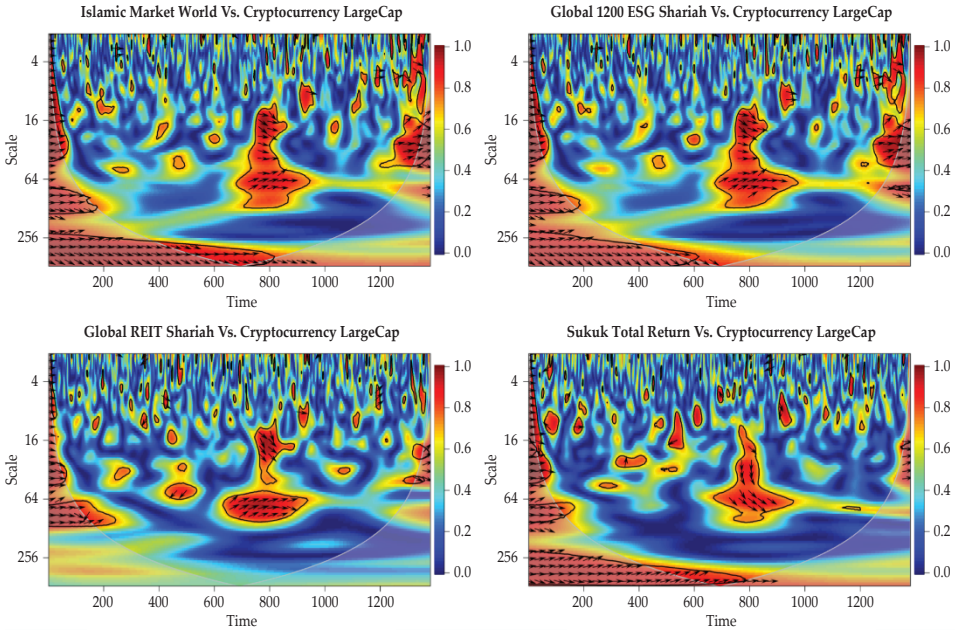


Figure 3.
Co-Movement of Islamic Asset Classes with Cryptocurrency Largecap

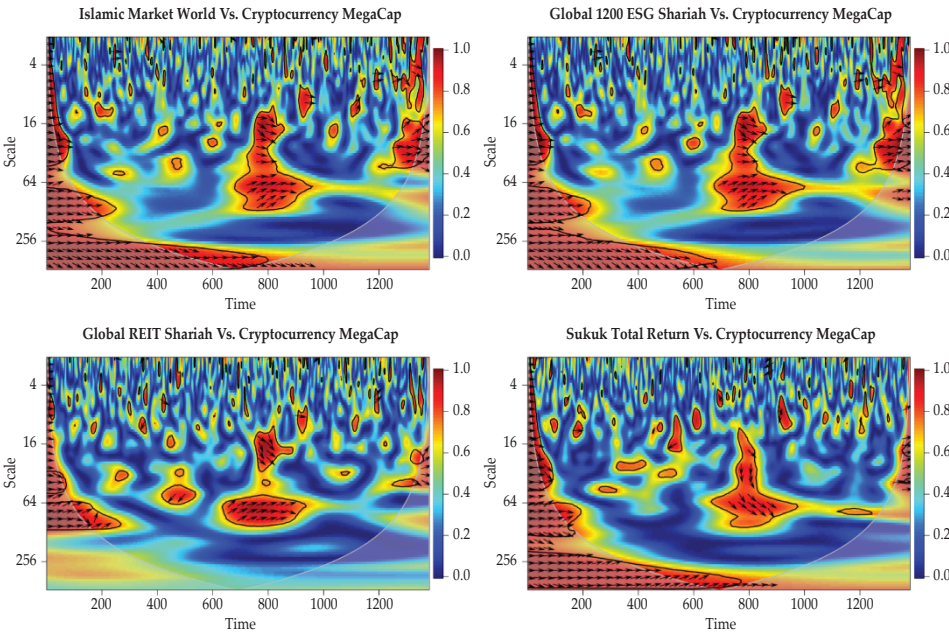


Figure 4.
Co-Movement of Islamic Asset Classes with Cryptocurrency Megacap

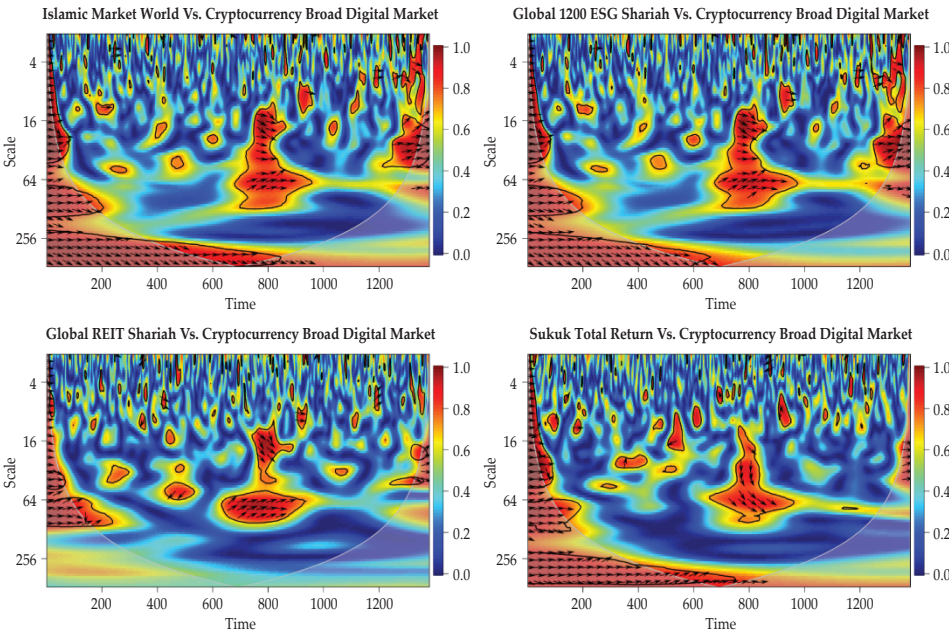


Figure 5.
Co-movement of Islamic Asset Classes with Cryptocurrency BDM

To substantiate the findings, the robustness is performed by assessing dynamic co-movement of Islamic assets with two other Cryptocurrency indices. Figure 4 shows the combinations of Islamic assets versus MGC and figure 5 shows the pair-wise dynamic co-movement of Islamic assets Vs. BDM. Although the composition and indexing methodology of both MGC and BDM is different from CLC, the results remain robust.

The results reveal that both the asset classes exhibit dynamic co-movements only during crisis periods and remain detached in the normal times. To add further credence to the existing results, the estimations are performed using three global quantifiable measure of market risk and investors' sentiments namely Chicago Board Options Exchange (CBOE) Volatility Index (VIX), CBOE Crude Oil Volatility Index (OVX) and CBOE Gold Volatility Index (GVZ). To begin, in case of Islamic VS. Cryptocurrency assets | VIX (figure 6), the contagion during pandemic considerably shrinks in size. This finding suggests that if the estimations are performed controlling for options volatility, no contagion exists. The similar results are observed when the dynamic co-movement of both the asset classes is estimated controlling for GVZ (figure 7) and OVX (figure 8). Hence the results remain robust to the change of global factors.

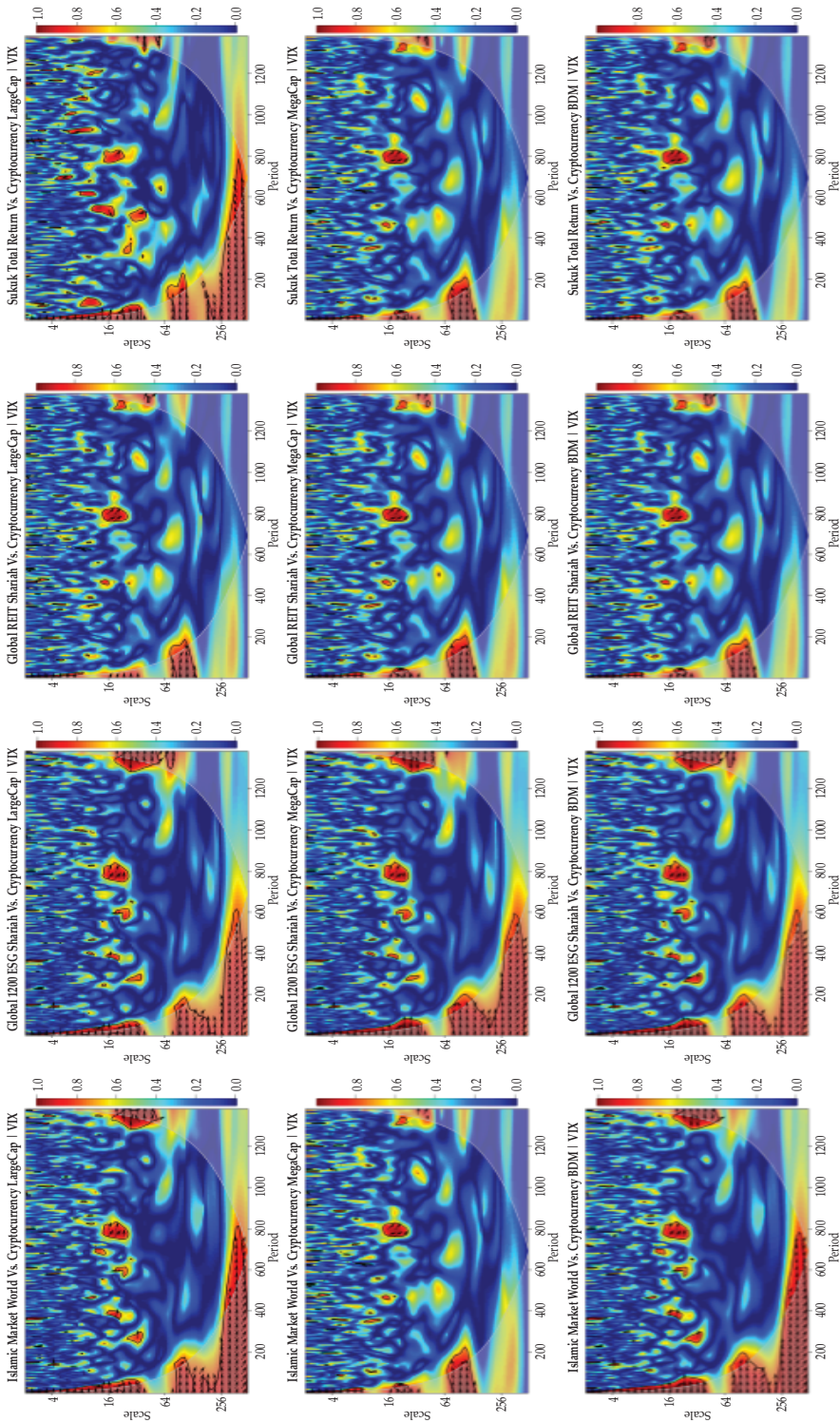


Figure 6. Co-Movement of Islamic Asset Classes with Cryptocurrency Excluding Impact of CBOE Volatility Index (VIX)

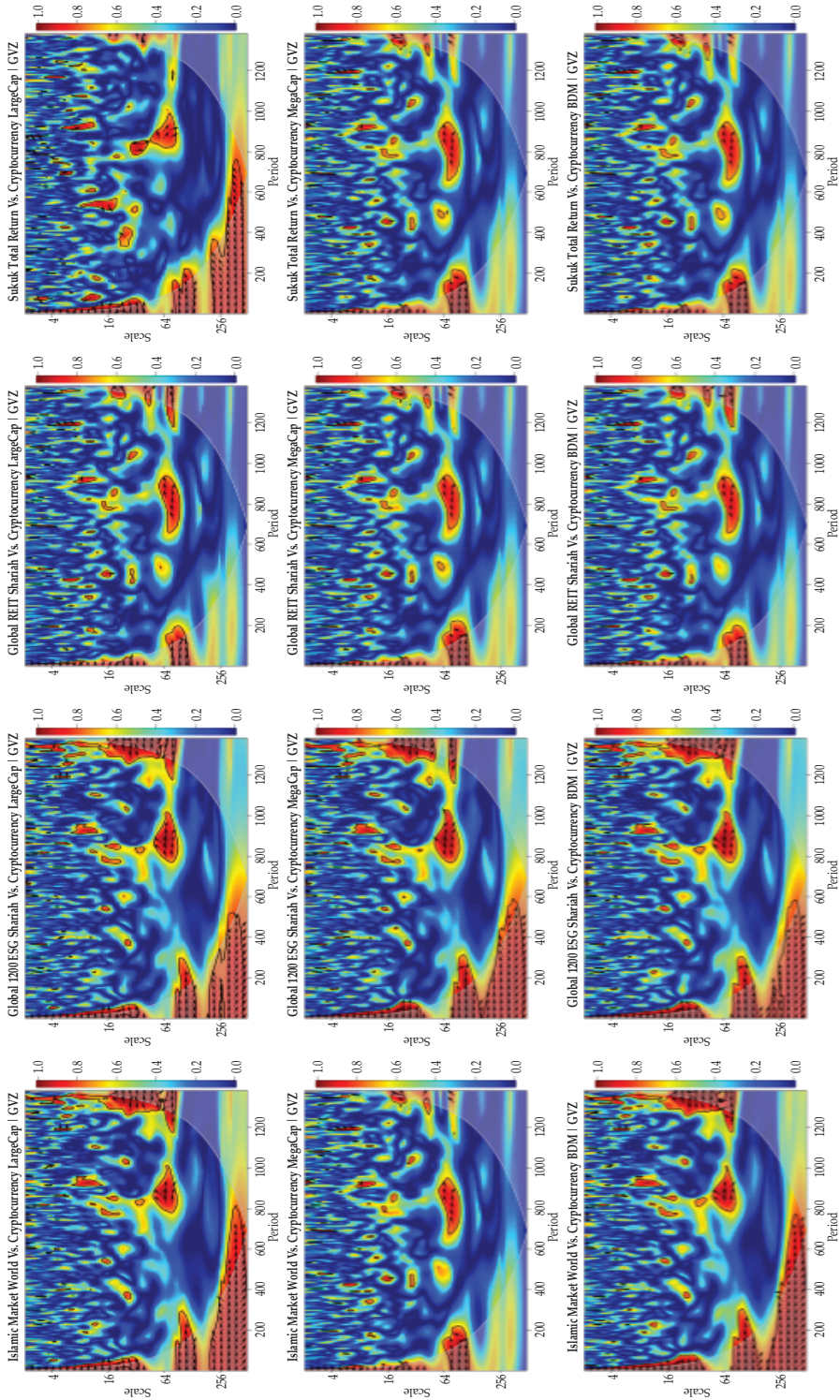


Figure 7. Co-Movement of Islamic Asset Classes with Cryptocurrency Excluding Impact of Gold Volatility Index (GVZ)

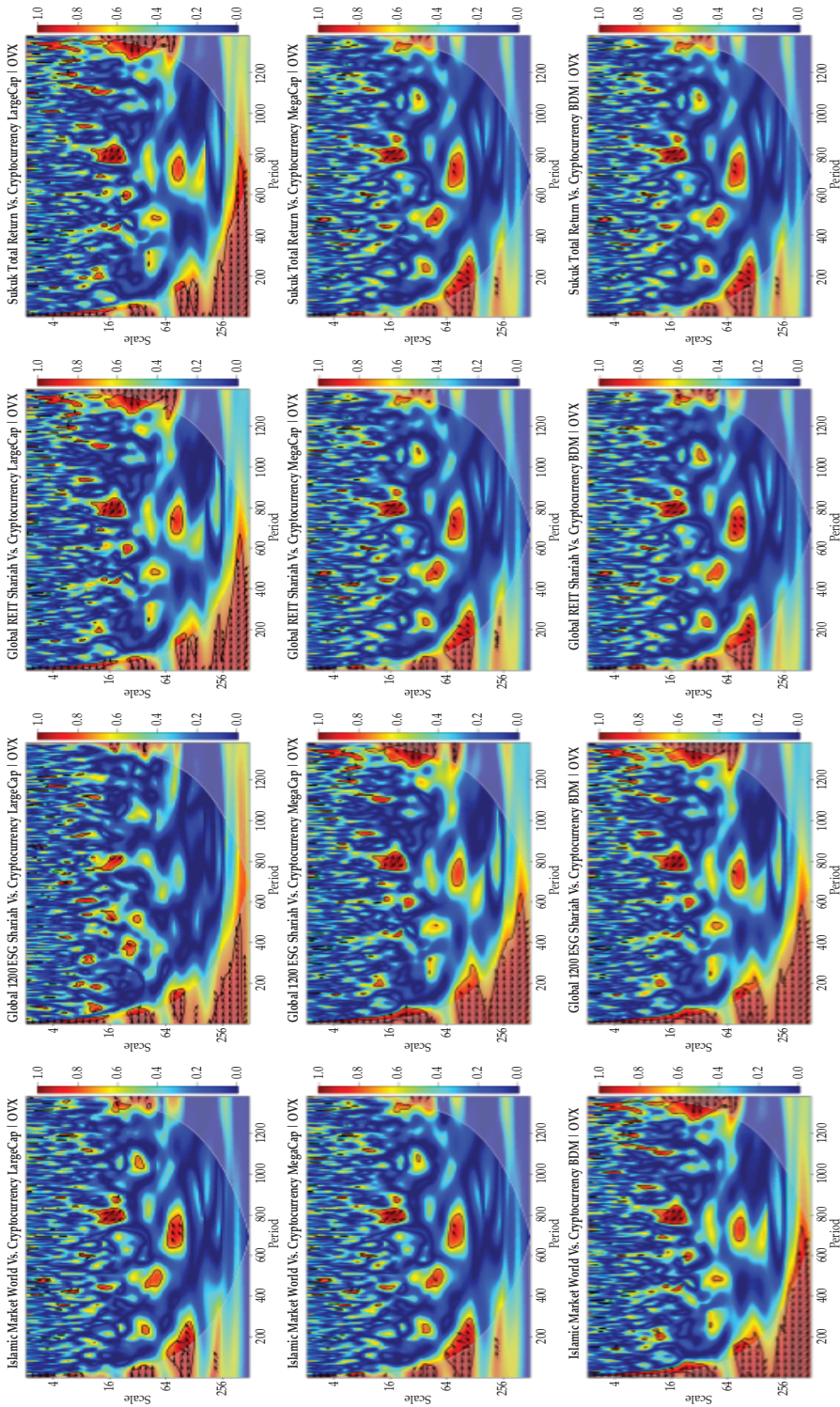


Figure 8. Co-Movement of Islamic Asset Classes with Cryptocurrency Largecap Excluding Impact of Crude Oil Volatility (OVX) Index

The findings related to co-movement of Islamic assets and cryptocurrencies are unique. Only Yousaf & Yarovaya (2022) have explored the co-movement of Islamic gold backed cryptocurrencies and Islamic assets. Their findings suggest that both the asset classes may be used as hedge against each other. Our crisis related findings are in line with various existing studies (Hasan et al. 2021; Karim et al. 2022; Naeem et al. 2022). We, therefore, contend that our research hypotheses are validated.

V. CONCLUSION

The present study investigates whether Islamic assets and cryptocurrencies demonstrate co-movement or serve as hedge against each other. The sample has representation of Islamic equities, Islamic socially responsible investments, Islamic REITs and Sukuk. In addition, different compositions of cryptocurrencies are used to study the dynamic relationship of both the asset classes. The results reveal that all the three hypotheses are validated. There is no co-movement between Islamic asset classes and cryptocurrencies and Islamic SRI and cryptocurrencies. Moreover, both the investment classes manifest dynamic co-movement during COVID19 crisis period. The co-movement during crisis period disappears when the estimations are performed using controls for global market risk and investor sentiments.

The study offers important policy implications: First, both the asset classes remain detached from each other in the normal times and may be used together to diversify the portfolios. However, the *Shariah* compliant investors may lose this diversification opportunity. Second, as during crisis periods, both the asset classes move together and do not offer diversification opportunities, the portfolio managers should consider extreme conditions while designing portfolios containing Islamic assets and cryptocurrencies.

There is an important limitation of this work. It could have been more appropriate if we could use indices developed by other vendors. However, it could not be done owing to non-availability of data.

This study may be extended by using indices from other index families like Financial Times Stock Exchange (FTSE) and Morgan Stanley Capital International (MSCI). In addition, subject to availability of data, the drivers of connectedness during pandemic may be explored.

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