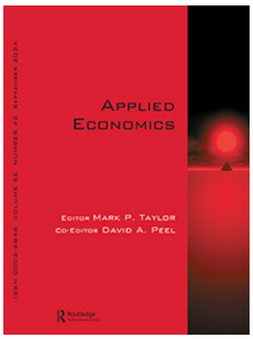

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RESEARCH ARTICLE

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Tail risk spillovers between Islamic sectoral equities and bond markets: a time-frequency domain approach

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ABSTRACT

This study examines the tail risk spillover between Islamic sectoral stock indices and country specific investable Islamic bonds in time and frequency domain and provides useful implications for portfolio management. For the analyses, Conditional Autoregressive ValueatRisk (CAViaR), Quantile Connectedness, and DCCGARCH t-Copula models are estimated utilizing daily data from 15 countries. The findings show that the connectedness and spillover of risks are much stronger at tails than at median, and in the short-term than in long-term. Whereas median risk connectedness surges during COVID-19 pandemic, the connectedness between tail risks is usually elevated even before the COVID-19 pandemic with industrial sector being consistently a significant net transmitter of shocks. Moreover, all the sectoral stock market indices are significant and consistent transmitter of left tail shocks indicating a much stronger role of sectoral stock markets in transmitting large negative shocks. A heightened connectedness is also observed during Russia-Ukraine war mainly in the short-term frequency. The portfolio analysis shows that long positions in sectoral stocks can usually be hedged by taking short positions in Islamic bonds. Hedging effectiveness and optimal portfolio weights are also calculated to provide market participants with further information.

KEYWORDS

Tail risk; islamic sectoral stock indices; sukuk; Russia-Ukraine war

JEL CLASSIFICATION

G11; G21; G14

Introduction

Islamic finance emerged in the 1970s and has since expanded globally. In the last decade, there has been significant growth in shariah-compliant securities, including Islamic stock indices, Sukuk, and mutual funds (Zulkhibri 2015). This growth is fuelled by Islamic banks and the issuance of shariah-compliant financial instruments. After the global financial crisis, Islamic markets gained more attention due to their better performance than conventional markets (Abbes and Trichilli 2015; Akhtar, Jahromi, and Smith 2017; Balli, A. de Bruin, and M. Chowdhury 2019).

Islamic securities outperform their conventional counterparts due to key features of Islamic financial contracts such as debt avoidance, real economy linkages, sharing of risk, and avoidance of toxic instruments (Ahmed 2009; Ajmi et al. 2014). Sukuk is an alternative instrument for debt financing that provides ownership claims instead of a claim on the cash flow of interest-bearing securities. Sukuk follows Shariah laws and allows claiming a proportional interest in an asset or pool of assets designed to own and sell the asset to recover the value.

Global Islamic finance industry assets grew to $3.06tn in 2021, a YoY increase of 11.3%. Islamic banking assets reached $2.10tn in 15 jurisdictions, while the Sukuk market was worth $775.7bn in 2021, with a YoY growth rate of 125% (IFSB 2018). The Sukuk market has become a significant alternative tool for raising finance globally while promoting sustainable and equitable economic development, attracting investors from non-Muslim countries, Asia, Africa, and Europe following the 2008 global financial crisis (Zulkhibri 2015).

The growing development of Islamic financial markets has attracted scholarly attention and triggered a surge in academic research aimed at comprehending the behaviour of Sharia-compliant financial instruments. Specifically, empirical studies

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related to Islamic stock markets and Sukuk markets can be classified into three distinct categories of inquiry. Firstly, there are studies that investigate the correlation between Islamic stock indices and conventional stock indices. Secondly, there are studies that delve into the association between Sukuk and conventional bond indices. Finally, there are studies that explore the interdependence of Islamic stock indices and Sukuk indices.

Several research studies have explored the relationship between Islamic stock indices and conventional stock indices. A recent study by Arif et al. (2022) investigated the safe-haven potential of Islamic stocks for G7 stock indices during two crisis periods. The results revealed that Islamic stocks did not exhibit safe-haven properties for G7 stock markets in general. However, they did provide diversification opportunities during the Global Financial Crisis (GFC) period and emerged as safe-haven assets for G7 stock markets during the COVID-19 pandemic. Similarly, L. Yarovaya, A. H. Elsayed, and S. Hammoudeh (2021) examined the role of the COVID-19 pandemic on the spillover between Islamic stock markets and conventional markets. They found that Islamic stocks outperformed conventional stock markets, demonstrating their safe-haven properties against economic shocks and uncertain events. Additionally, O. Al-Khazali, H. H. Lean, and A. Samet (2014) used stochastic dominance (SD) analysis to compare the performance of Islamic stock indices against traditional counterparts during and after the GFC period. The results showed that Islamic stocks outperformed traditional stocks during the GFC. Furthermore, other studies by B. Saiti, O. I. Bacha, and M. Masih (2014), S. A. R. Rizvi, S. Arshad, and N. Alam (2015), and C. Aloui, S. Hammoudeh, and H. B. Hamida (2015) looked into the diversification potential of Islamic stocks from various regions against global stocks. The findings of these studies indicated that Islamic stocks provide better diversification opportunities compared to their conventional counterparts.

Numerous studies analyse the relationship between Islamic bonds, also known as Sukuk and conventional bonds. While. Cakir and Raei (2007) reported a weak correlation between Sukuk and Eurobonds, El Mosaid and Boutti (2014) reported a positive correlation between Sukuk and conventional bond indices. Interestingly, Sukuk was found to be less volatile than other bond markets and displayed co-integration with EU and US bond markets. Additionally, Danila et al. (2021) found strong dynamic correlation and both unidirectional and bidirectional volatility spillovers of Sukuk and conventional bonds in ASEAN and GCC markets. However, Maghyereh and Awartani (2016) found that the Sukuk market is a net receiver of volatility spillover from conventional bond markets. Bhuiyan et al. (2018) found Sukuk provides diversification opportunities in global and regional bond markets, as documented by examining the correlations and volatilities of emerging economies' bond indices and the Malaysian Sukuk Index.

In the third strand of literature, there are only a few studies that examine the relationship between the Islamic stock market and the Islamic bonds/Sukuk market. C. Aloui, S. Hammoudeh, and H. B. Hamida (2015) documented a strong interdependence between the Islamic stock market and the Sukuk market in GCC countries, though they showed that the co-movement power varies over time. Similarly, Nasreen et al. (2020) observed varying correlations between the Islamic stock and the Sukuk market. They reported a positive correlation in the short term and a negative one in the long term. Kim (2013) shows a strong influence of the Islamic stock market on the Sukuk market as there is unidirectional volatility transmission from the Islamic stock market to the Sukuk market.

Our study falls under the third strand of literature. Since this third stream of literature is relatively new and small, there is still scope for further investigation and contribution. For example, the existing literature does not investigate the tail risk connectedness between Islamic sectoral stock markets and Sukuk markets. This is an important gap in the literature, because several studies (such as Billah, M. Alam, and M. Hoque 2024b; M. Billah, F. Balli 2023; Forhad and Alam 2022) show that the connectedness at the tails is quite different than at the median. It's worth mentioning that tail connectedness is especially useful to understand how the markets are connected at the extremes and to see if an asset class can be used as a hedge or safe haven for another asset class. Our study is the first one to address this gap in this rather new stream of literature. Therefore, the analysis of the transmission of

tail risks, as opposed to only risk at median, is a novel contribution to this sub-group of literature that examines interconnections between various sub-sectors of Islamic markets. Another gap in this small strand of literature is that the current studies consider the overall stock market index rather than sectoral stock market indices. The analysis of the sectoral stock indices, as opposed to an overall index, has more practical implications for the investors and portfolio managers, as different sectors may perform differently in normal situations and in crises. Considering only an overall stock market index may mask the significant ups or downs in a particular sector and may hide important information from the investors. Studies on the mainstream stock markets also show that sectoral indices may perform differently from the overall index, and, as a result, several studies consider the sectoral indices instead of or in addition to the overall index. Therefore, this is also an important gap in the literature that we address by considering the sectoral indices. The third gap in this stream of literature is that current studies consider overall Sukuk indices which are not investable. Addressing this gap in the literature, our study utilizes country-specific investable Sukuks providing better practical implications for the investors. Fourth, we consider more countries, covering different regions of the world, than other studies in this sub-group of literature typically include. Including more countries is important as Islamic markets are expanding to new countries and regions, and inclusion of diverse regions makes such analyses more comprehensive. Fifth, to provide more practical implications for the market participants and investors in Islamic financial markets, we calculate optimal portfolio weights, hedge ratios and hedging effectiveness for the portfolios consisting of Islamic sectoral stocks and country-specific Sukuks. Thus, as the investments in these faith-based instruments are increasing rapidly, our study provides portfolio managers and investors with useful information for effective portfolio management. We believe, the incremental knowledge, provided by our study, will enhance the understanding of the internal dynamics of the rapidly growing Islamic financial markets and help the investors and other market participants make informed decision.

Therefore, the objective of this study is to address the abovementioned gaps in the existing literature and analyse the tail risk connectedness and spillover between Islamic sectoral stock indices and country specific Sukuks. For this we chose 10 Dow Jones Islamic sector indices and 15 sovereigns Sukuks because these 15 Sukuk markets are the most active and diverse sovereign Sukuk markets in the world and cover a wide range of countries with different economic and financial characteristics (Billah, F. Balli, and H. Balli 2022).

Our findings document that connectedness and spillover of risks are much stronger at left and right tails than at median, and in the short-term than in long-term. This emphasizes the importance of extreme market conditions and short-term dynamics in the spillover of risks. Even though the median risk connectedness is higher during the crisis of COVID-19, the connectedness between tail risks is usually elevated even before the COVID-19 pandemic. Industrial sub-sector of Islamic stock market is consistently a significant net transmitter of median and left tail shocks. However, all the sectoral stock market indices are significant and consistent transmitter of left tail shocks indicating a much stronger role of sectoral stock markets in transmitting large negative shocks. The connectedness between these markets also increased during the Russia-Ukraine war though mainly in the short-term frequency. The portfolio analysis shows that long positions in sectoral stocks can usually be hedged by taking short positions in Sukuks. The values of hedging effectiveness are also promising in the portfolios with optimal weights. During COVID-19, the share of equities in optimal portfolios decreases.

The rest of the article is organized as follows. Section 2 discusses data and summary statistics; Section 3 provides methodology; Section 4 presents and discusses the findings of the study, and finally Section 5 concludes with implications.

Data and summary statistics

Our data on Sukuks include the daily returns of 15 sovereign Sukuk indices from 6 GCC countries, namely Bahrain (BAH), Kuwait (KWT), Oman (OMN), Qatar (QAT), Saudi Arabia (SAR), and the United Arab Emirates (UAE); a West Asian country, Turkey (TUR); four Southeast Asian regions, Hong Kong (HK), Singapore (SIN), Malaysia (MAL)

Table 1. Composition of the sukuk index.

	Country	Sukuk
	Bahrain	4
	Kuwait	5
GCC Countries	Oman	4
	Qatar	7
	Saudi Arabia	5
	United Arab Emirates (UAE)	16
Asian Countries	Hong Kong	3
	Indonesia	35
	Malaysia	47
	Pakistan	5
	Singapore	5
African countries	Nigeria	3
European Countries	Ireland	3
	Turkey	12
	United Kingdom (UK)	5

We used the daily return of Sukuk data available on the Bloomberg database, for the period from 1 January 2016 to 12 August 2022. To construct country Sukuk indices we use the same methodology of Bloomberg Index which has been implemented by M. Billah, F. Balli, and H. O. Balli (2022) and Balli et al. (2022).

and Indonesia (IND); a South Asian country, Pakistan (PAK), an African country, Nigeria (NGR); and finally two European countries, United Kingdom (UK) and Ireland (IRL). In this article, we used liquid Sukuk with standard day-to-day information as they are entirely tradable and can also be traded retrospectively on the secondary market. The schedule of Sukuk data is an essential consideration that brings about national choice. Therefore, the researches, such as M. Billah, F. Balli, and H. O. Balli (2022) and Balli et al. (2022), developed sovereign Sukuk indices following the Bloomberg method.[1] The following criteria are ensured to be met: first, a minimal maturation of 12 months; second, the exceptional equilibrium is more significant than $200 million; third, a rating from S&P, RAM, MARC, or Moody's; and fourth, USD denominated to avoid impact of exchange rates. 156 Sukuks from the above-mentioned countries were reviewed to select the ones that meet the above-mentioned criteria. Table 1 presents the selection of the Sukuks.[2]

We also consider Dow Jones Islamic sector stock indices that include Materials (BM), Consumer Discretionary (CG), Consumer Services (CS), Financials (FIN), Health Care (HC), Industrials (INDS), Oil & Gas (OG), Technology (TECH), Telecommunications (TELE) and Utilities (UTL). In general, the Dow Jones Islamic sector market, which ignores companies involved in businesses that are not in line with Sharia rules, such as trading in alcohol, tobacco, pork and related substances, gambling, etc., includes about 2,578 companies in 58 countries (Adekoya et al. 2022).

The data are obtained from Bloomberg Professional Service and Datastream database. The sample period, 1 January 2016, to August,10 2023, is dictated by the availability of Sukuk data. We calculate the daily return by taking the first difference of the log of the series.

In Table 2, we report the descriptive statistics. Most of the mean of the country specific Sukuk indices are negative while mean of almost half of the sectoral stock market indices are negative. All the series are significantly right skewed and leptokurtic. Moreover, the Jarque-Bera test shows that all the series are non-normally distributed. The Augmented Dicky–Fuller (ADF) and Phillip-Perron (PP) test reveals that all the series used in the analyses are stationary.

Methodology

Conditional autoregressive value-at-risk (CAViaR)

Contrary to most existing approaches that measure Value-at-Risk (VaR) by estimating the distribution of the returns first and then by recovering its quantiles in an indirect way, we follow the asymmetric slope CAViaR approach proposed by Engle and Manganelli (2004) which estimates the VaR in a direct fashion. From our perspective this method is the most flexible among the available options, as the slope CAViaR approach, unlike symmetric absolute value approach or indirect GARCH (1,1) approach, allows for asymmetric effects. Furthermore, the asymmetric slope CAViaR model assumes that the VaR of a certain quantile follows an autoregressive process which can be mathematically formulated as follows:

$$f_{a,t}(\beta) = \beta_0 + \beta_1 f_{a,t-1}(\beta) + \beta_2 x_{t-1}^{+} + \beta_3 x_{t-1}^{-} \quad (1)$$

where $f_{a,t}$ is the VaR at the level – which in our case is equal to 5% – in period t, β_0 is the model con-

[1]The document of Bloomberg, where the technical methodology has been explained, can be found at: http://www.bloombergindices.com/content/uploads/sites/2/2016/01/633470877 INDX GFI WP 151022.pdf.

[2]For Sukuk rates, we use the Bloomberg standard rate (BGN), a market consensus price for companies, as well as government bonds calculated utilizing costs from several resources to acquire precise quotes.

Table 2. Descriptive statistics of Sukuk and Islamic sectors.

	ABR	Mean	Max	Min	SD	Skew	Kurt	JB	ADF	PP
Sukuk Markets										
BAHRAIN	BAH	−0.075	3.562	−0.125	0.215	8.955	114.468	6.43E+06***	−15.36***	−15.39***
HONG KONG	HK	0.125	2.987	−0.125	0.135	8.529	151.282	1.95E+06***	−22.28***	−22.07***
INDONESIA	IND	−0.243	4.089	−0.125	0.217	9.417	137.511	5.93E+06***	−8.49***	−16.85***
IRELAND	IRL	0.182	3.772	−0.125	0.194	10.081	147.243	1.52E+08***	−23.23***	−26.32***
KUWAIT	KWT	−0.024	5.139	−0.125	0.257	8.247	116.380	4.26E+07***	−10.51***	−16.71***
MALAYSIA	MAL	−0.054	5.666	−0.125	0.253	14.189	271.764	2.26E+07***	−13.90***	−20.49***
NIGERA	NGR	0.091	6.742	−0.125	0.244	13.225	311.807	5.12E+07***	−15.94***	−15.65***
OMAN	OMN	−0.154	5.278	−0.125	0.286	11.252	159.826	6.36E+06***	−17.85***	−17.82***
PAKISTAN	PAK	0.244	1.616	−0.125	0.145	3.369	26.089	2.64E+05***	−12.32***	−13.97***
QATAR	QAT	−0.104	1.972	−0.125	0.134	4.341	46.604	3.40E+06***	−19.72***	−19.73***
SAUDI ARABIA	SAR	0.031	4.184	−0.125	0.195	11.138	203.035	2.09E+08***	−17.76***	−17.79***
SINGAPORE	SIN	0.196	6.391	−0.125	0.395	9.055	112.121	9.76E+06***	−13.06***	−12.70***
TURKEY	TUR	−0.372	3.874	−0.125	0.224	8.527	113.724	1.29E+07***	−19.69***	−19.71***
UAE	UAE	0.138	2.483	−0.124	0.161	6.887	81.625	3.97E+06***	−18.11***	−18.12***
UK	UK	0.024	3.403	−0.125	0.154	9.271	159.350	1.06E+07***	−19.19***	−19.18***
Islamic Sectoral Markets										
Basic Materials	BM	0.089	0.946	−0.125	0.104	1.736	9.036	1.45E+04***	−59.96***	−25.39***
Consumer Goods	CG	−0.019	0.593	−0.125	0.098	1.350	5.699	1.25E+04***	−51.67***	−23.07***
Consumer Services	CS	0.025	0.562	−0.124	0.099	1.256	5.092	3.16E+04***	−57.43***	−26.85***
Financials	FIN	−0.025	0.628	−0.125	0.102	1.400	5.792	2.38E+04***	−62.43***	−16.42***
Healthcare	HC	−0.012	0.540	−0.125	0.099	1.276	5.173	5.57E+03***	−30.84***	−19.71***
Industrials	INDS	−0.012	0.705	−0.124	0.100	1.398	6.029	1.67E+04***	−60.25***	−26.49***
Oil & Gas	OG	0.022	0.594	−0.125	0.103	1.266	5.076	2.72E+04***	−54.06***	−18.65***
Technology	TECH	0.008	0.569	−0.125	0.103	1.340	5.447	5.49E+03***	−61.66***	−19.82***
Telecommunication	TELE	−0.021	0.539	−0.125	0.099	1.195	4.726	1.75E+03***	−63.33***	−21.97***
Utilities	UTL	0.010	0.455	−0.125	0.097	1.144	4.365	1.76E+03***	−45.21***	−25.73***

This table provides the descriptive statistics for the Sukuk and Islamic sectoral markets under study. Max, Min, SD, Skew, Kurt and JB represents Maximum, Minimum, Standard Deviation, Skewness, and Kurtosis respectively. ADF (Augmented Dicky & Fuller) and PP (Phillip & Perron) are the tests of stationarity. *** Indicates significance at 1%.

stant, β_1 and $f_{a,t-1}(\beta)$ are the weights of the lagged VaRs and the lagged VaRs, respectively while β_2 and β_3 represent the effects positive and negative returns have on the VaR, respectively.[3]

Quantile-frequency connectedness analysis

In order to delve deeper into the connection between the indices we employ a method called the quantile connectedness technique. This technique was developed by N. Antonakakis, I. Chatziantoniou, and D. Gabauer (2020) and Chatziantoniou and Gabauer (2021) Due to space constraints, it is not possible to provide a detailed methodology of the quantile connectedness technique. However, the methodology has been provided in appendix A.1.1 for reference.

Empirical findings and discussion

Average median and tail risk connectedness

We start the analysis by examining the averaged median and tail risk connectedness among the assets over time. Tables 3, 4 and 5 show the average values of connectedness of the median risks in general, in short term (1–5 days) and in long term (more than 5 days) respectively. The cells in Table 3 exhibit the median risk contributions of sectoral stock and Sukuk indices to each other. The cells in a column related to an index demonstrate the contributions of that index to the other indices. For example, the second cell of the 1st column indicates that the BAH Sukuk index contributes 2.89% to the total variations of the HK Sukuk index. The cells in a row representing an index implies the contributions that the index receives from other indices. For instance, the second cell of 1st row implies that HK Sukuk receives 2.80% contributions to its total variation from the BAH Sukuk. Some of the significant contributions are as follows: BAH to MAL; IRL to UK; MAL to BAH; NGR to UK; UK to IRL and NGR; BM to INDS; CG to INDS; CS to INDS and TECH; FIN to TECH; INDS to CG, CS, FIN, TECH; TECH to CS, FIN, INDS. Therefore, INDS significantly contributes to more indices than any other index under

[3]As we know, the performance of CAViaR is highly dependent on the model specification, such as the choice of lag lengths. To test the robustness of the model and check for any pattern changes, we have conducted a sensitivity analysis using different lags (refer to Figure A.19). The results show that the patterns of CAViAR remain relatively the same.

Table 3. 50th Quantile tail risk spillover index between Sukuk and Islamic Sectoral markets

	BAH	HK	IND	IRL	KWT	MAL	NGR	OMN	PAK	QAT	SAR	SIN
BAH	47.97	2.80	6.43	1.80	3.06	12.84	0.85	4.82	0.26	2.30	4.07	3.30
HK	2.89	51.54	2.54	2.68	3.47	4.18	1.89	3.69	0.47	2.94	2.98	2.68
IND	6.70	2.96	52.38	1.40	3.47	3.21	1.32	4.41	0.58	1.54	4.50	3.38
IRL	1.92	2.71	1.42	58.18	3.01	0.90	4.48	2.19	0.73	1.34	1.35	2.46
KWT	2.77	2.29	2.64	2.47	62.46	2.99	1.65	3.39	0.39	2.42	2.34	2.67
MAL	11.61	3.72	3.50	0.91	3.66	44.68	1.22	4.76	0.44	5.03	2.84	1.97
NGR	1.36	2.18	1.22	4.85	2.24	1.28	61.28	1.35	0.52	2.57	1.44	1.53
OMN	4.40	3.03	3.34	1.45	3.23	4.41	0.97	58.89	0.15	2.35	2.62	3.28
PAK	0.79	0.68	1.01	1.05	1.28	0.74	0.95	0.48	77.50	0.90	0.93	1.16
QAT	2.95	2.56	1.74	1.32	3.33	5.87	2.44	3.01	0.96	54.21	3.64	1.83
SAR	4.59	3.20	4.90	2.71	2.83	2.71	1.34	3.24	0.65	3.08	51.80	2.59
SIN	3.48	2.37	3.33	2.11	2.80	1.90	0.88	4.00	0.57	1.45	2.33	64.92
TUR	5.56	2.55	3.63	1.77	3.04	3.97	1.04	3.77	0.46	2.47	4.12	2.30
UAE	2.35	3.45	2.43	1.17	3.68	3.75	1.28	4.13	0.59	3.18	2.81	2.62
UK	1.18	2.12	1.17	11.22	3.10	2.02	10.23	1.97	0.53	3.48	1.92	1.58
BM	0.61	0.59	0.59	0.38	0.54	0.39	0.42	0.69	0.49	0.49	0.46	0.74
CG	0.57	0.55	0.51	0.44	0.45	0.49	0.65	0.64	0.62	0.51	0.61	0.44
CS	0.69	0.60	0.73	0.62	0.60	0.37	0.36	0.54	0.42	0.44	0.39	0.63
FIN	0.62	0.66	0.37	0.30	0.53	0.58	0.45	0.30	0.55	0.39	0.70	0.40
HC	1.04	0.63	0.77	0.55	0.72	0.87	0.53	0.73	0.67	0.38	0.61	0.67
INDS	0.69	0.60	0.41	0.44	0.74	0.39	0.34	0.70	0.31	0.37	0.42	0.65
OG	0.77	0.84	0.75	0.69	0.99	0.99	0.95	0.89	0.59	1.16	0.88	0.96
TECH	0.66	0.73	0.69	0.42	0.98	0.54	0.47	0.49	0.46	0.61	1.09	0.77
TELE	0.74	1.03	0.66	0.95	0.60	0.88	0.82	1.12	0.75	1.24	1.07	0.86
UTL	0.78	0.76	0.95	0.85	0.73	1.01	0.99	0.77	1.15	1.26	0.79	1.02
TO	59.73	43.61	45.74	42.56	49.09	57.27	36.51	52.06	13.30	41.92	44.93	40.51
NET	7.70	-4.85	-1.88	0.74	11.56	1.95	-2.21	10.95	-9.20	-3.87	-3.27	5.43

	TUR	UAE	UK	BM	CG	CS	FIN	HC	INDS	OG	TECH	TELE	UTL	FROM
BAH	2.72	1.65	0.96	0.46	0.24	0.33	0.33	0.79	0.43	0.46	0.44	0.22	0.46	52.03
HK	2.46	3.39	2.42	1.06	1.02	0.81	0.95	0.90	1.00	1.39	1.04	0.84	0.78	48.46
IND	2.99	2.45	1.02	0.76	0.77	0.77	0.72	0.94	0.73	0.50	0.58	0.82	1.12	47.62
IRL	1.35	1.16	12.34	0.50	0.52	0.46	0.43	0.39	0.38	0.37	0.33	0.56	0.50	41.82
KWT	1.99	2.57	2.57	0.45	0.44	0.51	0.40	0.48	0.43	0.46	0.55	0.34	0.32	37.54
MAL	3.54	3.12	1.62	0.83	0.81	0.56	0.57	0.61	0.76	0.90	0.58	0.60	1.15	55.32
NGR	1.13	1.25	10.35	0.59	0.58	0.37	0.47	0.58	0.50	0.66	0.61	0.54	0.55	38.72
OMN	2.69	2.79	1.49	0.47	0.73	0.56	0.33	0.47	0.53	0.44	0.44	0.61	0.32	41.11
PAK	0.97	0.89	0.94	0.91	1.22	0.92	0.98	1.01	0.63	0.79	0.81	0.95	1.55	22.50
QAT	2.66	3.33	3.03	0.56	0.54	0.45	0.74	0.67	0.78	1.05	0.59	0.79	0.95	45.79
SAR	4.27	2.43	1.42	0.68	0.67	0.55	1.17	0.55	0.51	0.77	1.08	1.36	0.91	48.20
SIN	1.84	2.11	1.46	0.54	0.33	0.39	0.21	0.45	0.43	0.28	0.57	0.44	0.81	35.08
TUR	53.56	2.17	1.99	0.95	0.88	0.81	0.63	0.69	1.08	0.77	0.90	0.46	0.42	46.44
UAE	2.30	56.67	1.93	0.58	0.85	0.63	0.78	0.96	0.83	0.89	0.66	0.80	0.68	43.33
UK	1.87	1.95	49.95	0.58	0.47	0.51	0.53	0.72	0.42	0.83	0.44	0.71	0.48	50.05
BM	0.51	0.37	0.44	37.98	8.18	5.75	4.70	4.70	13.24	5.22	5.12	3.98	3.43	62.02
CG	0.47	0.48	0.40	7.88	35.61	8.52	6.05	7.48	11.02	2.42	7.15	2.74	3.29	64.39
CS	0.49	0.56	0.47	5.32	8.40	34.58	8.39	6.77	12.01	3.45	10.82	1.02	1.32	65.42
FIN	0.51	0.42	0.44	4.97	6.45	8.87	37.58	7.09	10.10	3.27	12.14	0.71	1.59	62.42
HC	0.48	0.63	0.67	5.15	8.31	7.27	7.60	39.53	9.14	2.43	7.47	1.33	1.80	60.47
INDS	0.43	0.49	0.52	10.80	9.33	10.30	7.94	6.95	29.89	4.30	9.23	1.74	2.02	70.11
OG	0.89	0.83	0.88	6.74	2.90	4.94	4.25	2.66	6.82	52.20	3.90	1.13	1.40	47.80
TECH	0.61	0.61	0.58	4.87	7.00	10.57	11.25	6.60	10.65	2.70	34.42	0.98	1.25	65.58
TELE	0.69	0.83	0.89	6.08	4.24	2.06	1.77	2.48	3.64	1.92	1.99	55.53	7.14	44.47
UTL	0.53	0.85	0.75	5.39	4.92	2.84	2.54	2.81	3.89	2.01	2.50	6.57	53.36	46.64
TO	38.40	37.33	49.56	67.11	69.80	69.75	63.74	57.74	89.95	38.29	69.93	30.25	34.25	**TCI**
NET	-8.05	-6.00	-0.49	5.09	5.41	4.33	1.32	-2.72	19.84	-9.51	4.35	-14.22	-12.4	**49.73**

The aforementioned table demonstrates the QVAR spillovers for Total, net, and pairwise, utilizing a lag length of order 1 (BIC), a forecast is 20-step-ahead, and a window size of 200.

consideration, followed by UK Sukuk, TECH and CS. However, an interesting and intuitive observation is that each country's index is a significant contributor to its own indices. Therefore, it suggests that tail risk of countries is influenced by the tail risk of own indices rather than the other country or sectoral indices. When it comes to short term (1–5 days, Table 4), there are fewer significant contributors to other indices. INDS still significantly contributes to more indices than any other index followed by TECH. Interestingly, in the long term (more than 5 days, Table 5), there are no significant contributors to other indices. That means, the shorter the time period the more connected the indices are.

Table 4. 50th Quantile tail risk spillover index between Sukuk and Islamic Sectoral markets at the short-term (1 to 5 days)

	BAH	HK	IND	IRL	KWT	MAL	NGR	OMN	PAK	QAT	SAR	SIN	TUR
BAH	40.43	2.33	5.45	1.55	2.59	10.35	0.68	4.01	0.21	1.90	3.45	2.80	2.29
HK	2.47	43.56	2.18	2.37	2.84	3.41	1.62	3.07	0.35	2.52	2.45	2.20	2.15
IND	5.63	2.46	43.31	1.19	2.78	2.62	1.01	3.68	0.46	1.21	3.76	2.85	2.47
IRL	1.63	2.37	1.23	50.34	2.49	0.74	3.60	1.89	0.65	1.12	1.16	2.15	1.14
KWT	2.35	1.94	2.25	2.08	52.33	2.52	1.34	2.89	0.32	2.04	1.98	2.27	1.68
MAL	9.37	3.04	2.73	0.78	3.02	36.17	0.90	3.83	0.33	4.02	2.27	1.64	2.79
NGR	1.12	1.82	0.99	4.22	1.78	0.98	50.87	1.14	0.41	2.01	1.14	1.31	0.81
OMN	3.69	2.59	2.87	1.26	2.77	3.56	0.81	49.75	0.12	1.95	2.18	2.82	2.27
PAK	0.63	0.53	0.83	0.91	1.03	0.59	0.72	0.38	63.80	0.72	0.72	0.86	0.77
QAT	2.42	2.15	1.44	1.13	2.78	4.76	1.98	2.49	0.73	44.67	3.00	1.49	2.24
SAR	3.95	2.65	4.21	2.41	2.43	2.31	1.12	2.75	0.56	2.54	44.50	2.17	3.66
SIN	2.95	1.98	2.83	1.78	2.37	1.61	0.74	3.39	0.48	1.23	1.97	54.66	1.55
TUR	4.67	2.19	3.06	1.54	2.64	3.34	0.83	3.19	0.38	2.05	3.49	1.97	45.41
UAE	1.96	2.96	2.03	1.01	3.18	3.12	1.03	3.39	0.45	2.64	2.41	2.15	2.02
UK	0.95	1.80	0.91	9.86	2.53	1.67	7.80	1.67	0.44	2.79	1.52	1.33	1.55
BM	0.51	0.51	0.48	0.33	0.45	0.32	0.31	0.59	0.41	0.41	0.39	0.57	0.44
CG	0.46	0.49	0.42	0.40	0.37	0.40	0.55	0.52	0.51	0.42	0.56	0.35	0.41
CS	0.56	0.52	0.55	0.54	0.48	0.30	0.28	0.42	0.34	0.35	0.32	0.47	0.39
FIN	0.50	0.54	0.31	0.25	0.43	0.44	0.36	0.23	0.42	0.34	0.56	0.32	0.41
HC	0.87	0.52	0.61	0.47	0.55	0.72	0.39	0.55	0.55	0.33	0.50	0.52	0.38
INDS	0.56	0.51	0.33	0.40	0.58	0.32	0.26	0.58	0.24	0.30	0.35	0.51	0.36
OG	0.64	0.72	0.61	0.59	0.77	0.83	0.80	0.76	0.50	0.97	0.73	0.78	0.78
TECH	0.54	0.60	0.54	0.36	0.78	0.45	0.37	0.40	0.37	0.51	0.85	0.59	0.53
TELE	0.64	0.89	0.59	0.87	0.50	0.74	0.68	0.95	0.64	1.01	0.90	0.68	0.61
UTL	0.67	0.66	0.80	0.75	0.58	0.83	0.78	0.61	0.93	1.01	0.65	0.87	0.47
TO	49.72	36.81	38.23	37.03	40.73	46.94	28.96	43.38	10.81	34.40	37.32	33.67	32.16
NET	6.80	-3.05	-0.30	1.56	9.24	3.12	-2.72	9.06	-7.29	-2.81	-3.37	4.03	-7.10

	UAE	UK	BM	CG	CS	FIN	HC	INDS	OG	TECH	TELE	UTL	FROM
BAH	1.35	0.78	0.32	0.18	0.27	0.26	0.65	0.31	0.34	0.33	0.18	0.35	42.92
HK	2.73	2.13	0.79	0.77	0.64	0.68	0.66	0.77	1.02	0.77	0.71	0.58	39.86
IND	1.91	0.84	0.53	0.56	0.58	0.54	0.69	0.55	0.35	0.41	0.61	0.83	38.53
IRL	0.97	10.39	0.42	0.47	0.43	0.40	0.34	0.36	0.31	0.30	0.49	0.45	35.47
KWT	2.15	2.07	0.37	0.35	0.43	0.33	0.40	0.35	0.37	0.45	0.29	0.27	31.49
MAL	2.58	1.31	0.55	0.52	0.40	0.40	0.45	0.52	0.66	0.42	0.46	0.82	43.82
NGR	1.01	8.55	0.45	0.50	0.31	0.36	0.48	0.41	0.51	0.46	0.45	0.45	31.68
OMN	2.39	1.19	0.37	0.59	0.43	0.25	0.40	0.40	0.33	0.35	0.49	0.24	34.31
PAK	0.66	0.71	0.72	1.02	0.73	0.76	0.84	0.52	0.67	0.71	0.77	1.29	18.10
QAT	2.69	2.39	0.40	0.42	0.35	0.58	0.54	0.63	0.80	0.47	0.60	0.73	37.21
SAR	2.04	1.25	0.50	0.54	0.48	0.98	0.45	0.42	0.58	0.92	1.04	0.74	40.69
SIN	1.76	1.24	0.44	0.28	0.33	0.18	0.38	0.36	0.24	0.48	0.37	0.68	29.65
TUR	1.86	1.74	0.80	0.71	0.70	0.54	0.57	0.91	0.63	0.77	0.36	0.33	39.26
UAE	46.81	1.59	0.43	0.68	0.50	0.62	0.82	0.64	0.67	0.54	0.63	0.57	36.04
UK	1.54	40.97	0.48	0.38	0.46	0.46	0.60	0.36	0.74	0.36	0.57	0.40	41.18
BM	0.32	0.37	32.45	6.89	4.85	3.88	3.84	11.05	4.45	4.14	3.31	2.86	51.67
CG	0.42	0.34	6.56	30.57	7.20	5.13	6.36	9.23	2.00	6.08	2.33	2.80	54.31
CS	0.47	0.38	4.53	7.18	29.89	7.05	5.80	10.25	2.83	9.20	0.86	1.17	55.25
FIN	0.34	0.36	3.93	5.29	7.34	32.02	5.88	8.29	2.55	10.06	0.55	1.30	50.99
HC	0.52	0.56	4.19	6.91	6.17	6.33	33.88	7.51	1.93	6.20	1.10	1.51	49.89
INDS	0.41	0.39	9.02	7.96	8.73	6.62	5.90	25.51	3.56	7.65	1.46	1.68	58.70
OG	0.68	0.68	5.64	2.44	4.01	3.48	2.22	5.75	45.39	3.13	0.94	1.18	39.65
TECH	0.49	0.46	3.91	6.00	9.15	9.47	5.61	8.85	2.17	29.51	0.81	1.05	54.87
TELE	0.70	0.71	4.92	3.43	1.63	1.39	1.93	2.85	1.52	1.57	48.21	6.14	36.53
UTL	0.71	0.59	4.26	4.03	2.28	2.02	2.21	3.11	1.50	1.89	5.45	45.58	37.68
TO	30.70	41.04	54.57	58.10	58.40	52.71	48.03	74.38	30.74	57.69	24.81	28.41	**TCI**
NET	-5.33	-0.15	2.89	3.79	3.14	1.73	-1.86	15.69	-8.90	2.82	-11.72	-9.27	**41.19**

The aforementioned table demonstrates the QVAR spillovers for Total, net, and pairwise, utilizing a lag length of order 1 (BIC), a forecast is 20-step-ahead, and a window size of 200.

In Tables 3, 4 and 5, the cells in the row named 'To', indicate the total contributions of one index to all the other index together. For instance, the first cell of the row named 'To' in Table 3 indicates that BAH contributes a total 59.73% to the variations in all the other indices together. Among the top contributors are INDS and TECH. They are top contributors in both short (Table 4) and long term (Table 5) as well. The cells in the column titled 'FROM', in Tables 3, 4 and 5, implies total contributions an index receives from the other indices together. For instance, the first cell of the column titled 'FROM', in Table 3, reveals that BAH receives in total 42.92% of the variation in its tail risk from other indices together. In Tables 3, 4 and 5, the row titled 'NET' indicates the difference between 'TO'

Table 5. 50th Quantile tail risk spillover index between Sukuk and Islamic Sectoral markets at the long-term (more than 5 days)

	BAH	HK	IND	IRL	KWT	MAL	NGR	OMN	PAK	QAT	SAR	SIN	TUR
BAH	7.54	0.46	0.98	0.25	0.47	2.49	0.17	0.81	0.05	0.40	0.62	0.51	0.43
HK	0.42	7.97	0.37	0.31	0.63	0.77	0.27	0.62	0.12	0.43	0.53	0.48	0.31
IND	1.07	0.50	9.07	0.21	0.70	0.59	0.31	0.73	0.12	0.33	0.73	0.53	0.52
IRL	0.29	0.34	0.19	7.84	0.53	0.16	0.88	0.30	0.09	0.22	0.19	0.31	0.21
KWT	0.42	0.36	0.39	0.39	10.13	0.47	0.31	0.50	0.07	0.38	0.36	0.40	0.31
MAL	2.25	0.67	0.77	0.13	0.65	8.50	0.32	0.93	0.11	1.00	0.57	0.33	0.75
NGR	0.24	0.36	0.23	0.63	0.46	0.30	10.41	0.21	0.11	0.56	0.29	0.23	0.32
OMN	0.71	0.44	0.48	0.20	0.46	0.85	0.15	9.14	0.03	0.41	0.44	0.47	0.42
PAK	0.15	0.15	0.18	0.14	0.25	0.15	0.23	0.10	13.70	0.17	0.21	0.29	0.19
QAT	0.53	0.40	0.30	0.19	0.55	1.11	0.47	0.52	0.23	9.54	0.63	0.35	0.42
SAR	0.64	0.55	0.69	0.30	0.40	0.39	0.22	0.49	0.09	0.54	7.30	0.42	0.61
SIN	0.53	0.39	0.50	0.33	0.43	0.29	0.14	0.61	0.08	0.22	0.36	10.26	0.30
TUR	0.90	0.36	0.57	0.23	0.40	0.63	0.21	0.58	0.08	0.43	0.63	0.32	8.15
UAE	0.39	0.49	0.40	0.16	0.50	0.62	0.25	0.74	0.14	0.54	0.41	0.47	0.28
UK	0.23	0.32	0.27	1.37	0.57	0.35	2.43	0.30	0.09	0.69	0.40	0.25	0.33
BM	0.10	0.08	0.12	0.05	0.08	0.07	0.10	0.10	0.08	0.08	0.08	0.17	0.07
CG	0.11	0.06	0.09	0.04	0.08	0.09	0.10	0.13	0.11	0.10	0.06	0.08	0.06
CS	0.13	0.08	0.18	0.08	0.12	0.07	0.08	0.12	0.07	0.09	0.07	0.16	0.10
FIN	0.13	0.12	0.06	0.05	0.10	0.14	0.09	0.07	0.12	0.05	0.14	0.08	0.10
HC	0.17	0.11	0.16	0.08	0.17	0.15	0.14	0.18	0.12	0.05	0.11	0.15	0.09
INDS	0.13	0.09	0.08	0.05	0.16	0.07	0.08	0.12	0.06	0.06	0.07	0.15	0.07
OG	0.13	0.11	0.14	0.10	0.22	0.16	0.15	0.13	0.09	0.20	0.15	0.17	0.11
TECH	0.13	0.13	0.15	0.06	0.20	0.09	0.09	0.09	0.09	0.10	0.24	0.19	0.08
TELE	0.10	0.14	0.07	0.07	0.10	0.14	0.14	0.17	0.11	0.23	0.17	0.18	0.08
UTL	0.10	0.10	0.15	0.10	0.15	0.18	0.21	0.16	0.21	0.24	0.14	0.16	0.06
TO	10.01	6.80	7.51	5.52	8.37	10.33	7.55	8.68	2.49	7.52	7.61	6.83	6.24
NET	0.90	-1.81	-1.58	-0.82	2.32	-1.18	0.51	1.88	-1.91	-1.06	0.10	1.40	-0.95

	UAE	UK	BM	CG	CS	FIN	HC	INDS	OG	TECH	TELE	UTL	FROM
BAH	0.30	0.18	0.15	0.06	0.06	0.07	0.13	0.12	0.12	0.11	0.05	0.11	9.11
HK	0.66	0.29	0.27	0.24	0.17	0.27	0.24	0.23	0.37	0.27	0.13	0.19	8.61
IND	0.54	0.18	0.23	0.21	0.19	0.18	0.25	0.18	0.14	0.17	0.21	0.29	9.09
IRL	0.20	1.95	0.08	0.05	0.04	0.04	0.05	0.03	0.06	0.03	0.07	0.05	6.34
KWT	0.42	0.50	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.10	0.05	0.05	6.05
MAL	0.53	0.31	0.28	0.29	0.16	0.17	0.16	0.24	0.24	0.16	0.15	0.33	11.50
NGR	0.24	1.80	0.13	0.08	0.06	0.10	0.10	0.09	0.15	0.15	0.09	0.10	7.04
OMN	0.40	0.29	0.10	0.15	0.12	0.08	0.07	0.13	0.11	0.09	0.12	0.08	6.80
PAK	0.23	0.22	0.19	0.20	0.19	0.22	0.17	0.10	0.11	0.10	0.18	0.27	4.40
QAT	0.64	0.64	0.17	0.13	0.09	0.16	0.13	0.15	0.26	0.11	0.19	0.22	8.58
SAR	0.40	0.17	0.18	0.13	0.07	0.19	0.10	0.09	0.19	0.16	0.32	0.17	7.51
SIN	0.34	0.22	0.10	0.05	0.06	0.03	0.07	0.07	0.04	0.08	0.07	0.13	5.43
TUR	0.31	0.25	0.15	0.17	0.11	0.10	0.12	0.17	0.14	0.13	0.11	0.09	7.18
UAE	9.87	0.34	0.14	0.17	0.13	0.16	0.14	0.19	0.22	0.12	0.17	0.11	7.29
UK	0.41	8.98	0.09	0.09	0.05	0.07	0.12	0.07	0.09	0.07	0.13	0.08	8.87
BM	0.05	0.07	5.53	1.29	0.90	0.81	0.86	2.20	0.78	0.98	0.66	0.57	10.35
CG	0.06	0.06	1.31	5.04	1.32	0.92	1.12	1.79	0.41	1.07	0.42	0.49	10.08
CS	0.09	0.10	0.79	1.22	4.69	1.34	0.98	1.76	0.62	1.62	0.16	0.15	10.17
FIN	0.07	0.08	1.03	1.16	1.53	5.56	1.21	1.81	0.72	2.08	0.16	0.30	11.43
HC	0.11	0.12	0.96	1.40	1.10	1.28	5.65	1.63	0.50	1.27	0.23	0.29	10.58
INDS	0.08	0.12	1.78	1.37	1.58	1.31	1.05	4.38	0.74	1.58	0.29	0.33	11.41
OG	0.15	0.19	1.10	0.45	0.93	0.77	0.44	1.08	6.81	0.77	0.19	0.23	8.15
TECH	0.12	0.11	0.96	1.00	1.41	1.78	0.99	1.80	0.53	4.92	0.17	0.20	10.71
TELE	0.12	0.18	1.16	0.81	0.43	0.38	0.55	0.79	0.40	0.42	7.33	1.00	7.94
UTL	0.15	0.16	1.13	0.89	0.56	0.52	0.60	0.78	0.51	0.60	1.12	7.79	8.96
TO	6.63	8.52	12.54	11.70	11.36	11.03	9.71	15.56	7.55	12.25	5.43	5.84	**TCI**
NET	-0.66	-0.34	2.20	1.62	1.18	-0.41	-0.87	4.15	-0.60	1.54	-2.50	-3.11	**8.54**

The aforementioned table demonstrates the QVAR spillovers for Total, net, and pairwise, utilizing a lag length of order 1 (BIC), a forecast is 20-step-ahead, and a window size of 200.

and 'FROM'. For instance, the first cell of row 'NET' in Table 3 is 7.70 which is the difference between BAH's contribution to (59.73) and from (52.03) the system of the indices. A positive number, thus, indicates that the index under consideration is a net contributor to the system of these indices and a negative number indicates that the index is a net receiver. Table 3 shows that INDS is the largest net contributor of shocks to the system while TELE is the largest net receiver of shocks from the system. Same is true in short (Table 4) and long (Table 5) term, UTL replaces TELE as largest net receiver of shocks in long term though. Interestingly, all the Sukuks, except that of Kuwait, are mostly net receiver of the shocks. This shows that Islamic bond markets are rather in the

receiving side of shocks from the Islamic sectoral stock markets. Especially, INDS sector of stock markets seems to exert mentionable shocks to the Sukuks. In Tables 3, 4 and 5, the bottom-right cell indicates the average value of the total connectedness index (TCI). For instance, Table 3 reveals that the TCI is 49.73. It implies that a robust 49.73% of the forecast error variance in this system of these indices can be explained from within the network of these variables. Tables 3 and 5 show that TCI is 41.19 in the short term and 8.54 in the long term. This shows that the total average connectedness among these variables in this system is much stronger in the short term than in the long term. In the long term, this network is more prone to outside shocks. Such result, that the total connectedness is predominantly driven by short-term dynamics and not by long-term shocks, goes along with the findings of Chatziantoniou and Gabauer (2021). In line with similar findings, Nagayev et al. (2016) demonstrate that the relation between Islamic equity markets and commodity markets are rather volatile. From a country-level analysis, M. Billah, F. Balli, and H. O. Balli (2022) claim that how Sukuks will respond to global shocks depends on whether the Sukuks are issued by financial or non-financial corporations.

Tables 6–8 show the average values of connectedness of the left tail risks (5th quantile) in general, in short term (1–5 days) and in long term (more than 5 days) respectively. With a few exceptions, the contributors and receivers of left tail risks are same as those of median risks. However, in terms of magnitude, the connectedness is much stronger in the left tail than in the median. For example, whereas INDS contributes 89% at median (Table 3), it contributes 107% at left tail (Table 6). The values of net contribution and receive are also large in the left tail than in median. This is true in both short (1–5 days) and long (more than 5 days) term. This is clearly evident when Tables 7 and 8 are compared to Tables 4 and 5. The value of TCI is also much higher in left tail than in median. Specifically, in the left tail TCI is 8253 (as opposed to only 49.73 in median). In the short-term, left tail TCI is 68.05 as opposed to 41.19 at median. In the long term, the left tail TCI is 14.48 as opposed to 8.54 at median. Therefore, it is clear that in the left tail the connectedness of risk is much higher in both short and long term than at the median.

Tables 9–11 show the average values of connectedness of the right tail risks (95th quantile) in total, in short term (1–5 days) and in long term (more than 5 days), respectively. With a few exceptions, the contributors and receivers of right tail risks are same as those of median risks. However, in terms of magnitude the connectedness is much higher in the right tail than in the median. For example, whereas INDS contributes 89% at median (Table 3), it contributes 100% at right tail (Table 9). The values of net contributions and receives are also bigger in the right tail than in median. This is true in both short (1–5 days) and long (more than 5 days) term, which is evident when Tables 10 and 11 are compared with Tables 4 and 5. The value of TCI is also much higher in right tail than in median. Specifically, in the right tail, TCI is 9591 (as opposed to only 49.73 in median). In the short-term right, tail TCI is 77.45 as opposed to 41.19 at median. In the long term, the right tail TCI is 18.46 as opposed to 8.54 at median. Therefore, it is clear that in the right tail the connectedness of risk is much stronger in both short and long term than at the median.

The fact that connectedness is much higher at the extremes/tails of the distribution than at the median goes along the findings from M. Billah, F. Balli, and I. Hoxha (2023), (2024a)) Nitoi and Pochea (2019), Balli et al. (2021), Iqbal et al. (2022) and many other studies that document the connectedness is much stronger in tails than at the median or mean of the distributions.

Trend and dynamics of total and net directional median and tail risk connectedness

Figure 1 demonstrates the evolution of total connectedness of median risk over time in both short and long term. The red (green) colour shows the total connectedness in short (long) term while the black area shows that total connectedness in total. It is clear that the dynamic total connectedness is much higher in short term (red) than in long (green) term. This is true throughout the sample period. Another salient feature of Figure 1 is that there is a sharp jump in total connectedness in 2020 which is only subdued slightly in 2023. The sharp

Table 6. 5th Quantile tail risk spillover index between Sukuk and Islamic Sectoral markets

	BAH	HK	IND	IRL	KWT	MAL	NGR	OMN	PAK	QAT	SAR	SIN	TUR
BAH	20.29	4.07	6.12	3.03	3.02	7.89	2.16	4.24	2.08	3.76	4.66	2.65	3.38
HK	3.36	14.05	3.62	3.72	2.91	4.70	2.87	3.20	2.96	4.31	4.03	2.19	3.20
IND	6.08	4.33	17.75	3.02	3.25	4.28	2.44	4.05	2.47	3.58	5.25	2.93	3.62
IRL	2.91	4.57	2.92	20.34	3.15	2.77	4.57	2.53	3.22	3.45	2.77	2.00	2.70
KWT	3.30	4.07	3.77	3.68	25.52	4.15	2.77	3.62	2.17	4.07	3.50	2.37	2.94
MAL	6.32	5.11	3.91	2.58	3.55	17.19	2.48	4.15	2.38	5.25	3.90	2.07	3.95
NGR	2.39	3.91	2.68	5.00	2.49	2.88	22.22	1.97	2.78	4.13	2.67	1.33	2.27
OMN	4.65	4.09	4.20	2.47	3.41	4.94	1.76	28.05	1.73	3.74	3.42	2.89	3.54
PAK	2.02	3.62	2.45	3.03	1.54	2.76	2.47	1.38	19.71	3.25	2.87	0.91	2.36
QAT	3.16	4.46	3.08	2.89	3.02	5.11	3.26	2.94	2.80	15.32	4.17	1.48	3.40
SAR	4.59	4.61	5.19	2.51	2.93	3.95	2.24	2.94	2.64	4.38	18.30	1.97	3.71
SIN	3.75	3.94	3.97	3.01	3.01	2.95	1.63	3.88	1.83	2.81	3.08	36.82	2.37
TUR	3.85	4.36	4.01	2.92	3.07	4.94	2.27	3.61	2.40	4.22	4.59	1.88	20.56
UAE	3.02	5.04	3.33	2.87	3.14	4.44	2.66	3.28	2.76	4.75	3.92	1.94	3.12
UK	2.44	4.28	2.83	6.15	3.05	3.43	5.88	2.36	2.93	5.01	3.08	1.43	3.10
BM	1.73	3.11	2.10	2.17	1.27	2.34	2.13	1.39	2.79	2.75	2.39	0.77	1.91
CG	1.69	3.16	2.05	2.03	1.29	2.36	1.84	1.44	2.95	2.80	2.53	0.75	2.01
CS	1.76	3.07	2.22	2.33	1.36	2.31	1.97	1.50	3.00	2.81	2.31	0.86	2.15
FIN	1.74	2.91	1.95	2.26	1.24	2.26	1.98	1.25	3.02	2.79	2.46	0.74	1.98
HC	1.78	3.20	2.22	2.11	1.36	2.37	1.99	1.51	2.92	2.80	2.56	0.86	1.87
INDS	1.70	2.98	1.91	2.04	1.35	2.17	1.80	1.37	2.75	2.67	2.19	0.80	1.80
OG	2.02	3.54	2.26	2.51	1.60	2.64	2.33	1.60	3.23	3.43	2.78	0.89	2.19
TECH	1.77	3.13	2.19	2.08	1.44	2.23	2.19	1.42	2.93	2.79	2.51	0.94	2.02
TELE	1.78	3.38	2.38	2.51	1.54	2.61	2.33	1.54	3.43	3.70	3.04	0.85	2.11
UTL	2.01	3.43	2.57	2.60	1.51	2.84	2.38	1.60	3.59	3.48	2.78	1.02	2.12
TO	69.82	92.38	73.91	69.53	55.51	83.30	60.42	58.80	65.74	86.75	77.45	36.50	63.79
NET	-9.89	6.44	-8.34	-10.13	-18.98	0.49	-17.36	-13.15	-14.55	2.08	-4.24	-26.68	-15.66

	UAE	UK	BM	CG	CS	FIN	HC	INDS	OG	TECH	TELE	UTL	FROM
BAH	3.24	2.90	2.61	2.57	2.67	2.66	2.71	2.64	2.70	2.69	2.49	2.77	79.71
HK	4.45	3.91	3.66	3.81	3.67	3.40	3.64	3.64	3.75	3.67	3.57	3.68	85.95
IND	3.57	3.22	2.93	2.95	3.11	2.80	3.03	2.78	2.91	3.07	3.14	3.42	82.25
IRL	3.16	7.02	3.16	3.04	3.42	3.32	2.84	2.99	3.24	3.05	3.43	3.44	79.66
KWT	3.82	4.23	2.43	2.63	2.62	2.46	2.51	2.67	2.68	2.62	2.76	2.62	74.48
MAL	4.31	3.44	2.93	3.00	2.91	2.79	2.96	2.81	3.04	2.78	2.94	3.26	82.81
NGR	3.19	7.15	3.38	3.00	3.27	3.18	3.15	3.05	3.37	3.61	3.38	3.54	77.78
OMN	3.77	2.66	2.43	2.69	2.59	2.20	2.49	2.37	2.38	2.44	2.51	2.56	71.95
PAK	3.09	3.39	4.24	4.57	4.65	4.50	4.25	4.36	4.38	4.55	4.60	5.03	80.29
QAT	4.39	4.74	3.37	3.52	3.53	3.41	3.30	3.45	3.83	3.42	4.04	3.92	84.68
SAR	3.80	3.07	3.13	3.31	3.11	3.49	3.23	2.91	3.32	3.44	3.77	3.48	81.70
SIN	3.05	2.75	1.95	1.91	2.22	1.92	2.17	2.03	1.99	2.26	2.18	2.50	63.18
TUR	3.64	3.84	2.92	3.13	3.33	2.97	2.68	2.88	3.04	3.07	2.90	2.92	79.44
UAE	17.07	3.96	3.43	3.46	3.54	3.42	3.46	3.41	3.49	3.43	3.48	3.56	82.93
UK	3.76	15.80	3.50	3.29	3.58	3.38	3.29	3.22	3.67	3.41	3.63	3.49	84.20
BM	2.65	2.86	12.57	6.71	6.15	5.68	5.70	8.05	5.75	5.97	5.62	5.45	87.43
CG	2.60	2.60	6.56	12.28	7.00	6.21	6.63	7.55	4.68	6.70	5.02	5.28	87.72
CS	2.64	2.81	5.87	6.87	11.98	6.87	6.30	7.65	5.17	7.48	4.25	4.44	88.02
FIN	2.61	2.74	5.75	6.40	7.22	12.67	6.73	7.45	5.15	7.98	4.14	4.57	87.33
HC	2.74	2.74	5.80	6.94	6.70	6.80	12.84	7.12	4.86	6.71	4.48	4.73	87.16
INDS	2.52	2.50	7.51	7.24	7.50	6.93	6.49	11.73	5.47	7.24	4.60	4.77	88.27
OG	2.97	3.27	6.25	5.19	5.87	5.57	5.15	6.35	13.70	5.46	4.60	4.62	86.30
TECH	2.62	2.73	5.76	6.62	7.54	7.69	6.36	7.44	4.87	12.16	4.18	4.38	87.84
TELE	2.99	3.24	6.29	5.77	4.97	4.60	4.92	5.52	4.73	4.86	14.18	6.72	85.82
UTL	3.05	3.08	5.89	5.86	5.05	4.96	5.03	5.47	4.64	4.92	6.52	13.60	86.40
TO	78.61	84.85	101.75	104.51	106.24	101.23	99.04	107.81	93.10	104.84	92.23	95.15	**TCI**
NET	-4.31	0.65	14.32	16.79	18.22	13.91	11.88	19.54	6.80	17.00	6.41	8.75	**82.53**

The aforementioned table demonstrates the QVAR spillovers for Total, net, and pairwise, utilizing a lag length of order 1 (BIC), a forecast is 20-step-ahead, and a window size of 200.

increase of connectedness coincides with the outbreak of COVID-19 pandemic indicating the effect of the crisis on the connectedness.

Figures 2 and 3 demonstrate the evolution of total connectedness of left and right tail risk, respectively, over time in both short and long term. The red (green) colour shows the total connectedness in short (long) term while the black area shows that total connectedness in total. It's clear that the connectedness of risks at both left and right tail are much stronger (Figures 2 and 3) than the connectedness of median risks (Figure 1). Another striking difference with Figure 1 is that, whereas the median risk connectedness experienced sharp jump during COVID-19, both left and right tail risk connectedness are elevated for the entire

Table 7. 5th Quantile tail risk spillover index between Sukuk and Islamic Sectoral markets at the short-term (1 to 5 days)

	BAH	HK	IND	IRL	KWT	MAL	NGR	OMN	PAK	QAT	SAR	SIN	TUR
BAH	17.14	3.37	5.11	2.50	2.52	6.57	1.76	3.53	1.70	3.10	3.89	2.22	2.80
HK	2.75	11.68	2.94	3.01	2.37	3.79	2.33	2.62	2.34	3.50	3.28	1.80	2.60
IND	5.04	3.52	14.80	2.43	2.69	3.47	1.95	3.36	1.95	2.88	4.33	2.46	2.96
IRL	2.40	3.79	2.39	17.31	2.61	2.28	3.80	2.11	2.67	2.83	2.26	1.68	2.21
KWT	2.79	3.45	3.19	3.14	21.78	3.52	2.35	3.07	1.83	3.44	2.96	2.01	2.49
MAL	5.26	4.25	3.23	2.12	2.99	14.43	2.02	3.48	1.93	4.32	3.20	1.74	3.26
NGR	2.01	3.28	2.24	4.24	2.08	2.40	18.90	1.65	2.34	3.45	2.20	1.12	1.88
OMN	3.92	3.45	3.55	2.08	2.90	4.16	1.48	23.95	1.44	3.16	2.89	2.46	2.99
PAK	1.65	2.98	2.01	2.50	1.26	2.26	2.03	1.13	16.61	2.68	2.34	0.73	1.93
QAT	2.60	3.68	2.50	2.36	2.49	4.21	2.66	2.42	2.27	12.81	3.42	1.23	2.81
SAR	3.87	3.85	4.37	2.09	2.47	3.29	1.85	2.45	2.19	3.65	15.49	1.67	3.10
SIN	3.22	3.40	3.42	2.58	2.59	2.54	1.41	3.32	1.59	2.42	2.64	31.60	2.03
TUR	3.29	3.74	3.44	2.50	2.63	4.23	1.94	3.08	2.05	3.62	3.91	1.61	17.59
UAE	2.46	4.16	2.74	2.35	2.64	3.66	2.18	2.72	2.24	3.93	3.27	1.64	2.60
UK	2.02	3.62	2.34	5.25	2.55	2.87	4.96	1.96	2.46	4.18	2.50	1.20	2.59
BM	1.37	2.54	1.69	1.78	1.02	1.90	1.72	1.11	2.29	2.22	1.93	0.59	1.55
CG	1.37	2.62	1.68	1.68	1.06	1.94	1.51	1.16	2.42	2.29	2.08	0.58	1.66
CS	1.39	2.50	1.78	1.90	1.08	1.88	1.58	1.19	2.44	2.26	1.86	0.67	1.74
FIN	1.38	2.36	1.56	1.82	0.99	1.82	1.60	0.98	2.45	2.24	2.00	0.58	1.59
HC	1.43	2.61	1.77	1.65	1.09	1.91	1.58	1.19	2.38	2.24	2.08	0.67	1.50
INDS	1.36	2.41	1.52	1.63	1.06	1.75	1.45	1.05	2.22	2.13	1.75	0.63	1.43
OG	1.61	2.87	1.82	2.01	1.27	2.14	1.85	1.27	2.62	2.77	2.24	0.69	1.75
TECH	1.40	2.51	1.75	1.66	1.13	1.81	1.75	1.13	2.38	2.22	2.01	0.73	1.64
TELE	1.45	2.81	1.99	2.11	1.27	2.19	1.94	1.24	2.90	3.08	2.54	0.71	1.74
UTL	1.62	2.79	2.09	2.11	1.23	2.31	1.91	1.29	2.95	2.81	2.26	0.82	1.73
TO	57.66	76.56	61.10	57.49	45.98	68.88	49.61	48.51	54.04	71.43	63.84	30.22	52.59
NET	-7.98	7.40	-5.23	-8.28	-17.08	0.83	-15.49	-11.95	-12.05	2.13	-4.08	-24.26	-15.37
	BAH	HK	IND	IRL	KWT	MAL	NGR	OMN	PAK	QAT	SAR	SIN	TUR
BAH	17.14	3.37	5.11	2.50	2.52	6.57	1.76	3.53	1.70	3.10	3.89	2.22	2.80
HK	2.75	11.68	2.94	3.01	2.37	3.79	2.33	2.62	2.34	3.50	3.28	1.80	2.60
IND	5.04	3.52	14.80	2.43	2.69	3.47	1.95	3.36	1.95	2.88	4.33	2.46	2.96
IRL	2.40	3.79	2.39	17.31	2.61	2.28	3.80	2.11	2.67	2.83	2.26	1.68	2.21
KWT	2.79	3.45	3.19	3.14	21.78	3.52	2.35	3.07	1.83	3.44	2.96	2.01	2.49
MAL	5.26	4.25	3.23	2.12	2.99	14.43	2.02	3.48	1.93	4.32	3.20	1.74	3.26
NGR	2.01	3.28	2.24	4.24	2.08	2.40	18.90	1.65	2.34	3.45	2.20	1.12	1.88
OMN	3.92	3.45	3.55	2.08	2.90	4.16	1.48	23.95	1.44	3.16	2.89	2.46	2.99
PAK	1.65	2.98	2.01	2.50	1.26	2.26	2.03	1.13	16.61	2.68	2.34	0.73	1.93
QAT	2.60	3.68	2.50	2.36	2.49	4.21	2.66	2.42	2.27	12.81	3.42	1.23	2.81
SAR	3.87	3.85	4.37	2.09	2.47	3.29	1.85	2.45	2.19	3.65	15.49	1.67	3.10
SIN	3.22	3.40	3.42	2.58	2.59	2.54	1.41	3.32	1.59	2.42	2.64	31.60	2.03
TUR	3.29	3.74	3.44	2.50	2.63	4.23	1.94	3.08	2.05	3.62	3.91	1.61	17.59
UAE	2.46	4.16	2.74	2.35	2.64	3.66	2.18	2.72	2.24	3.93	3.27	1.64	2.60
UK	2.02	3.62	2.34	5.25	2.55	2.87	4.96	1.96	2.46	4.18	2.50	1.20	2.59
BM	1.37	2.54	1.69	1.78	1.02	1.90	1.72	1.11	2.29	2.22	1.93	0.59	1.55
CG	1.37	2.62	1.68	1.68	1.06	1.94	1.51	1.16	2.42	2.29	2.08	0.58	1.66
CS	1.39	2.50	1.78	1.90	1.08	1.88	1.58	1.19	2.44	2.26	1.86	0.67	1.74
FIN	1.38	2.36	1.56	1.82	0.99	1.82	1.60	0.98	2.45	2.24	2.00	0.58	1.59
HC	1.43	2.61	1.77	1.65	1.09	1.91	1.58	1.19	2.38	2.24	2.08	0.67	1.50
INDS	1.36	2.41	1.52	1.63	1.06	1.75	1.45	1.05	2.22	2.13	1.75	0.63	1.43
OG	1.61	2.87	1.82	2.01	1.27	2.14	1.85	1.27	2.62	2.77	2.24	0.69	1.75
TECH	1.40	2.51	1.75	1.66	1.13	1.81	1.75	1.13	2.38	2.22	2.01	0.73	1.64
TELE	1.45	2.81	1.99	2.11	1.27	2.19	1.94	1.24	2.90	3.08	2.54	0.71	1.74
UTL	1.62	2.79	2.09	2.11	1.23	2.31	1.91	1.29	2.95	2.81	2.26	0.82	1.73
TO	57.66	76.56	61.10	57.49	45.98	68.88	49.61	48.51	54.04	71.43	63.84	30.22	52.59
NET	-7.98	7.40	-5.23	-8.28	-17.08	0.83	-15.49	-11.95	-12.05	2.13	-4.08	-24.26	-15.37

The aforementioned table demonstrates the QVAR spillovers for Total, net, and pairwise, utilizing a lag length of order 1 (BIC), a forecast is 20-step-ahead, and a window size of 200.

sample period even before the COVID-19 pandemic. Like in the case of median risk, in the case of left and right tail risk as well dynamic total connectedness is much higher in short term (red) than in long (green) term.

Figure 4 displays the dynamic net directional connectedness between median risk indices. INDS (TELE) consistently transmits (receives) shocks, while other indices alternate their roles or are not significant. Figure 5 highlights that most sectoral stock indices transmit left tail risk, with INDS being a significant transmitter throughout the sample period. Interestingly, TELE and UTL, which received median risks, were found to transmit left tail shocks. This implies that Islamic sectoral stock markets are crucial in transmitting negative shocks.

Table 8. 5th Quantile tail risk spillover index between Sukuk and Islamic Sectoral markets at the long-term (more than 5 days)

	BAH	HK	IND	IRL	KWT	MAL	NGR	OMN	PAK	QAT	SAR	SIN	TUR
BAH	3.15	0.71	1.01	0.52	0.50	1.32	0.40	0.71	0.39	0.66	0.77	0.43	0.57
HK	0.62	2.38	0.67	0.71	0.54	0.91	0.54	0.59	0.61	0.81	0.75	0.40	0.60
IND	1.03	0.81	2.95	0.59	0.56	0.82	0.49	0.69	0.52	0.71	0.93	0.47	0.66
IRL	0.51	0.77	0.52	3.03	0.54	0.49	0.77	0.43	0.55	0.61	0.52	0.32	0.49
KWT	0.51	0.62	0.57	0.54	3.74	0.63	0.42	0.55	0.34	0.62	0.54	0.36	0.45
MAL	1.06	0.86	0.68	0.46	0.57	2.76	0.46	0.67	0.45	0.93	0.70	0.33	0.69
NGR	0.38	0.63	0.44	0.77	0.41	0.48	3.33	0.32	0.44	0.68	0.47	0.21	0.39
OMN	0.73	0.64	0.65	0.39	0.51	0.77	0.29	4.11	0.29	0.59	0.53	0.43	0.56
PAK	0.37	0.64	0.45	0.53	0.28	0.50	0.44	0.26	3.10	0.57	0.53	0.18	0.42
QAT	0.56	0.78	0.57	0.53	0.53	0.90	0.59	0.52	0.53	2.51	0.74	0.25	0.59
SAR	0.72	0.76	0.82	0.42	0.46	0.66	0.39	0.49	0.45	0.73	2.81	0.30	0.60
SIN	0.53	0.54	0.56	0.42	0.43	0.41	0.22	0.56	0.24	0.38	0.44	5.22	0.34
TUR	0.56	0.63	0.58	0.42	0.44	0.71	0.33	0.53	0.35	0.61	0.68	0.27	2.96
UAE	0.56	0.88	0.59	0.53	0.50	0.78	0.49	0.56	0.52	0.82	0.65	0.30	0.53
UK	0.43	0.66	0.49	0.90	0.50	0.55	0.93	0.40	0.47	0.82	0.58	0.23	0.51
BM	0.36	0.58	0.40	0.39	0.25	0.44	0.41	0.28	0.50	0.53	0.45	0.17	0.36
CG	0.31	0.54	0.38	0.35	0.23	0.42	0.33	0.28	0.52	0.51	0.44	0.16	0.35
CS	0.37	0.57	0.43	0.44	0.28	0.43	0.39	0.32	0.56	0.55	0.44	0.19	0.41
FIN	0.36	0.55	0.40	0.44	0.25	0.44	0.38	0.27	0.57	0.55	0.46	0.16	0.39
HC	0.35	0.59	0.45	0.45	0.27	0.46	0.41	0.31	0.54	0.56	0.48	0.19	0.37
INDS	0.35	0.57	0.40	0.40	0.29	0.42	0.35	0.32	0.52	0.54	0.44	0.17	0.36
OG	0.41	0.67	0.45	0.50	0.33	0.50	0.48	0.33	0.61	0.66	0.54	0.20	0.43
TECH	0.37	0.62	0.44	0.42	0.31	0.42	0.45	0.29	0.55	0.57	0.50	0.21	0.38
TELE	0.33	0.57	0.39	0.40	0.28	0.42	0.40	0.30	0.53	0.62	0.50	0.14	0.36
UTL	0.39	0.64	0.47	0.49	0.28	0.53	0.46	0.31	0.64	0.67	0.53	0.20	0.39
TO	12.16	15.82	12.80	12.03	9.52	14.42	10.81	10.29	11.70	15.32	13.62	6.29	11.20
NET	-1.91	-0.96	-3.11	-1.85	-1.90	-0.34	-1.86	-1.20	-2.49	-0.05	-0.16	-2.42	-0.29

	UAE	UK	BM	CG	CS	FIN	HC	INDS	OG	TECH	TELE	UTL	FROM
BAH	0.58	0.52	0.50	0.49	0.50	0.50	0.51	0.49	0.50	0.50	0.47	0.53	14.07
HK	0.84	0.74	0.75	0.78	0.75	0.70	0.73	0.74	0.76	0.75	0.75	0.75	16.78
IND	0.68	0.65	0.62	0.61	0.64	0.59	0.63	0.59	0.61	0.63	0.67	0.72	15.92
IRL	0.54	1.11	0.56	0.55	0.61	0.58	0.52	0.55	0.57	0.56	0.63	0.60	13.88
KWT	0.59	0.63	0.37	0.41	0.41	0.38	0.39	0.42	0.42	0.41	0.43	0.41	11.42
MAL	0.74	0.62	0.56	0.57	0.54	0.53	0.55	0.53	0.56	0.53	0.57	0.62	14.76
NGR	0.52	1.12	0.55	0.49	0.53	0.53	0.53	0.50	0.55	0.59	0.57	0.57	12.67
OMN	0.59	0.42	0.40	0.45	0.43	0.37	0.41	0.40	0.40	0.40	0.42	0.42	11.48
PAK	0.56	0.61	0.75	0.79	0.80	0.78	0.75	0.76	0.76	0.78	0.81	0.86	14.19
QAT	0.78	0.85	0.63	0.65	0.66	0.63	0.62	0.63	0.71	0.63	0.74	0.73	15.37
SAR	0.64	0.52	0.56	0.59	0.55	0.59	0.57	0.51	0.59	0.60	0.66	0.60	13.77
SIN	0.42	0.38	0.26	0.26	0.30	0.26	0.29	0.27	0.26	0.30	0.29	0.34	8.70
TUR	0.52	0.54	0.42	0.46	0.47	0.41	0.39	0.41	0.43	0.43	0.44	0.43	11.48
UAE	2.77	0.69	0.63	0.64	0.64	0.63	0.63	0.62	0.64	0.62	0.65	0.66	14.75
UK	0.62	2.41	0.58	0.54	0.57	0.57	0.56	0.53	0.60	0.57	0.61	0.57	13.81
BM	0.50	0.54	2.06	1.16	1.07	1.00	1.01	1.41	0.97	1.09	0.99	0.98	15.83
CG	0.47	0.46	1.11	1.96	1.16	1.03	1.11	1.25	0.82	1.13	0.85	0.89	15.11
CS	0.51	0.54	1.05	1.21	2.01	1.19	1.13	1.32	0.96	1.31	0.78	0.81	16.19
FIN	0.52	0.53	1.04	1.15	1.28	2.15	1.20	1.32	0.95	1.41	0.76	0.84	16.21
HC	0.51	0.54	1.00	1.22	1.17	1.16	2.11	1.24	0.89	1.14	0.82	0.85	15.96
INDS	0.51	0.50	1.29	1.27	1.31	1.25	1.15	1.98	0.98	1.31	0.84	0.90	16.45
OG	0.56	0.64	1.12	0.95	1.09	1.03	0.95	1.16	2.25	1.01	0.86	0.87	16.36
TECH	0.53	0.55	1.04	1.18	1.36	1.37	1.12	1.31	0.91	2.09	0.78	0.82	16.50
TELE	0.50	0.55	1.02	0.94	0.80	0.77	0.83	0.92	0.78	0.80	2.13	1.06	14.21
UTL	0.59	0.58	1.06	1.07	0.93	0.93	0.93	0.99	0.89	0.90	1.15	2.25	16.02
TO	13.80	14.81	17.87	18.41	18.57	17.78	17.50	18.90	16.53	18.41	16.54	16.83	**TCI**
NET	-0.95	1.00	2.04	3.30	2.38	1.57	1.54	2.44	0.17	1.91	2.33	0.80	**14.48**

The aforementioned table demonstrates the QVAR spillovers for Total, net, and pairwise, utilizing a lag length of order 1 (BIC), a forecast is 20-step-ahead, and a window size of 200.

Sukuks of Middle Eastern and European countries alternate between being net transmitters and receivers of left tail risk, while other Sukuks, except Malaysia, receive shock. Figure 6 shows no significant net transmitter or receiver of right tail shocks. Such results match with the results of other papers which demonstrate that shocks are usually transmitted from developed markets to developing markets (Chowdhury et al. 2021, Billah, M. Alam, and M. Hoque 2024b). On the other hand, Shahzad et al. (2019) argue that fund managers of Islamic portfolio better include both stocks and Sukuks for more diversity and better balance. Analysing Turkish bond funds that invest in both conventional and Islamic bonds, B. Pirgaip, O. Arslan-Ayaydin, and M. B. Karan (2021) also argue that

Table 9. 95th Quantile tail risk spillover index between Sukuk and Islamic Sectoral markets

	BAH	HK	IND	IRL	KWT	MAL	NGR	OMN	PAK	QAT	SAR	SIN	TUR
BAH	3.50	4.05	3.90	3.29	3.92	3.51	4.55	3.12	4.30	4.19	3.95	4.27	4.17
HK	3.36	4.14	3.92	3.35	3.88	3.61	4.59	3.12	4.20	4.12	3.95	4.30	4.16
IND	3.35	4.05	4.01	3.33	3.92	3.54	4.74	3.05	4.15	4.11	3.96	4.23	4.21
IRL	3.38	4.08	3.93	3.44	3.91	3.51	4.65	3.11	4.28	4.19	3.96	4.24	4.21
KWT	3.37	4.07	3.88	3.24	4.02	3.59	4.70	3.08	4.25	4.19	3.90	4.32	4.18
MAL	3.41	4.10	3.99	3.26	3.92	3.64	4.71	3.05	4.24	4.11	3.94	4.21	4.12
NGR	3.30	4.06	3.96	3.27	3.91	3.58	4.87	3.09	4.24	4.16	3.93	4.32	4.18
OMN	3.36	4.10	3.91	3.28	3.89	3.57	4.70	3.20	4.19	4.18	3.90	4.28	4.22
PAK	3.39	4.10	3.94	3.27	3.90	3.55	4.61	3.08	4.41	4.17	3.93	4.24	4.13
QAT	3.34	4.09	3.92	3.25	3.88	3.55	4.61	3.12	4.24	4.27	3.98	4.15	4.17
SAR	3.35	3.98	3.90	3.28	3.92	3.48	4.79	3.03	4.32	4.22	4.07	4.20	4.21
SIN	3.38	4.06	3.90	3.29	3.93	3.64	4.69	3.11	4.29	4.20	3.94	4.40	4.16
TUR	3.39	4.04	3.93	3.29	3.90	3.57	4.65	3.18	4.24	4.22	3.94	4.37	4.29
UAE	3.34	4.07	3.88	3.27	3.93	3.52	4.67	3.09	4.27	4.21	3.92	4.23	4.17
UK	3.33	4.07	3.88	3.26	3.92	3.59	4.71	3.12	4.25	4.18	3.93	4.30	4.07
BM	3.33	4.03	3.90	3.31	3.82	3.63	4.69	3.04	4.26	4.20	3.93	4.17	4.20
CG	3.36	4.04	3.91	3.30	3.91	3.58	4.65	3.08	4.24	4.15	3.96	4.21	4.14
CS	3.34	4.08	3.86	3.32	3.86	3.59	4.68	3.08	4.29	4.16	3.93	4.16	4.18
FIN	3.38	4.08	3.91	3.29	3.93	3.58	4.67	3.13	4.21	4.13	3.95	4.26	4.16
HC	3.35	4.11	3.88	3.28	3.93	3.53	4.62	3.10	4.25	4.18	3.91	4.23	4.18
INDS	3.29	4.11	3.94	3.35	3.93	3.52	4.66	3.16	4.23	4.17	3.96	4.24	4.24
OG	3.27	4.09	3.92	3.29	3.90	3.60	4.71	3.09	4.10	4.16	3.95	4.38	4.14
TECH	3.35	4.07	3.91	3.33	3.99	3.56	4.67	3.06	4.18	4.19	3.96	4.19	4.21
TELE	3.35	4.12	3.97	3.31	3.92	3.55	4.69	3.14	4.28	4.11	3.99	4.34	4.17
UTL	3.33	4.08	3.93	3.27	3.94	3.58	4.65	3.10	4.26	4.16	3.91	4.32	4.16
TO	80.40	97.73	93.98	78.98	93.88	85.52	112.07	74.33	101.77	100.04	94.58	102.15	100.14
NET	-16.10	1.87	-2.01	-17.58	-2.10	-10.84	16.94	-22.48	6.17	4.31	-1.35	6.55	4.43

	UAE	UK	BM	CG	CS	FIN	HC	INDS	OG	TECH	TELE	UTL	FROM
BAH	3.96	3.89	4.05	3.94	4.11	4.19	4.22	4.17	4.14	4.06	4.29	4.23	96.50
HK	3.93	3.89	4.07	3.99	4.07	4.25	4.23	4.16	4.10	4.05	4.32	4.23	95.86
IND	3.97	3.97	4.06	3.94	4.10	4.25	4.20	4.19	4.07	4.04	4.34	4.23	95.99
IRL	3.93	3.93	4.04	3.93	4.08	4.21	4.18	4.15	4.07	4.05	4.29	4.22	96.56
KWT	4.04	3.86	4.00	3.99	4.12	4.19	4.24	4.13	4.07	4.05	4.32	4.19	95.98
MAL	3.96	3.88	4.02	3.95	4.11	4.27	4.23	4.15	4.12	4.07	4.34	4.21	96.36
NGR	4.00	3.89	4.05	3.89	4.05	4.26	4.20	4.14	4.04	4.07	4.31	4.24	95.13
OMN	3.99	3.89	3.96	3.96	4.09	4.24	4.20	4.16	4.09	4.05	4.36	4.24	96.80
PAK	3.96	3.91	3.99	3.98	4.08	4.22	4.17	4.20	4.11	4.08	4.34	4.25	95.59
QAT	3.99	3.89	4.02	3.96	4.08	4.24	4.23	4.22	4.11	4.09	4.34	4.25	95.73
SAR	3.91	3.94	4.04	3.97	4.10	4.26	4.19	4.22	4.06	4.07	4.27	4.22	95.93
SIN	3.96	3.93	3.98	3.93	4.08	4.20	4.17	4.13	4.03	4.04	4.32	4.23	95.60
TUR	3.94	3.88	4.02	3.98	4.05	4.16	4.19	4.14	4.04	4.03	4.31	4.23	95.71
UAE	4.12	3.91	4.00	4.01	4.10	4.25	4.22	4.13	4.06	4.10	4.33	4.21	95.88
UK	3.98	3.98	4.03	3.98	4.05	4.21	4.21	4.18	4.05	4.06	4.37	4.28	96.02
BM	3.95	3.93	4.14	3.95	4.14	4.25	4.20	4.22	4.08	4.07	4.35	4.22	95.86
CG	3.98	3.94	4.02	3.98	4.09	4.28	4.22	4.17	4.10	4.12	4.31	4.25	96.02
CS	3.94	3.88	4.10	3.97	4.18	4.26	4.23	4.21	4.11	4.09	4.29	4.21	95.82
FIN	3.97	3.93	4.03	3.99	4.06	4.27	4.25	4.13	4.13	4.04	4.32	4.21	95.73
HC	3.96	3.90	4.05	4.01	4.11	4.25	4.27	4.19	4.06	4.08	4.34	4.23	95.73
INDS	3.92	3.88	4.00	3.98	4.13	4.21	4.21	4.21	4.10	4.05	4.33	4.20	95.79
OG	3.94	3.92	4.06	3.98	4.10	4.26	4.23	4.16	4.09	4.05	4.38	4.21	95.91
TECH	4.00	3.89	4.07	3.95	4.09	4.21	4.21	4.21	4.09	4.08	4.29	4.23	95.92
TELE	3.92	3.87	3.95	3.96	4.01	4.20	4.19	4.14	4.06	4.06	4.37	4.31	95.63
UTL	3.99	3.90	3.97	3.97	4.09	4.23	4.24	4.09	4.07	4.07	4.35	4.34	95.66
TO	95.11	93.72	96.58	95.16	98.11	101.54	101.06	100.02	97.95	97.55	103.83	101.54	**TCI**
NET	-0.78	-2.31	0.72	-0.86	2.29	5.81	5.33	4.24	2.04	1.62	8.20	5.88	**95.91**

The aforementioned table demonstrates the QVAR spillovers for Total, net, and pairwise, utilizing a lag length of order 1 (BIC), a forecast is 20-step-ahead, and a window size of 200.

considering Islamic bonds in conventional bond portfolios provides mentionable diversification for investors.

Fig. A.1-A.3 compare the median risk connection network between pre-COVID and COVID period for total, short term (1–5 days) and long term (5–22 days), respectively. The results show that, for the median risk, indices are much more connected in terms of coverage during the COVID period than before COVID-19 period. This pattern is true for both short (Figure 2) and long (Figure 3) term. In the pre-COVID period INDS is the significant net transmitters in both short (1–5 days) and long (more than 5 days) term. However, in

Table 10. 95th Quantile tail risk spillover index between Sukuk and Islamic Sectoral markets at the short-term (1 to 5 days)

	BAH	HK	IND	IRL	KWT	MAL	NGR	OMN	PAK	QAT	SAR	SIN	TUR
BAH	2.77	3.17	3.03	2.59	3.03	2.73	3.71	2.53	3.47	3.34	3.12	3.51	3.33
HK	2.75	3.36	3.18	2.75	3.11	2.92	3.84	2.60	3.49	3.39	3.25	3.67	3.43
IND	2.71	3.24	3.22	2.70	3.11	2.84	3.96	2.52	3.43	3.35	3.20	3.57	3.46
IRL	2.73	3.28	3.17	2.79	3.09	2.82	3.87	2.56	3.53	3.41	3.19	3.56	3.44
KWT	2.70	3.21	3.03	2.56	3.11	2.79	3.84	2.48	3.46	3.35	3.08	3.57	3.36
MAL	2.69	3.19	3.11	2.54	3.02	2.80	3.83	2.45	3.41	3.26	3.10	3.47	3.26
NGR	2.65	3.22	3.17	2.63	3.07	2.83	3.99	2.53	3.48	3.36	3.16	3.66	3.39
OMN	2.69	3.25	3.09	2.62	3.05	2.81	3.89	2.61	3.44	3.38	3.13	3.57	3.44
PAK	2.72	3.24	3.13	2.61	3.04	2.78	3.81	2.53	3.63	3.36	3.14	3.53	3.34
QAT	2.65	3.22	3.08	2.60	3.03	2.76	3.77	2.54	3.46	3.44	3.18	3.45	3.37
SAR	2.72	3.20	3.14	2.68	3.15	2.79	4.01	2.51	3.60	3.46	3.30	3.55	3.48
SIN	2.75	3.28	3.15	2.70	3.14	2.92	3.91	2.59	3.57	3.45	3.20	3.72	3.43
TUR	2.74	3.22	3.13	2.66	3.07	2.83	3.85	2.62	3.49	3.40	3.17	3.68	3.50
UAE	2.67	3.23	3.07	2.61	3.09	2.78	3.86	2.55	3.49	3.39	3.14	3.52	3.38
UK	2.68	3.26	3.11	2.65	3.10	2.86	3.91	2.58	3.51	3.39	3.16	3.63	3.31
BM	2.69	3.23	3.11	2.68	3.03	2.87	3.87	2.52	3.51	3.42	3.16	3.49	3.45
CG	2.71	3.22	3.13	2.66	3.08	2.83	3.83	2.54	3.51	3.38	3.21	3.54	3.38
CS	2.67	3.24	3.07	2.68	3.02	2.82	3.84	2.53	3.51	3.37	3.16	3.50	3.40
FIN	2.74	3.27	3.12	2.67	3.10	2.85	3.88	2.58	3.50	3.38	3.22	3.60	3.40
HC	2.72	3.30	3.11	2.66	3.11	2.83	3.85	2.57	3.50	3.41	3.17	3.58	3.40
INDS	2.64	3.27	3.14	2.69	3.09	2.78	3.84	2.59	3.46	3.38	3.19	3.58	3.44
OG	2.68	3.32	3.18	2.72	3.12	2.89	3.92	2.56	3.42	3.43	3.24	3.77	3.42
TECH	2.68	3.21	3.10	2.68	3.12	2.81	3.84	2.51	3.39	3.38	3.17	3.49	3.40
TELE	2.76	3.37	3.25	2.75	3.16	2.88	3.96	2.63	3.60	3.41	3.28	3.71	3.47
UTL	2.73	3.31	3.20	2.66	3.14	2.90	3.88	2.58	3.55	3.44	3.22	3.69	3.44
TO	64.89	77.93	75.02	63.75	74.07	67.93	92.75	61.21	83.78	81.27	76.22	85.89	81.63
NET	-11.40	-0.59	-2.98	-14.41	-2.25	-8.21	16.15	-16.65	7.27	4.83	-2.07	7.99	4.54

	UAE	UK	BM	CG	CS	FIN	HC	INDS	OG	TECH	TELE	UTL	FROM
BAH	3.07	3.05	3.15	3.14	3.16	3.30	3.35	3.25	3.23	3.20	3.43	3.41	76.29
HK	3.14	3.17	3.30	3.29	3.25	3.47	3.48	3.35	3.32	3.29	3.58	3.51	78.52
IND	3.14	3.20	3.27	3.23	3.25	3.45	3.44	3.36	3.24	3.27	3.57	3.49	78.00
IRL	3.12	3.15	3.24	3.18	3.21	3.39	3.39	3.31	3.24	3.25	3.52	3.47	78.16
KWT	3.12	3.03	3.15	3.19	3.18	3.32	3.40	3.25	3.18	3.21	3.48	3.38	76.31
MAL	3.04	3.03	3.15	3.16	3.17	3.38	3.37	3.24	3.20	3.22	3.48	3.38	76.14
NGR	3.15	3.11	3.25	3.15	3.18	3.43	3.41	3.28	3.20	3.28	3.53	3.47	76.59
OMN	3.14	3.12	3.17	3.21	3.22	3.39	3.40	3.31	3.24	3.25	3.57	3.47	77.86
PAK	3.09	3.11	3.16	3.20	3.19	3.36	3.35	3.32	3.23	3.26	3.54	3.47	76.52
QAT	3.12	3.08	3.18	3.20	3.19	3.37	3.40	3.33	3.23	3.26	3.51	3.46	76.44
SAR	3.13	3.19	3.27	3.26	3.27	3.47	3.44	3.38	3.25	3.31	3.54	3.50	78.29
SIN	3.16	3.19	3.22	3.22	3.26	3.40	3.43	3.32	3.24	3.28	3.58	3.50	77.91
TUR	3.11	3.10	3.21	3.21	3.17	3.33	3.38	3.30	3.19	3.23	3.52	3.47	77.09
UAE	3.22	3.10	3.20	3.25	3.22	3.41	3.41	3.29	3.22	3.29	3.53	3.44	77.11
UK	3.14	3.22	3.22	3.24	3.21	3.40	3.44	3.35	3.23	3.29	3.60	3.53	77.79
BM	3.11	3.15	3.31	3.22	3.25	3.41	3.40	3.36	3.24	3.26	3.57	3.44	77.44
CG	3.15	3.18	3.24	3.26	3.24	3.45	3.45	3.35	3.27	3.34	3.54	3.49	77.73
CS	3.10	3.10	3.25	3.21	3.27	3.41	3.41	3.33	3.24	3.28	3.49	3.44	77.06
FIN	3.14	3.16	3.25	3.26	3.21	3.46	3.47	3.32	3.31	3.27	3.56	3.47	77.73
HC	3.13	3.15	3.23	3.27	3.24	3.43	3.48	3.35	3.24	3.28	3.56	3.48	77.55
INDS	3.11	3.11	3.16	3.22	3.23	3.37	3.40	3.32	3.25	3.23	3.53	3.44	77.13
OG	3.17	3.20	3.29	3.27	3.27	3.47	3.48	3.35	3.30	3.29	3.63	3.50	78.59
TECH	3.13	3.09	3.22	3.18	3.19	3.35	3.39	3.32	3.23	3.24	3.48	3.45	76.82
TELE	3.18	3.17	3.23	3.29	3.24	3.45	3.48	3.38	3.32	3.34	3.66	3.62	78.94
UTL	3.21	3.16	3.22	3.27	3.27	3.44	3.48	3.32	3.27	3.32	3.62	3.60	78.31
TO	75.10	75.09	77.21	77.31	77.29	81.66	82.05	79.70	77.84	78.48	84.95	83.29	**TCI**
NET	-2.01	-2.71	-0.23	-0.42	0.23	3.93	4.50	2.58	-0.75	1.66	6.01	4.97	**77.45**

The aforementioned table demonstrates the QVAR spillovers for Total, net, and pairwise, utilizing a lag length of order 1 (BIC), a forecast is 20-step-ahead, and a window size of 200.

COVID sub-sample, some of Sukuks, for example, Sukuks of OMN and KWT also emerged as significant net transmitters of shocks in both short and long term. The significant effect of COVID-19 pandemic and Russia-Ukraine war on connectedness is also reported by M. Billah, F. Balli, and I. Hoxha (2023), who investigate frequency connectedness between Islamic bank stocks and fintech indexes Billah et al. (2024a), who analyse tail risk connectedness between Islamic and conventional bond markets M. Billah, M. R. Alam, and M. E. Hoque (2024b), who analyse the tail risk spillover between

Table 11. 95th Quantile tail risk spillover index between Sukuk and Islamic Sectoral markets at the long-term (more than 5 days)

	BAH	HK	IND	IRL	KWT	MAL	NGR	OMN	PAK	QAT	SAR	SIN	TUR
BAH	0.73	0.88	0.87	0.70	0.89	0.78	0.85	0.58	0.83	0.85	0.83	0.76	0.84
HK	0.61	0.79	0.74	0.60	0.78	0.70	0.74	0.52	0.71	0.72	0.71	0.63	0.73
IND	0.64	0.80	0.80	0.63	0.81	0.70	0.78	0.53	0.72	0.76	0.75	0.66	0.75
IRL	0.65	0.81	0.76	0.65	0.82	0.69	0.78	0.55	0.75	0.78	0.76	0.68	0.77
KWT	0.67	0.87	0.85	0.68	0.92	0.80	0.87	0.59	0.78	0.84	0.82	0.75	0.82
MAL	0.72	0.91	0.88	0.72	0.90	0.84	0.89	0.61	0.83	0.85	0.84	0.74	0.86
NGR	0.65	0.83	0.79	0.64	0.84	0.75	0.88	0.56	0.75	0.80	0.76	0.66	0.79
OMN	0.67	0.85	0.82	0.66	0.84	0.76	0.81	0.59	0.75	0.80	0.77	0.70	0.78
PAK	0.67	0.85	0.82	0.66	0.86	0.77	0.80	0.55	0.78	0.81	0.79	0.71	0.79
QAT	0.69	0.87	0.84	0.64	0.85	0.79	0.83	0.58	0.77	0.83	0.81	0.70	0.80
SAR	0.63	0.78	0.76	0.60	0.78	0.69	0.79	0.52	0.72	0.76	0.77	0.65	0.73
SIN	0.62	0.78	0.75	0.59	0.79	0.72	0.78	0.51	0.72	0.75	0.74	0.69	0.73
TUR	0.65	0.83	0.80	0.63	0.84	0.74	0.80	0.56	0.75	0.82	0.78	0.69	0.79
UAE	0.67	0.84	0.81	0.66	0.84	0.74	0.81	0.55	0.77	0.82	0.78	0.72	0.78
UK	0.64	0.81	0.77	0.61	0.83	0.73	0.80	0.54	0.74	0.79	0.77	0.67	0.77
BM	0.64	0.81	0.79	0.63	0.80	0.76	0.82	0.51	0.76	0.78	0.78	0.68	0.75
CG	0.65	0.82	0.78	0.64	0.83	0.75	0.82	0.54	0.73	0.77	0.74	0.67	0.77
CS	0.67	0.85	0.78	0.64	0.83	0.76	0.84	0.55	0.78	0.79	0.78	0.66	0.78
FIN	0.63	0.81	0.79	0.62	0.83	0.72	0.80	0.55	0.72	0.75	0.74	0.66	0.76
HC	0.63	0.81	0.77	0.62	0.82	0.70	0.78	0.53	0.76	0.77	0.74	0.65	0.77
INDS	0.64	0.84	0.80	0.65	0.85	0.74	0.82	0.57	0.77	0.79	0.76	0.66	0.80
OG	0.60	0.77	0.74	0.57	0.77	0.70	0.79	0.53	0.69	0.73	0.71	0.61	0.71
TECH	0.67	0.86	0.81	0.65	0.87	0.75	0.83	0.55	0.79	0.80	0.79	0.70	0.81
TELE	0.59	0.75	0.72	0.56	0.76	0.67	0.73	0.50	0.68	0.70	0.71	0.63	0.70
UTL	0.60	0.77	0.73	0.61	0.80	0.68	0.77	0.52	0.72	0.72	0.69	0.63	0.72
TO	15.51	19.80	18.96	15.23	19.82	17.59	19.32	13.12	17.98	18.76	18.36	16.26	18.51
NET	-4.70	2.46	0.97	-3.18	0.15	-2.64	0.78	-5.83	-1.09	-0.52	0.73	-1.44	-0.11

	UAE	UK	BM	CG	CS	FIN	HC	INDS	OG	TECH	TELE	UTL	FROM
BAH	0.90	0.84	0.89	0.80	0.95	0.90	0.87	0.92	0.91	0.86	0.86	0.82	20.20
HK	0.79	0.72	0.77	0.71	0.83	0.78	0.75	0.80	0.78	0.76	0.74	0.72	17.33
IND	0.83	0.77	0.79	0.71	0.85	0.80	0.76	0.83	0.82	0.77	0.77	0.74	17.99
IRL	0.81	0.78	0.81	0.75	0.87	0.81	0.79	0.84	0.83	0.80	0.77	0.75	18.40
KWT	0.93	0.83	0.85	0.80	0.94	0.88	0.84	0.88	0.89	0.84	0.83	0.81	19.67
MAL	0.91	0.85	0.87	0.79	0.94	0.90	0.86	0.92	0.92	0.85	0.86	0.82	20.23
NGR	0.85	0.79	0.81	0.74	0.86	0.83	0.79	0.85	0.83	0.80	0.78	0.77	18.53
OMN	0.84	0.78	0.80	0.75	0.87	0.84	0.80	0.85	0.85	0.81	0.79	0.77	18.95
PAK	0.87	0.80	0.83	0.78	0.89	0.86	0.82	0.88	0.88	0.83	0.80	0.78	19.08
QAT	0.87	0.80	0.84	0.76	0.89	0.87	0.84	0.90	0.87	0.83	0.83	0.80	19.29
SAR	0.78	0.75	0.77	0.71	0.83	0.79	0.75	0.83	0.81	0.76	0.74	0.73	17.64
SIN	0.80	0.74	0.76	0.70	0.82	0.80	0.75	0.80	0.79	0.75	0.74	0.73	17.69
TUR	0.83	0.78	0.81	0.76	0.88	0.82	0.81	0.84	0.84	0.80	0.79	0.76	18.62
UAE	0.90	0.81	0.80	0.76	0.88	0.84	0.81	0.85	0.84	0.81	0.80	0.77	18.77
UK	0.84	0.76	0.80	0.74	0.84	0.81	0.77	0.84	0.82	0.78	0.77	0.75	18.23
BM	0.83	0.78	0.83	0.73	0.89	0.84	0.80	0.86	0.83	0.80	0.79	0.77	18.43
CG	0.83	0.77	0.78	0.72	0.85	0.82	0.77	0.82	0.83	0.78	0.78	0.76	18.29
CS	0.85	0.79	0.85	0.76	0.91	0.85	0.82	0.88	0.87	0.81	0.80	0.77	18.76
FIN	0.82	0.77	0.78	0.73	0.85	0.81	0.78	0.81	0.82	0.77	0.76	0.74	18.00
HC	0.83	0.75	0.82	0.74	0.87	0.82	0.79	0.84	0.83	0.79	0.78	0.75	18.19
INDS	0.81	0.77	0.84	0.76	0.90	0.84	0.81	0.89	0.85	0.82	0.80	0.76	18.66
OG	0.78	0.72	0.78	0.71	0.83	0.79	0.75	0.81	0.79	0.76	0.75	0.71	17.32
TECH	0.87	0.80	0.85	0.77	0.90	0.86	0.82	0.89	0.86	0.84	0.81	0.78	19.10
TELE	0.74	0.70	0.72	0.67	0.77	0.75	0.71	0.77	0.75	0.72	0.71	0.69	16.69
UTL	0.78	0.74	0.75	0.70	0.82	0.78	0.76	0.78	0.80	0.75	0.74	0.74	17.35
TO	20.01	18.63	19.37	17.85	20.82	19.88	19.01	20.32	20.11	19.07	18.88	18.25	**TCI**
	1.23	0.40	0.95	-0.44	2.07	1.88	0.82	1.66	2.79	-0.03	2.19	0.90	**18.46**

The aforementioned table demonstrates the QVAR spillovers for Total, net, and pairwise, utilizing a lag length of order 1 (BIC), a forecast is 20-step-ahead, and a window size of 200.

Islamic and Green markets, and Salisu and Shaik (2022) who analyse Islamic stock indices under COVID-19.

Fig. A.4-A.6 compare the left tail risk (5th quantile) connection network between pre-COVID and COVID period for total, short term (1–5 days) and long term (5–22 days), respectively. The results show that, for the left tail risk, indices are much more connected in terms of both coverage and strength compared to the median risk network. However, unlike in the case of median risk, in the case of left tail risk, there is not much difference between pre-COVID and COVID period implying that the left tail risk connectedness between the indices was high even before COVID-19. Moreover, in the left tail almost all the sectoral

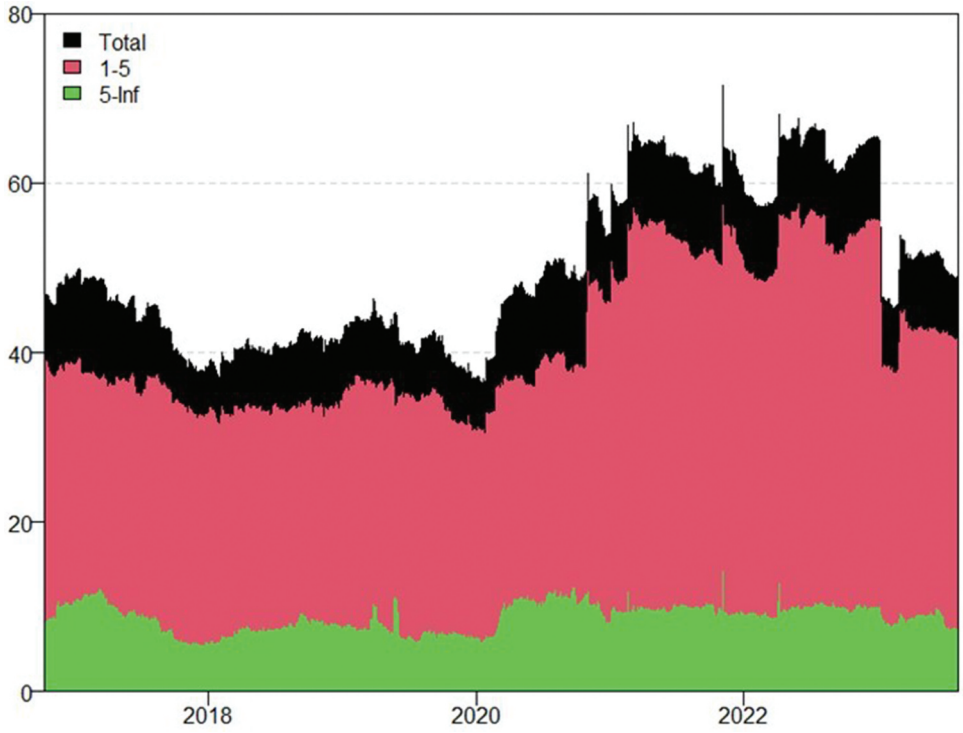

Figure 1. Total time-varying tail risk connectedness at the 50th quantile between Sukuk and Islamic sectoral markets. The aforementioned table demonstrates the QVAR spillovers for Total, net, and pairwise, utilizing a lag length of order 1 (BIC), a forecast is 20-step-ahead, and a window size of 200.

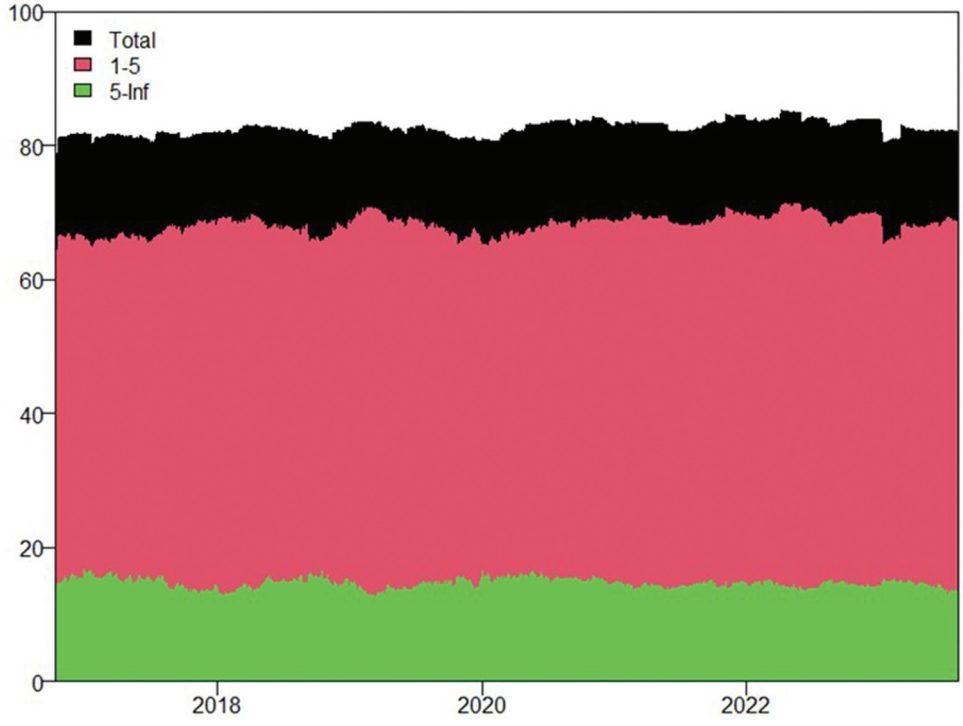

Figure 2. Total time-varying tail risk connectedness at the 5th quantile between Sukuk and Islamic sectoral markets. Notes: See Figure 1.

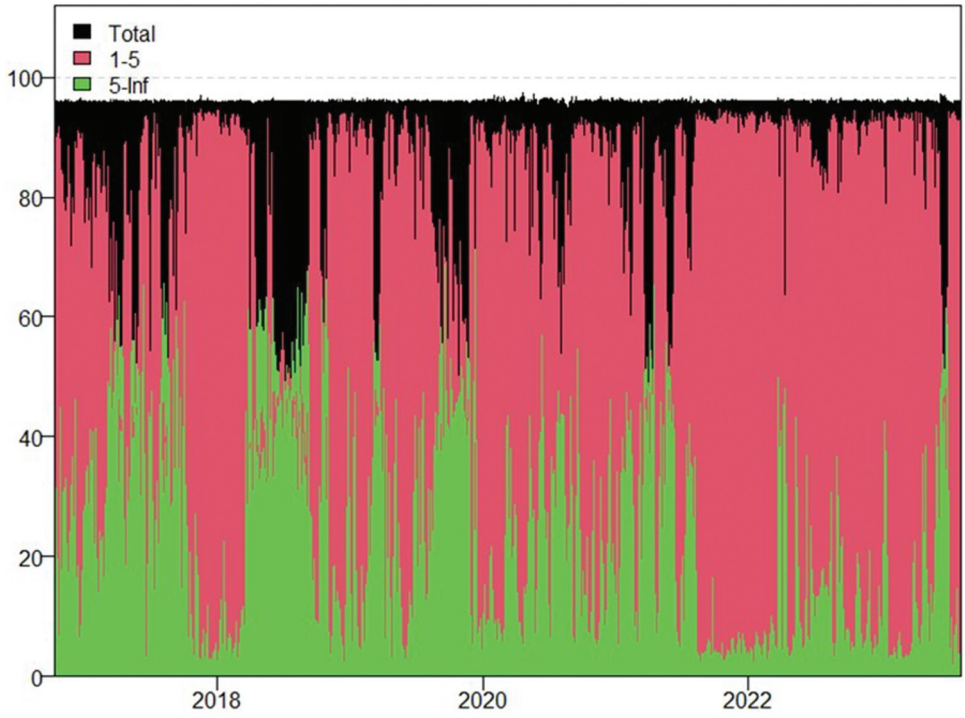

Figure 3. Total time-varying tail risk connectedness at the 95th quantile between Sukuk and Islamic sectoral markets.

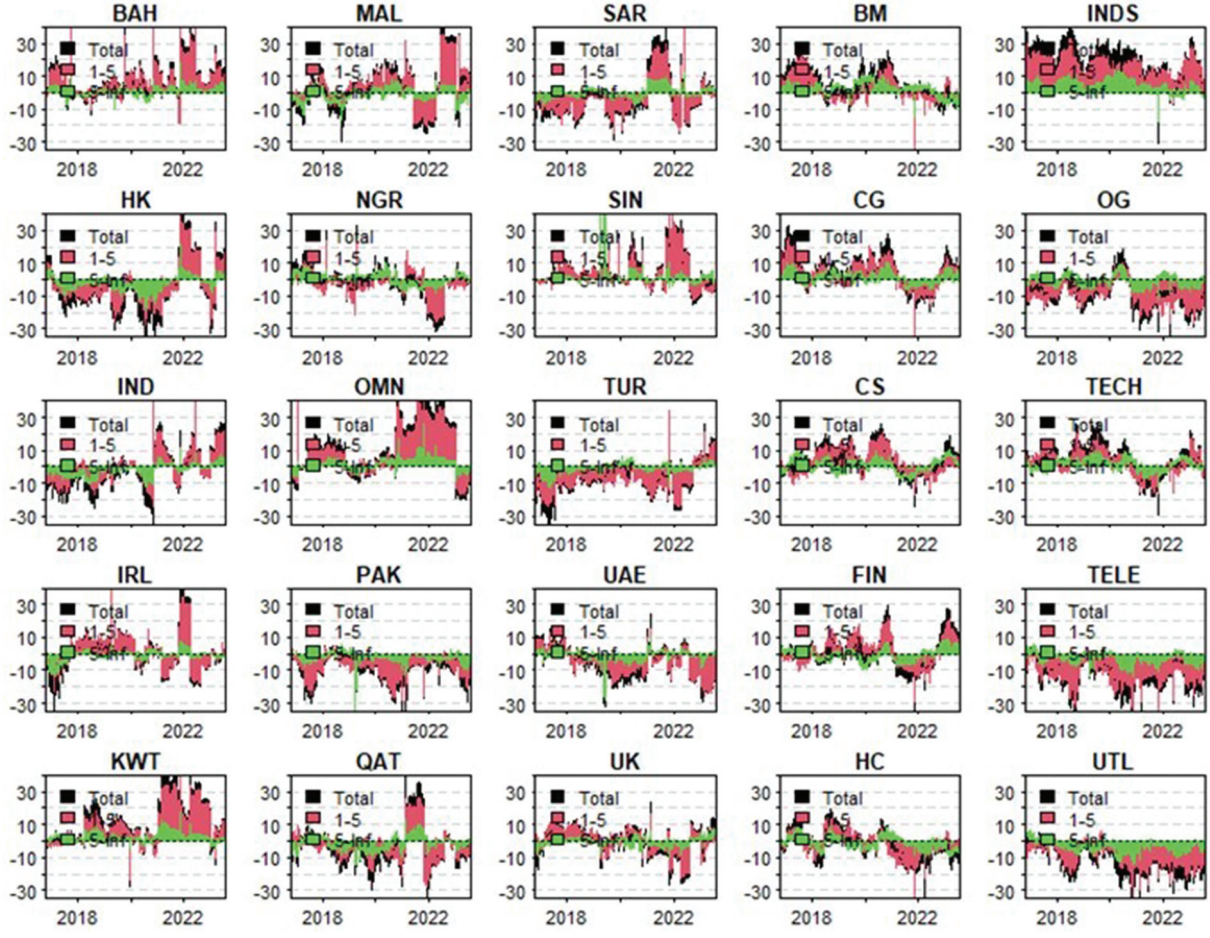

Figure 4. Net tail risk connectedness at the 50th quantile between Sukuk and Islamic sectoral markets.

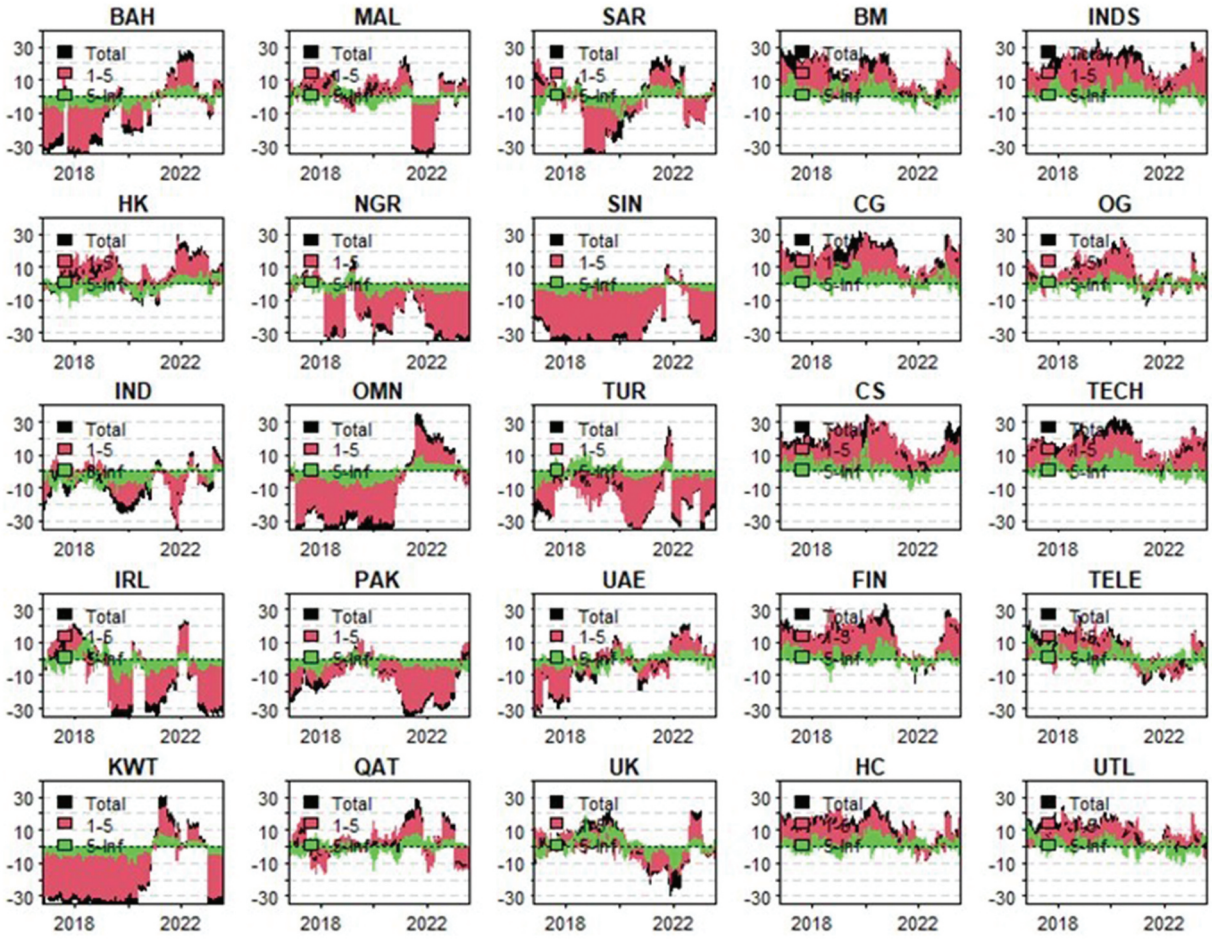

Figure 5. Net tail risk connectedness at the 5th quantile between Sukuk and Islamic sectoral markets.

stock indices are net transmitters while the country specific Sukuks are net receivers. Such patterns are almost true in both the short and long term.

Fig. A.7-A.9 compare the right tail risk (95th quantile) connection network between pre-COVID and COVID period for total, short term (1–5 days) and long term (5–22 days), respectively. The results show that, for the right tail risk, indices are much more connected in terms of both coverage and strength compared to the median risk network. However, unlike in the case of median risk, in the case right tail risk, there is not much difference between pre-COVID and COVID periods implying that the right tail risk connectedness between the indices was high even before COVID-19. Moreover, in the right tail almost all the sectoral stock indices are net transmitters while the country specific Sukuks are net receivers. Such patterns of results are almost true in both short and long term.

Fig. A.10-A.12 compare the median risk connection network between pre-Russia-Ukraine war and during the period of Russia-Ukraine war for total, short term (1–5 days) and long term (5–22 days) respectively. The results show that, for the median risk, indices are much more connected in terms of coverage during the Russia-Ukraine war than before Russia-Ukraine war. This pattern is true for both short and long term. However, there is not much difference in net transmitters/receivers between pre- and during Russia-Ukraine war.

Fig. A.13-A.15 compare the left tail risk (5th quantile) connection network between pre-Russia-Ukraine war and during Russia-Ukraine war for total, short term (1–5 days) and long term (5–22 days), respectively. In case of left tail risk, indices are much more connected in terms of both coverage and strength compared to the median risk network reported in Fig. A.16-A.18. However, unlike the median risks, the left tail risk

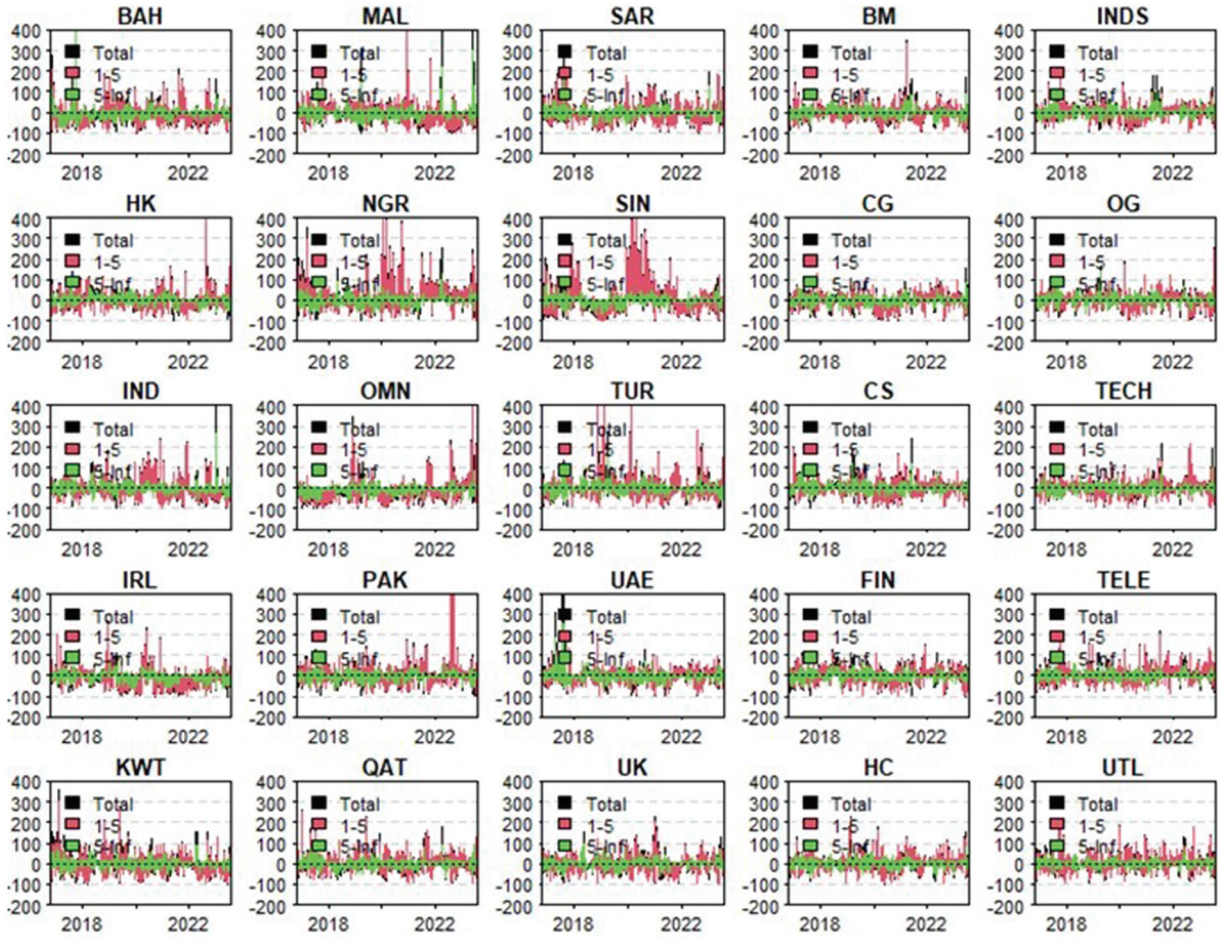

Figure 6. Net tail risk connectedness at the 95th quantile between Sukuk and Islamic sectoral markets.

connectedness do not differ much between pre-war and during war. Moreover, in the left tail almost all the sectoral stock indices are net transmitters while most of the country specific Sukuks are net receivers in both pre and during war. Such patterns of results are almost true both in short (Fig. A.17) and long (Fig. A.18) term.

Fig. A.19-A.21 compare the right tail risk (95th quantile) connection network between pre-war and during war period for total, short term (1–5 days) and long term (5–22 days), respectively. The results show that, for the right tail risk, indices are much more connected in terms of both coverage and strength compared to the median risk network. In the short term (1–5 days), the connectedness is higher in terms of coverage during the war compared to pre-war. However, in the long term there is not much difference in connectedness between pre-war and during war. Moreover, in the right tail, in both short and long term, usually most of the sectoral stock indices are net transmitters while most of the country specific Sukuks are net receivers, though there are some differences between pre- and during war.

Portfolio implications

In this section, portfolio implications of pairwise relationship among the assets are explored. For this purpose, 15 bivariate portfolios for 15 country-specific Sukuks are constructed with each of six Islamic sectoral stock indices that have least connectedness with Sukuk markets. The sectoral stock indices are Basic Materials (BM), Financials (FIN), Healthcare (HC), Oil & Gas (OG), Telecommunication (TELE), and Utilities (UTL). The results are presented in Table 12 (dynamic hedge ratios), Table 13 (dynamic portfolio weights), and Table 14 (hedge effectiveness). Each table contains four sets of results representing four

Table 12. Dynamic Hedge ratios

	PRE COVID-19				During COVID-19				PRE-WAR				During WAR			
	MN	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*
Pairs (BM/Sukuk)																
BM/BAH	0.33	0.19	0.06	0.65	2.24	1.05	0.56	4.22	0.11	0.25	-0.15	0.41	0.02	0.53	-0.93	0.98
BM/HK	-0.32	0.33	-0.85	0.08	-2.6	1.43	-5.07	-1.01	-0.33	0.5	-1.37	0.2	-0.18	0.86	-1.35	1.22
BM/IND	0.28	0.14	0.09	0.53	0.48	1.57	-0.6	2.29	0.38	0.4	0.05	0.82	0.15	1.01	-1.41	1.64
BM/IRL	0.76	0.37	0.31	1.43	-0.53	1.53	-2.29	1.43	-0.28	0.3	-0.86	0.09	-0.33	4.78	-7.05	7.11
BM/KWT	-0.28	0.26	-0.82	0.02	0.1	0.47	-0.29	0.62	-0.08	0.09	-0.22	0.04	0.18	1	-1.45	2.11
BM/MAL	1.15	0.5	0.41	2.07	2.7	0.97	1.3	4.5	0.11	0.08	0	0.24	0.33	0.86	-0.87	1.8
BM/NGR	0.25	0.13	0.01	0.46	0.63	0.44	0.12	1.35	0.11	0.13	-0.01	0.32	0.72	3.42	-5	5.96
BM/OMN	-0.01	0.01	-0.04	0	1.23	0.66	0.23	2.46	-0.02	0.13	-0.15	0.06	0.59	1.24	-1.34	2.58
BM/PAK	0.34	0.16	0.13	0.63	0.27	0.27	0.03	0.98	0.21	0.24	-0.12	0.6	0.05	0.74	-1.14	1.18
BM/QAT	0.97	0.46	0.45	1.99	2.44	0.97	1.12	4.21	0.77	0.71	0	1.99	0.7	1.8	-2.58	3.55
BM/SAR	-0.01	0.11	-0.17	0.18	-2.6	2.16	-6.81	-0.77	-0.06	0.38	-0.74	0.42	-0.14	0.24	-0.42	0.07
BM/SIN	-0.25	0.26	-0.71	-0.01	-0.17	0.24	-0.67	0.13	0.05	0.06	-0.02	0.15	0	0.05	-0.1	0.09
BM/TUR	0.26	0.1	0.09	0.42	-0.37	0.16	-0.65	-0.11	0.13	0.24	-0.22	0.53	-0.17	1.95	-2.02	3.15
BM/UAE	0.22	0.26	-0.28	0.66	-0.09	0.46	-0.69	0.54	0	0.46	-0.72	0.8	0.58	3.3	-5.14	5.13
BM/UK	0.9	0.54	0.05	1.8	-0.36	0.62	-1.34	0.31	0.15	0.49	-0.62	0.98	0.03	1.11	-1.91	1.86
Pairs (FIN/Sukuk)																
FIN/BAH	0.35	0.22	0.05	0.74	2.07	1.04	0.46	3.71	0.09	0.27	-0.27	0.42	0.05	0.54	-0.9	0.95
FIN/HK	-0.63	0.54	-1.68	-0.1	-2.49	1.65	-5.33	-0.68	-0.4	0.64	-1.46	0.27	-0.06	0.94	-1.51	1.33
FIN/IND	0.12	0.12	-0.03	0.34	0.12	1.42	-1.16	1.24	0.41	0.48	0.05	0.97	-0.12	1.14	-2.27	1.6
FIN/IRL	1.53	0.74	0.75	3.12	3.87	2.61	0.7	8.05	-0.18	0.33	-0.73	0.23	0.07	4.95	-7.86	7.27
FIN/KWT	-0.55	0.47	-1.52	-0.08	0.68	0.83	0.06	1.81	-0.01	0.12	-0.17	0.12	0.43	1.01	-1	2
FIN/MAL	0.99	0.45	0.34	1.85	2.33	0.78	1.16	3.56	0.1	0.07	0	0.25	0.45	1.05	-0.54	1.98
FIN/NGR	0.45	0.24	0.02	0.93	1.72	1.09	0.43	3.69	0.27	0.21	0.01	0.57	0.59	3.76	-5.37	7.19
FIN/OMN	0.03	0.01	0.01	0.05	0.04	0.06	-0.01	0.12	0	0.13	-0.12	0.05	0.44	1.5	-1.52	2.6
FIN/PAK	0.37	0.18	0.17	0.76	0.36	0.36	0.04	1.23	0.22	0.3	-0.2	0.71	0.04	0.83	-1.24	1.31
FIN/QAT	1.01	0.42	0.48	1.85	2.56	1.15	1.19	4.75	0.72	0.82	-0.11	1.73	0.02	2.1	-3.04	3.59
FIN/SAR	0.08	0.16	-0.17	0.35	-2.52	2.51	-6.33	-0.65	0.04	0.51	-0.75	0.71	-0.12	0.27	-0.43	0.17
FIN/SIN	0.15	0.17	0	0.5	0.61	0.51	0.18	1.63	0.16	0.18	0	0.5	0	0.05	-0.08	0.09
FIN/TUR	0.13	0.08	0.03	0.28	0.01	0.05	-0.04	0.09	0.14	0.24	-0.19	0.52	-0.36	1.88	-2.56	1.83
FIN/UAE	0.41	0.27	0.09	0.93	-1.12	0.64	-2.16	-0.32	0.07	0.61	-0.95	1.02	0.76	3.27	-4.38	5.21
FIN/UK	2.16	1.43	0.13	5.27	2.22	1.25	0.51	4.59	0.88	0.74	-0.05	2.11	0.16	1.17	-1.5	2.13
Pairs (HC/Sukuk)																
HC/BAH	0.18	0.11	0.03	0.38	1.46	0.75	0.32	2.63	0.03	0.18	-0.18	0.26	-0.04	0.43	-0.78	0.68
HC/HK	-0.61	0.39	-1.36	-0.18	-1.88	1.03	-3.73	-0.76	-0.22	0.4	-0.98	0.26	-0.08	0.71	-1.05	1.02
HC/IND	0.18	0.1	0.05	0.36	-0.87	0.93	-2.19	-0.27	0.3	0.32	0.04	0.63	-0.05	0.8	-1.22	1.25
HC/IRL	1.23	0.54	0.62	2.27	0.95	1.49	-0.93	3.14	-0.18	0.28	-0.55	0.22	0.08	3.71	-5.37	5.66
HC/KWT	-0.13	0.16	-0.52	0.02	-0.01	0.4	-0.61	0.37	-0.03	0.07	-0.14	0.07	0.1	0.73	-1.12	1.41
HC/MAL	0.74	0.31	0.31	1.31	1.56	0.65	0.7	2.76	0.11	0.06	0.03	0.21	0.24	0.72	-0.7	1.47
HC/NGR	0.47	0.23	0.02	0.92	0.46	0.32	0.07	1.22	0.18	0.16	-0.01	0.51	0.88	2.79	-3.41	5.26
HC/OMN	0.03	0.01	0.01	0.06	0.54	0.31	0.11	1.05	0.01	0.09	-0.07	0.05	0.26	1.05	-1.38	1.92
HC/PAK	0.21	0.09	0.09	0.37	0.16	0.2	-0.03	0.63	0.12	0.19	-0.13	0.43	-0.03	0.6	-0.97	0.93
HC/QAT	0.8	0.27	0.43	1.26	1.82	0.76	0.83	3.27	0.63	0.52	0.05	1.41	0.03	1.6	-2.39	2.57
HC/SAR	0.09	0.1	-0.07	0.26	-1.71	1.36	-3.97	-0.53	0.01	0.3	-0.41	0.41	-0.08	0.17	-0.3	0.13
HC/SIN	-0.06	0.05	-0.16	0	0.11	0.33	-0.3	0.71	0.13	0.13	0	0.37	0	0.04	-0.08	0.06
HC/TUR	0.16	0.07	0.06	0.27	-0.17	0.07	-0.3	-0.05	0.13	0.19	-0.16	0.46	-0.1	1.36	-1.84	1.84
HC/UAE	0.1	0.14	-0.11	0.35	-0.83	0.39	-1.48	-0.29	0.05	0.4	-0.6	0.74	0.47	2.47	-3.41	4.22
HC/UK	1.47	0.95	0.11	3.52	0.01	0.01	0	0.01	0.57	0.59	-0.17	1.56	0.16	0.87	-1.19	1.56

(*Continued*)

Table 12. (Continued).

	PRE COVID-19				During COVID-19				PRE-WAR				During WAR			
	MN	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*
Pairs (OG/Sukuk)																
OG/BAH	0.25	0.14	0.05	0.48	3.41	1.74	0.72	6.11	0.09	0.41	-0.3	0.64	0.03	0.76	-1.31	1.36
OG/HK	-1.39	0.79	-2.99	-0.39	-5.65	3.2	-11.1	-1.53	-1.04	1.06	-3.34	0.04	-0.25	1.28	-2.02	1.77
OG/IND	0.22	0.12	0.07	0.45	-0.02	2.66	-1.91	2.83	0.38	0.5	0.04	0.9	0.36	1.48	-1.9	2.96
OG/IRL	1.69	0.72	0.84	3.15	-0.55	2.56	-3.68	4.83	-0.18	0.48	-0.9	0.6	-1.04	6.47	-9.92	9.76
OG/KWT	-0.28	0.35	-0.87	0.32	0.15	1.18	-1.09	1.31	-0.12	0.2	-0.34	0.14	0.16	1.46	-2.78	2.43
OG/MAL	0.85	0.35	0.31	1.4	3.84	1.46	1.99	6.59	0.12	0.12	-0.01	0.36	0.15	1.37	-2.3	2.23
OG/NGR	0.38	0.16	0.03	0.62	0.58	0.57	0.05	1.29	0.2	0.27	-0.04	0.68	0.98	4.92	-7.35	9.01
OG/OMN	-0.02	0.02	-0.06	0.01	2.22	1.2	0.36	4.28	-0.01	0.23	-0.17	0.13	0.53	1.99	-2.44	3.88
OG/PAK	-0.09	0.13	-0.35	0.14	0.07	0.37	-0.3	0.82	-0.07	0.35	-0.6	0.46	0.01	1.1	-1.79	1.77
OG/QAT	0.11	0.27	-0.23	0.7	2.67	1.67	0.91	5.45	0.2	1.08	-0.94	1.61	0.72	2.95	-4	5.44
OG/SAR	-0.22	0.17	-0.51	0.04	-6.09	5.26	-14.7	-1.82	-0.31	0.73	-1.6	0.56	-0.1	0.29	-0.53	0.2
OG/SIN	0.01	0.02	-0.02	0.05	-0.07	0.89	-0.82	0.74	0.21	0.22	0	0.55	0	0.08	-0.13	0.13
OG/TUR	-0.06	0.07	-0.18	0.04	-0.19	0.11	-0.35	-0.05	0.04	0.31	-0.44	0.55	-0.23	2.36	-2.73	2.42
OG/UAE	-0.52	0.3	-1.1	-0.1	-2.25	1.02	-4.3	-0.92	-0.63	0.68	-1.75	0.31	-0.07	4.88	-7.52	7.2
OG/UK	0.99	0.66	0.09	2.28	0.07	0.03	0.03	0.13	0.28	0.66	-0.63	1.38	-0.07	1.6	-2.72	2.6
Pairs (TEL/Sukuk)																
TELE/BAH	0.33	0.18	0.06	0.61	1.31	0.75	0.22	2.69	0.17	0.12	-0.02	0.39	0.03	0.24	-0.36	0.48
TELE/HK	0.34	0.18	-0.02	0.6	-0.69	0.34	-1.32	-0.23	-0.1	0.27	-0.59	0.33	-0.04	0.35	-0.54	0.54
TELE/IND	0.27	0.12	0.08	0.48	0.34	0.84	-0.33	2.22	0.14	0.22	-0.05	0.35	-0.02	0.48	-0.94	0.76
TELE/IRL	0.44	0.34	-0.05	1.05	-0.27	0.86	-1.55	0.86	0.06	0.15	-0.18	0.32	-0.26	1.98	-3.03	2.95
TELE/KWT	-0.15	0.13	-0.38	0	-0.27	0.25	-0.83	-0.05	0	0.05	-0.08	0.07	0.09	0.45	-0.64	0.74
TELE/MAL	0.92	0.39	0.37	1.6	1.41	0.62	0.56	2.62	0.02	0.05	-0.07	0.1	0.12	0.32	-0.33	0.82
TELE/NGR	0.14	0.12	-0.01	0.37	0.68	0.34	0.19	1.26	0.04	0.1	-0.15	0.21	0.23	1.6	-2.53	2.69
TELE/OMN	0.01	0.01	-0.02	0.02	0.37	0.23	0.08	0.81	0.02	0.06	-0.04	0.08	0.26	0.5	-0.65	1.18
TELE/PAK	0.27	0.15	0.08	0.54	-0.08	0.12	-0.3	0.1	0.14	0.25	-0.2	0.63	0.01	0.34	-0.55	0.53
TELE/QAT	0.95	0.35	0.51	1.66	1.29	0.4	0.76	2.01	0.49	0.43	-0.1	1.26	0.22	0.89	-1.41	1.53
TELE/SAR	0.15	0.09	0.02	0.32	-0.66	0.54	-1.74	-0.13	0.02	0.22	-0.3	0.42	-0.06	0.1	-0.19	0.05
TELE/SIN	-0.22	0.2	-0.59	-0.01	-0.33	0.31	-0.9	0.02	-0.16	0.14	-0.39	0	0	0.02	-0.04	0.04
TELE/TUR	0.32	0.1	0.17	0.51	-0.14	0.05	-0.21	-0.05	0.17	0.17	-0.07	0.48	-0.11	0.66	-1.02	0.74
TELE/UAE	0.53	0.32	0.04	1.14	0.7	0.32	0.26	1.16	0.16	0.42	-0.46	0.91	-0.09	1.42	-2.09	2.24
TELE/UK	1.04	0.51	0	1.81	0.16	0.38	-0.36	0.82	0.13	0.46	-0.61	0.92	-0.05	0.48	-0.75	0.83
Pairs (UTL/Sukuk)																
UTL/BAH	0.24	0.14	0.04	0.5	1.39	0.74	0.22	2.47	0.11	0.14	-0.11	0.33	0.01	0.35	-0.68	0.64
UTL/HK	0.2	0.15	-0.1	0.43	-0.17	0.21	-0.52	0.08	0.12	0.23	-0.26	0.47	-0.04	0.56	-0.85	0.84
UTL/IND	0.25	0.1	0.1	0.42	-0.27	0.76	-1.07	1.35	0.17	0.25	-0.01	0.38	0.02	0.7	-1.14	1.39
UTL/IRL	1.4	0.69	0.72	2.65	4.24	1.74	1.75	6.73	0.26	0.24	0.08	0.75	0.91	3.12	-4.4	5.05
UTL/KWT	-0.17	0.16	-0.5	0	0	0.35	-0.31	0.23	-0.1	0.07	-0.26	0	0.12	0.63	-0.94	1.3
UTL/MAL	0.89	0.44	0.29	1.73	1.51	0.66	0.53	2.64	0.11	0.06	0.02	0.22	0.13	0.46	-0.39	0.87
UTL/NGR	0.23	0.12	0.01	0.44	0.68	0.34	0.2	1.28	0.13	0.12	0	0.35	0.45	2.39	-3.6	3.99
UTL/OMN	0	0.01	-0.03	0.01	0.72	0.4	0.15	1.42	0	0.07	-0.09	0.05	0.09	0.76	-1.31	1.35
UTL/PAK	0.36	0.16	0.15	0.65	0.13	0.14	-0.01	0.43	0.25	0.24	-0.09	0.67	0.01	0.52	-0.75	0.84
UTL/QAT	1.1	0.46	0.56	2.11	1.51	0.47	0.87	2.26	0.8	0.48	0.09	1.69	0.12	1.37	-2.06	2.24
UTL/SAR	0.19	0.12	0.03	0.45	0.31	0.52	-0.17	1.37	0.19	0.25	-0.15	0.65	-0.06	0.13	-0.22	0.1
UTL/SIN	0.03	0.03	0	0.07	0.79	0.92	0.32	1.73	0.14	0.13	0	0.39	0	0.03	-0.06	0.06
UTL/TUR	0.2	0.07	0.1	0.35	-0.03	0.02	-0.06	0.01	0.16	0.15	-0.04	0.44	-0.01	0.99	-1.05	1.2
UTL/UAE	0.41	0.26	0.07	0.87	0.76	0.42	0.28	1.55	0.32	0.4	-0.16	1.11	0.04	2.24	-3.25	3.38
UTL/UK	0.99	0.46	0.06	1.86	1.85	1.06	0.5	3.86	0.5	0.44	-0.02	1.36	0.08	0.76	-1.11	1.3

This table illustrate the hedge ratios, among Sukuk and Islamic sectoral markets in pre and during COVID-19 and War.

Table 13. Dynamic Portfolio weights

	PRE COVID-19				During COVID-19				PRE-WAR				During WAR			
	MN	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*
Pairs (BM/Sukuk)																
BM/BAH	0.11	0.2	0	0.57	0.03	0.13	0	0.25	0.14	0.18	0.02	0.53	0.37	0.12	0.02	0.45
BM/HK	0.07	0.05	0.01	0.18	0.06	0.04	0.02	0.12	0.07	0.1	0.01	0.22	0.28	0.14	0	0.41
BM/IND	0.08	0.08	0.01	0.27	0.01	0.01	0	0.02	0.13	0.21	0	0.67	0.27	0.23	0	0.7
BM/IRL	0	0.03	0	0	0	0	0	0.01	0.01	0.06	0	0.02	0.04	0.04	0	0.1
BM/KWT	0.07	0.1	0	0.28	0.02	0.02	0	0.06	0.15	0.17	0.02	0.52	0.03	0.12	0	0.04
BM/MAL	0.05	0.12	0	0.28	0	0	0	0	0.2	0.2	0.05	0.73	0.03	0.12	0	0.03
BM/NGR	0.11	0.25	0.01	0.96	0.03	0.1	0	0.08	0.19	0.29	0.01	0.95	0.04	0.06	0	0.15
BM/OMN	0.46	0.18	0.2	0.83	0.05	0.19	0	0.32	0.37	0.18	0.11	0.73	0.02	0.12	0	0.03
BM/PAK	0.07	0.06	0.01	0.17	0.1	0.12	0	0.4	0.09	0.09	0.01	0.24	0.27	0.14	0	0.41
BM/QAT	0.01	0.03	0	0.05	0	0	0	0	0.03	0.08	0	0.15	0.06	0.07	0	0.19
BM/SAR	0.06	0.05	0.01	0.15	0.03	0.02	0	0.06	0.06	0.04	0.01	0.11	0.36	0.06	0.33	0.38
BM/SIN	0.28	0.35	0	0.95	0.01	0.01	0	0.02	0.28	0.37	0	0.99	0.97	0.04	0.89	1
BM/TUR	0.13	0.14	0.03	0.35	0.21	0.19	0.06	0.66	0.15	0.22	0.01	0.71	0.04	0.11	0	0.13
BM/UAE	0.03	0.05	0	0.12	0.02	0.02	0	0.05	0.03	0.07	0	0.13	0.04	0.05	0	0.14
BM/UK	0.04	0.16	0	0.29	0.01	0.01	0	0.04	0.04	0.13	0	0.17	0.17	0.12	0	0.33
Pairs (FIN/Sukuk)																
FIN/BAH	0.11	0.19	0	0.58	0.03	0.1	0	0.19	0.13	0.17	0.01	0.49	0.37	0.13	0.07	0.52
FIN/HK	0.07	0.05	0.01	0.18	0.04	0.02	0.01	0.09	0.06	0.09	0.01	0.17	0.27	0.15	0	0.44
FIN/IND	0.09	0.08	0.01	0.24	0.01	0	0	0.01	0.13	0.2	0	0.64	0.28	0.19	0	0.65
FIN/IRL	0	0.03	0	0	0	0	0	0	0.01	0.06	0	0.02	0.03	0.04	0	0.1
FIN/KWT	0.07	0.1	0	0.3	0.01	0.01	0	0.03	0.14	0.17	0.01	0.49	0.03	0.12	0	0.03
FIN/MAL	0.05	0.13	0	0.32	0	0	0	0	0.19	0.2	0.03	0.72	0.03	0.12	0	0.04
FIN/NGR	0.11	0.27	0	0.98	0.02	0.09	0	0.04	0.17	0.3	0.01	0.96	0.05	0.06	0	0.17
FIN/OMN	0.45	0.19	0.13	0.78	0.05	0.16	0	0.23	0.35	0.18	0.09	0.65	0.03	0.12	0	0.06
FIN/PAK	0.07	0.06	0	0.19	0.07	0.1	0	0.35	0.08	0.09	0	0.24	0.28	0.16	0	0.46
FIN/QAT	0.01	0.03	0	0.05	0	0	0	0	0.03	0.08	0	0.13	0.09	0.08	0	0.22
FIN/SAR	0.06	0.05	0.01	0.14	0.02	0.01	0	0.03	0.05	0.04	0.01	0.11	0.36	0.1	0.21	0.46
FIN/SIN	0.27	0.35	0	0.96	0	0	0	0.01	0.27	0.37	0	0.98	0.97	0.03	0.91	1
FIN/TUR	0.14	0.14	0.02	0.36	0.15	0.19	0.02	0.58	0.14	0.2	0.01	0.63	0.04	0.11	0	0.15
FIN/UAE	0.03	0.07	0	0.1	0.02	0.01	0	0.04	0.03	0.08	0	0.1	0.04	0.05	0	0.13
FIN/UK	0.05	0.17	0	0.48	0	0	0	0.01	0.03	0.12	0	0.14	0.17	0.13	0	0.35
Pairs (HC/Sukuk)																
HC/BAH	0.13	0.2	0.01	0.64	0.06	0.17	0	0.41	0.17	0.18	0.03	0.61	0.53	0.09	0.43	0.65
HC/HK	0.09	0.05	0.02	0.18	0.06	0.03	0.02	0.12	0.08	0.11	0.01	0.21	0.4	0.14	0	0.5
HC/IND	0.1	0.08	0.02	0.23	0.02	0.01	0	0.04	0.16	0.24	0.01	0.75	0.38	0.23	0	0.79
HC/IRL	0	0.03	0	0	0	0	0	0	0.02	0.06	0	0.02	0.04	0.05	0	0.12
HC/KWT	0.08	0.11	0	0.31	0.02	0.02	0	0.06	0.17	0.18	0.03	0.55	0.04	0.12	0	0.06
HC/MAL	0.08	0.14	0	0.31	0.02	0.05	0	0.12	0.24	0.21	0.06	0.84	0.04	0.12	0	0.07
HC/NGR	0.11	0.27	0	1	0.03	0.1	0	0.09	0.2	0.3	0.02	0.98	0.06	0.08	0	0.22
HC/OMN	0.51	0.17	0.25	0.84	0.07	0.18	0	0.31	0.43	0.17	0.17	0.74	0.04	0.12	0	0.08
HC/PAK	0.09	0.06	0.02	0.21	0.15	0.17	0	0.58	0.12	0.11	0.02	0.34	0.43	0.14	0.12	0.61
HC/QAT	0.02	0.03	0	0.05	0	0.01	0	0.02	0.04	0.09	0	0.18	0.11	0.1	0	0.27
HC/SAR	0.07	0.06	0.02	0.16	0.03	0.02	0	0.05	0.07	0.05	0.02	0.13	0.47	0.07	0.39	0.54
HC/SIN	0.29	0.36	0	0.96	0.01	0.01	0	0.02	0.29	0.38	0	0.99	0.98	0.03	0.92	1
HC/TUR	0.16	0.15	0.03	0.42	0.23	0.2	0.07	0.69	0.18	0.23	0.01	0.76	0.05	0.13	0	0.18
HC/UAE	0.03	0.07	0	0.15	0.03	0.02	0.01	0.07	0.04	0.09	0	0.16	0.06	0.06	0	0.17
HC/UK	0.05	0.18	0	0.49	0.01	0.01	0	0.04	0.04	0.14	0	0.22	0.22	0.15	0	0.41

(*Continued*)

Table 13. (Continued).

	PRE COVID-19				During COVID-19				PRE-WAR				During WAR			
	MN	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*	*MN*	*STD.D*	*5%*	*95%*
Pairs (OG/Sukuk)																
OG/BAH	0.08	0.17	0	0.39	0.01	0.05	0	0.07	0.08	0.15	0.01	0.32	0.21	0.11	0	0.34
OG/HK	0.05	0.03	0.02	0.11	0.04	0.02	0.01	0.08	0.04	0.07	0.01	0.11	0.17	0.13	0	0.32
OG/IND	0.05	0.04	0.01	0.13	0	0	0	0.01	0.07	0.12	0	0.36	0.16	0.16	0	0.54
OG/IRL	0	0.03	0	0	0	0	0	0	0.01	0.05	0	0.01	0.03	0.03	0	0.07
OG/KWT	0.04	0.06	0	0.17	0.01	0.01	0	0.02	0.09	0.14	0.01	0.32	0.02	0.11	0	0.03
OG/MAL	0.04	0.09	0	0.17	0	0	0	0	0.12	0.19	0.01	0.51	0.02	0.12	0	0.03
OG/NGR	0.09	0.25	0	0.94	0.01	0.07	0	0.03	0.13	0.26	0	0.89	0.03	0.04	0	0.11
OG/OMN	0.33	0.16	0.14	0.71	0.03	0.15	0	0.12	0.24	0.16	0.05	0.54	0.02	0.11	0	0.03
OG/PAK	0.05	0.04	0.02	0.11	0.05	0.06	0	0.19	0.05	0.05	0.01	0.15	0.16	0.11	0	0.31
OG/QAT	0.02	0.02	0	0.04	0	0	0	0	0.02	0.05	0	0.08	0.04	0.05	0	0.14
OG/SAR	0.04	0.03	0.01	0.09	0.01	0.01	0	0.03	0.03	0.02	0	0.07	0.21	0.08	0.16	0.25
OG/SIN	0.22	0.31	0	0.91	0	0	0	0.01	0.22	0.33	0	0.95	0.96	0.05	0.85	1
OG/TUR	0.1	0.11	0.02	0.23	0.1	0.14	0.02	0.41	0.09	0.15	0	0.44	0.02	0.08	0	0.06
OG/UAE	0.02	0.04	0	0.08	0.01	0.01	0	0.04	0.02	0.05	0	0.08	0.03	0.04	0	0.1
OG/UK	0.03	0.13	0	0.23	0	0	0	0.01	0.02	0.1	0	0.08	0.1	0.09	0	0.24
Pairs (TEL/Sukuk)																
TELE/BAH	*0.14*	*0.21*	*0.01*	*0.71*	*0.12*	*0.24*	*0*	*0.75*	*0.21*	*0.2*	*0.05*	*0.73*	*0.81*	*0.1*	*0.67*	*1*
TELE/HK	*0.06*	*0.05*	*0.01*	*0.15*	*0.08*	*0.06*	*0.03*	*0.22*	*0.1*	*0.12*	*0.02*	*0.28*	*0.74*	*0.13*	*0.61*	*1*
TELE/IND	*0.12*	*0.1*	*0.03*	*0.31*	*0.02*	*0.02*	*0*	*0.05*	*0.2*	*0.26*	*0.02*	*0.85*	*0.63*	*0.22*	*0.26*	*1*
TELE/IRL	*0*	*0.04*	*0*	*0*	*0*	*0*	*0*	*0.01*	*0.02*	*0.07*	*0*	*0.03*	*0.09*	*0.08*	*0*	*0.2*
TELE/KWT	*0.1*	*0.13*	*0.01*	*0.38*	*0.05*	*0.03*	*0.01*	*0.1*	*0.22*	*0.2*	*0.05*	*0.65*	*0.08*	*0.13*	*0.02*	*0.13*
TELE/MAL	*0.09*	*0.15*	*0*	*0.37*	*0.06*	*0.16*	*0*	*0.45*	*0.31*	*0.2*	*0.12*	*0.87*	*0.07*	*0.12*	*0.01*	*0.11*
TELE/NGR	*0.14*	*0.25*	*0.02*	*0.97*	*0.04*	*0.12*	*0*	*0.24*	*0.24*	*0.3*	*0.04*	*0.97*	*0.13*	*0.14*	*0*	*0.39*
TELE/OMN	*0.57*	*0.17*	*0.31*	*0.91*	*0.11*	*0.2*	*0*	*0.45*	*0.52*	*0.17*	*0.22*	*0.86*	*0.05*	*0.13*	*0*	*0.11*
TELE/PAK	*0.11*	*0.07*	*0.03*	*0.25*	*0.24*	*0.21*	*0.04*	*0.67*	*0.16*	*0.14*	*0.03*	*0.48*	*0.77*	*0.14*	*0.63*	*1*
TELE/QAT	*0.02*	*0.05*	*0*	*0.07*	*0.01*	*0.01*	*0*	*0.03*	*0.06*	*0.12*	*0*	*0.28*	*0.21*	*0.14*	*0*	*0.38*
TELE/SAR	*0.09*	*0.07*	*0.02*	*0.2*	*0.03*	*0.02*	*0*	*0.06*	*0.1*	*0.06*	*0.02*	*0.2*	*0.71*	*0.03*	*0.68*	*0.75*
TELE/SIN	*0.31*	*0.36*	*0.01*	*0.96*	*0.02*	*0.01*	*0*	*0.04*	*0.31*	*0.38*	*0.01*	*0.99*	*0.99*	*0.02*	*0.96*	*1*
TELE/TUR	*0.18*	*0.15*	*0.04*	*0.44*	*0.33*	*0.21*	*0.13*	*0.77*	*0.22*	*0.26*	*0.02*	*0.84*	*0.09*	*0.17*	*0.01*	*0.46*
TELE/UAE	*0.03*	*0.08*	*0*	*0.15*	*0.02*	*0.02*	*0*	*0.07*	*0.06*	*0.11*	*0*	*0.26*	*0.13*	*0.11*	*0*	*0.27*
TELE/UK	*0.05*	*0.17*	*0*	*0.51*	*0.02*	*0.03*	*0*	*0.07*	*0.06*	*0.15*	*0*	*0.33*	*0.57*	*0.1*	*0.46*	*0.82*
Pairs (UTL/Sukuk)																
UTL/BAH	*0.16*	*0.22*	*0.01*	*0.72*	*0.1*	*0.22*	*0*	*0.73*	*0.2*	*0.2*	*0.04*	*0.68*	*0.63*	*0.1*	*0.55*	*0.86*
UTL/HK	*0.07*	*0.05*	*0.02*	*0.18*	*0.05*	*0.05*	*0.02*	*0.14*	*0.08*	*0.12*	*0.01*	*0.25*	*0.5*	*0.04*	*0.47*	*0.54*
UTL/IND	*0.13*	*0.1*	*0.03*	*0.33*	*0.02*	*0.02*	*0*	*0.05*	*0.18*	*0.22*	*0.02*	*0.76*	*0.42*	*0.26*	*0*	*0.85*
UTL/IRL	*0*	*0.04*	*0*	*0*	*0*	*0*	*0*	*0*	*0.02*	*0.07*	*0*	*0.02*	*0.04*	*0.05*	*0*	*0.14*
UTL/KWT	*0.1*	*0.13*	*0.01*	*0.43*	*0.03*	*0.02*	*0*	*0.07*	*0.21*	*0.19*	*0.05*	*0.61*	*0.04*	*0.12*	*0*	*0.07*
UTL/MAL	*0.11*	*0.17*	*0*	*0.49*	*0.05*	*0.13*	*0*	*0.31*	*0.28*	*0.21*	*0.07*	*0.82*	*0.04*	*0.12*	*0*	*0.05*
UTL/NGR	*0.13*	*0.25*	*0.02*	*0.97*	*0.03*	*0.1*	*0*	*0.15*	*0.22*	*0.29*	*0.03*	*0.97*	*0.06*	*0.07*	*0*	*0.18*
UTL/OMN	*0.58*	*0.18*	*0.24*	*0.9*	*0.08*	*0.19*	*0*	*0.43*	*0.49*	*0.18*	*0.19*	*0.82*	*0.04*	*0.12*	*0*	*0.08*
UTL/PAK	*0.11*	*0.08*	*0.02*	*0.26*	*0.19*	*0.22*	*0.02*	*0.68*	*0.13*	*0.13*	*0.02*	*0.39*	*0.51*	*0.08*	*0.42*	*0.63*
UTL/QAT	*0.02*	*0.04*	*0*	*0.07*	*0*	*0.01*	*0*	*0.01*	*0.04*	*0.1*	*0*	*0.21*	*0.13*	*0.11*	*0*	*0.28*
UTL/SAR	*0.09*	*0.07*	*0.01*	*0.22*	*0.01*	*0.01*	*0*	*0.03*	*0.08*	*0.06*	*0.01*	*0.18*	*0.53*	*0.04*	*0.51*	*0.55*
UTL/SIN	*0.3*	*0.35*	*0*	*0.96*	*0.01*	*0.01*	*0*	*0.02*	*0.3*	*0.38*	*0*	*0.99*	*0.99*	*0.02*	*0.93*	*1*
UTL/TUR	*0.21*	*0.15*	*0.04*	*0.46*	*0.29*	*0.24*	*0.08*	*0.8*	*0.2*	*0.23*	*0.02*	*0.74*	*0.05*	*0.14*	*0*	*0.25*
UTL/UAE	*0.04*	*0.07*	*0*	*0.16*	*0.01*	*0.02*	*0*	*0.04*	*0.04*	*0.09*	*0*	*0.17*	*0.08*	*0.07*	*0*	*0.19*
UTL/UK	*0.04*	*0.16*	*0*	*0.28*	*0*	*0.01*	*0*	*0.03*	*0.04*	*0.14*	*0*	*0.21*	*0.28*	*0.15*	*0*	*0.42*

This table illustrate the hedge ratios, among Sukuk and Islamic sectoral markets in pre and during COVID-19 and War.

Table 14. Hedging effectiveness

	PRE COVID-19				During COVID-19				PRE-WAR				During WAR			
	Dynamic Portfolio Weights		*Dynamic hedge ratios*		*Dynamic Portfolio Weights*		*Dynamic hedge ratios*		*Dynamic Portfolio Weights*		*Dynamic hedge ratios*		*Dynamic Portfolio Weights*		*Dynamic hedge ratios*	
	HE	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*
Pairs (BM/Sukuk)																
BM/BAH	0.14	0.02	0	0.99	0.86	0	0.28	0.02	0.38	0	-0.01	0.81	0.59	0	0.59	0
BM/HK	0.96	0	0.01	0.89	0.99	0	0.06	0.65	0.93	0	0	0.98	0.64	0	0.64	0
BM/IND	0.93	0	0	0.96	1	0	0	0.98	0.7	0	-0.06	0.26	-0.18	0.37	-0.18	0.37
BM/IRL	0.98	0	0	0.98	1	0	-0.02	0.9	0.83	0	-0.01	0.9	0.98	0	0.98	0
BM/KWT	0.91	0	-0.01	0.93	1	0	-0.01	0.96	0.25	0	0	0.95	-4.46	0	-4.46	0
BM/MAL	0.9	0	0.07	0.28	0.87	0	0.39	0	-4.18	0	0	0.99	-13.68	0	-13.68	0
BM/NGR	0.79	0	0	0.99	0.97	0	-0.02	0.89	0.55	0	0	0.94	0.96	0	0.96	0
BM/OMN	-0.62	0	0	1	0.86	0	0.06	0.67	-0.71	0	0	0.96	-4.97	0	-4.97	0
BM/PAK	0.92	0	0.01	0.84	0.85	0	-0.01	0.96	0.88	0	-0.02	0.75	0.67	0	0.67	0
BM/QAT	0.97	0	0.04	0.55	0.98	0	0.16	0.22	0.96	0	0.01	0.91	0.86	0	0.86	0
BM/SAR	0.94	0	0	1	1	0	0.02	0.91	0.96	0	-0.01	0.91	-88.36	0	-88.36	0
BM/SIN	-4.86	0	0	0.95	1	0	0	1	-2.52	0	-0.01	0.83	-0.19	0.33	-0.19	0.33
BM/TUR	0.82	0	0.02	0.76	0.81	0	-0.06	0.67	0.68	0	-0.01	0.92	-1.81	0	-1.81	0
BM/UAE	0.97	0	0	0.98	0.99	0	0.01	0.97	0.95	0	-0.01	0.89	0.97	0	0.97	0
BM/UK	0.71	0	0	0.96	0.99	0	-0.02	0.88	0.84	0	0	0.93	0.76	0	0.76	0
Pairs (FIN/Sukuk)																
FIN/BAH	0.06	0.34	0	1	0.93	0	0.13	0.34	-0.02	0.76	-0.02	0.76	0.64	0	0.64	0
FIN/HK	0.96	0	0	0.97	0.99	0	0.09	0.52	0.01	0.85	0.01	0.85	0.62	0	0.62	0
FIN/IND	0.94	0	0	0.97	1	0	0	0.97	-0.05	0.36	-0.05	0.36	-0.05	0.77	-0.05	0.77
FIN/IRL	0.98	0	0	0.96	1	0	-0.02	0.9	-0.01	0.9	-0.01	0.9	0.98	0	0.98	0
FIN/KWT	0.92	0	-0.01	0.87	1	0	0	1	0	0.98	0	0.98	-4	0	-4	0
FIN/MAL	0.91	0	0.03	0.67	0.93	0	0.24	0.06	0.01	0.78	0.01	0.78	-12.54	0	-12.54	0
FIN/NGR	0.83	0	0	0.96	0.99	0	-0.03	0.82	-0.03	0.51	-0.03	0.51	0.97	0	0.97	0
FIN/OMN	-0.81	0	0	0.99	0.92	0	0.01	0.97	0	0.95	0	0.95	-4.49	0	-4.49	0
FIN/PAK	0.93	0	0.02	0.81	0.91	0	-0.02	0.88	-0.02	0.76	-0.02	0.76	0.7	0	0.7	0
FIN/QAT	0.97	0	0.04	0.58	0.99	0	0.14	0.31	0.02	0.65	0.02	0.65	0.87	0	0.87	0
FIN/SAR	0.95	0	0	0.96	1	0	0.01	0.95	0	0.99	0	0.99	-82.88	0	-82.88	0
FIN/SIN	-4.31	0	0	0.94	1	0	0	1	-0.02	0.73	-0.02	0.73	-0.11	0.58	-0.11	0.58
FIN/TUR	0.86	0	0	0.97	0.89	0	0	0.98	0	0.99	0	0.99	-1.6	0	-1.6	0
FIN/UAE	0.97	0	0.01	0.93	1	0	0.03	0.83	0	0.97	0	0.97	0.97	0	0.97	0
FIN/UK	0.72	0	-0.01	0.83	0.99	0	-0.04	0.81	-0.02	0.71	-0.02	0.71	0.79	0	0.79	0
Pairs (HC/Sukuk)																
HC/BAH	-0.18	0.01	0	0.99	0.81	0	0.18	0.16	0.17	0	-0.03	0.62	0.52	0	0.52	0
HC/HK	0.95	0	0.01	0.85	0.98	0	0.08	0.56	0.91	0	0	0.96	0.56	0	0.56	0
HC/IND	0.91	0	0	0.97	1	0	0.02	0.91	0.64	0	-0.06	0.23	-0.28	0.17	-0.28	0.17
HC/IRL	0.97	0	0.01	0.92	1	0	-0.01	0.92	0.78	0	-0.02	0.65	0.97	0	0.97	0
HC/KWT	0.88	0	0	0.96	0.99	0	-0.01	0.95	0.15	0	0	0.93	-7.35	0	-7.35	0
HC/MAL	0.87	0	-0.02	0.76	0.8	0	0.3	0.01	-5.08	0	-0.01	0.85	-21.79	0	-21.79	0
HC/NGR	0.83	0	0.01	0.83	0.96	0	-0.01	0.92	0.6	0	0.04	0.46	0.94	0	0.94	0
HC/OMN	-1.25	0	0	0.99	0.8	0	0.04	0.8	-1.12	0	0	0.94	-8.47	0	-8.47	0
HC/PAK	0.9	0	0	0.96	0.84	0	-0.03	0.85	0.86	0	-0.03	0.53	0.64	0	0.64	0
HC/QAT	0.96	0	0.03	0.68	0.98	0	0.15	0.27	0.94	0	0.02	0.67	0.78	0	0.78	0
HC/SAR	0.93	0	0	1	1	0	0.01	0.94	0.94	0	0	0.95	-88.87	0	-88.87	0

(*Continued*)

Table 14. (Continued).

	PRE COVID-19				During COVID-19				PRE-WAR				During WAR			
	Dynamic Portfolio Weights		*Dynamic hedge ratios*		*Dynamic Portfolio Weights*		*Dynamic hedge ratios*		*Dynamic Portfolio Weights*		*Dynamic hedge ratios*		*Dynamic Portfolio Weights*		*Dynamic hedge ratios*	
	HE	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*
HC/SIN	-6.65	0	0	1	1	0	0	1	-3.65	0	-0.01	0.8	-0.08	0.66	-0.08	0.66
HC/TUR	0.77	0	0.01	0.92	0.76	0	-0.01	0.92	0.6	0	0	1	-3.46	0	-3.46	0
HC/UAE	0.96	0	0	0.97	0.99	0	0.02	0.87	0.94	0	0	1	0.95	0	0.95	0
HC/UK	0.65	0	0.02	0.76	0.98	0	0.63	0	0.79	0	0.02	0.64	0.67	0	0.67	0
Pairs (OG/Sukuk)																
OG/BAH	0.37	0	0	0.98	0.96	0	0.23	0.06	0.7	0	-0.01	0.89	0.73	0	0.73	0
OG/HK	0.98	0	0.02	0.78	1	0	0.09	0.53	0.97	0	0	0.93	0.76	0	0.76	0
OG/IND	0.96	0	0	0.98	1	0	0	1	0.86	0	-0.04	0.41	0.43	0	0.43	0
OG/IRL	0.99	0	0	0.97	1	0	-0.02	0.91	0.94	0	0	0.95	0.99	0	0.99	0
OG/KWT	0.95	0	-0.01	0.92	1	0	0	0.97	0.63	0	-0.01	0.88	-1.67	0	-1.67	0
OG/MAL	0.93	0	0.04	0.47	0.96	0	0.39	0	-1.49	0	0	0.96	-6.2	0	-6.2	0
OG/NGR	0.78	0	0.01	0.81	0.99	0	-0.02	0.89	0.63	0	0.06	0.21	0.98	0	0.98	0
OG/OMN	-0.71	0	0	0.99	0.96	0	0.06	0.69	-0.07	0.17	0	0.98	-1.9	0	-1.9	0
OG/PAK	0.95	0	0	0.99	0.94	0	0.01	0.97	0.95	0	-0.01	0.85	0.82	0	0.82	0
OG/QAT	0.98	0	0	0.96	1	0	0.11	0.42	0.98	0	0.01	0.85	0.93	0	0.93	0
OG/SAR	0.97	0	0	0.99	1	0	0.04	0.78	0.98	0	0	0.92	-75.12	0	-75.12	0
OG/SIN	-2.55	0	0	1	1	0	0	1	-0.5	0	-0.01	0.87	-0.11	0.57	-0.11	0.57
OG/TUR	0.89	0	0	0.96	0.93	0	-0.01	0.96	0.84	0	0	1	-0.38	0.08	-0.38	0.08
OG/UAE	0.98	0	0	0.98	1	0	0.02	0.91	0.98	0	0	0.97	0.98	0	0.98	0
OG/UK	0.78	0	0.03	0.61	1	0	0.65	0	0.92	0	0.05	0.3	0.86	0	0.86	0
Pairs (TELE/Sukuk)																
TELE/BAH	-0.3	0	-0.01	0.89	0.5	0	0.29	0.02	-0.14	0.01	0	1	0.22	0.16	0.22	0.16
TELE/HK	0.93	0	0.05	0.41	0.95	0	-0.01	0.96	0.85	0	-0.01	0.85	0.16	0.33	0.16	0.33
TELE/IND	0.88	0	0.02	0.73	0.99	0	0.03	0.85	0.44	0	0	0.98	-3.32	0	-3.32	0
TELE/IRL	0.97	0	0	0.97	1	0	0	1	0.61	0	0	1	0.92	0	0.92	0
TELE/KWT	0.85	0	-0.01	0.94	0.98	0	0	0.98	0.3	0	-0.01	0.8	-23.5	0	-23.5	0
TELE/MAL	0.82	0	0.02	0.71	0.51	0	0.49	0	-3.36	0	-0.01	0.9	-62.2	0	-62.2	0
TELE/NGR	0.76	0	0.01	0.9	0.89	0	0	0.98	0.56	0	0.06	0.19	0.82	0	0.82	0
TELE/OMN	-1.98	0	0	1	0.46	0	0.04	0.77	-1.92	0	0	0.99	-22.12	0	-22.12	0
TELE/PAK	0.87	0	0.02	0.81	0.64	0	0.04	0.78	0.79	0	-0.01	0.92	0.2	0.22	0.2	0.22
TELE/QAT	0.95	0	0.07	0.25	0.94	0	0.09	0.51	0.92	0	0.01	0.81	0.65	0	0.65	0
TELE/SAR	0.9	0	0.01	0.92	0.99	0	0	0.99	0.91	0	0	0.99	-54.74	0	-54.74	0
TELE/SIN	-8.9	0	-0.01	0.93	0.99	0	0	0.99	-6.89	0	-0.01	0.83	-0.11	0.58	-0.11	0.58
TELE/TUR	0.69	0	0.03	0.63	0.42	0	-0.02	0.9	0.42	0	0	0.99	-11.19	0	-11.19	0
TELE/UAE	0.94	0	0	0.96	0.97	0	0	0.98	0.9	0	-0.03	0.55	0.87	0	0.87	0
TELE/UK	0.6	0	0.01	0.85	0.95	0	0	0.97	0.65	0	0.05	0.31	0.41	0	0.41	0
Pairs (UTL/Sukuk)																
UTL/BAH	-0.24	0	0	0.96	0.58	0	0.3	0.01	-0.01	0.87	0	0.99	0.42	0	0.42	0
UTL/HK	0.93	0	0.04	0.57	0.96	0	-0.01	0.97	0.87	0	0	0.98	0.48	0	0.48	0
UTL/IND	0.88	0	0.01	0.82	0.99	0	0.05	0.73	0.49	0	-0.02	0.73	-1.24	0	-1.24	0
UTL/IRL	0.97	0	0	0.95	1	0	0.06	0.66	0.69	0	0	0.99	0.96	0	0.96	0
UTL/KWT	0.86	0	0	0.96	0.99	0	0	0.98	0.09	0.06	-0.02	0.66	-9.45	0	-9.45	0
UTL/MAL	0.84	0	0.01	0.84	0.59	0	0.45	0	-5.46	0	-0.02	0.66	-26.11	0	-26.11	0
UTL/NGR	0.68	0	0	0.99	0.91	0	0.05	0.7	0.34	0	-0.01	0.92	0.93	0	0.93	0

(*Continued*)

Table 14. (Continued).

	PRE COVID-19				During COVID-19				PRE-WAR				During WAR			
	Dynamic Portfolio Weights		*Dynamic hedge ratios*		*Dynamic Portfolio Weights*		*Dynamic hedge ratios*		*Dynamic Portfolio Weights*		*Dynamic hedge ratios*		*Dynamic Portfolio Weights*		*Dynamic hedge ratios*	
	HE	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*	*HE*	*p-value*
UTL/OMN	-1.22	0	0	0.99	0.58	0	0.04	0.8	-1.45	0	0	0.96	-9.09	0	-9.09	0
UTL/PAK	0.87	0	0.02	0.79	0.66	0	0	1	0.8	0	-0.01	0.8	0.55	0	0.55	0
UTL/QAT	0.95	0	0.07	0.24	0.96	0	0.2	0.12	0.92	0	0.04	0.4	0.82	0	0.82	0
UTL/SAR	0.91	0	0.01	0.86	0.99	0	0	0.97	0.92	0	0	0.93	-84.64	0	-84.64	0
UTL/SIN	-8.53	0	0	1	1	0	0	1	-5.55	0	-0.01	0.92	-0.1	0.6	-0.1	0.6
UTL/TUR	0.72	0	0.01	0.82	0.55	0	0	0.97	0.45	0	0	0.97	-4.19	0	-4.19	0
UTL/UAE	0.94	0	0.01	0.92	0.98	0	0.02	0.86	0.91	0	0	0.97	0.95	0	0.95	0
UTL/UK	0.51	0	0	0.99	0.97	0	0.11	0.41	0.7	0	-0.01	0.88	0.6	0	0.6	0

This table illustrate the hedging effectiveness, among Sukuk and Islamic sectoral markets in pre and during COVID-19 and War.

sub-samples: pre-COVID, COVID, pre- Russia-Ukraine war, and Russia-Ukraine war.

Table 12 shows mean values and other statistics of dynamic hedge ratios. The mean value of BM/BAH is 0.33 in pre-COVID sample, which implies that $ 1 long position of Basic material (BM) in the portfolio can be shorted by about 0.33 in the BAH Sukuk index. On the other hand, during the pandemic of COVID-19, the same value has increased to 2.24 indicating that an 189% increase of BAH is required to hedge a $1 long position in BM during the COVID-19 crisis. In pre-COVID period, for the BM/HK, BM/LWT, BM/OMN BM/SAR, and BM/SIN hedges, the average value of the hedge ratios are negative. This is because the pairs are negatively correlated, and the hedge is formed by taking the same position (either short or long) on both assets. During COVID-19, the mean of the hedge ratios such as BM/HK, BM/IRL, BM/PAK, BM/SAR, BM/TUR, BM/UAE, and BM/UK decreases while the mean of the other hedge ratios increases. During Russian-Ukraine war mean of hedge ratios decrease for most pairs except BM/KWT, BM/MAL, BM/NGR, BM/OMN, and BM/UAE. Usually the volatility of hedge ratios is higher During COVID-19 and Russia-Ukraine war. Interestingly, Q (5%) indicates that in case of economic turmoil most of the bivariate portfolios will turn to be ineffective as values are negative. The scenario is opposite in the times of economic prosperity Q (95%), when all the values are positive except for BM/SIN. This finding has significant implications for the investors in the Islamic markets. It shows the potential for diversification of portfolio consisting of Islamic sectoral stocks and Sukuks for the investors in the Islamic markets.

Table 13 shows the dynamic portfolio weights for the four sub-samples. For example, the average weight for BM/BAH pair is 0.11, which implies that for every $1 investment in the portfolio combination, 11% should be invested in the BM and remaining 89% in BAH. The values of the weights vary between 0.00 (BM/IRL) to 0.58 (UTL/OMN). During COVID-19, the mean values declined implying lower shares by sectoral stocks. However, during the Russia-Ukraine war, the mean values increased significantly implying greater weights of sectoral stocks in the portfolio. Next, standard deviation show the variability in the

portfolio weights overtime. For example, the standard deviation of dynamic weights for BM/BAH pair is 20%, implying 20% variability around the mean value. Usually the variability increases during COVID-19 and Russia-Ukraine war. The table also reports the weights for the pairs at 5% quantile (bearish) and 95% quantile (bullish) of the distributions.

The results of the Hedging Effectiveness (HE) are presented in Table 14. Usually, positive HE values closer to 1 indicate safer portfolios with less risk. Table 14 shows that for most of the cases the HE values for the pairs with optimal portfolio weights are positive and close to 1, indicating significant risk reduction if investors invest in these bivariate portfolios. However, BM/OMN (−0.62), are BM/SIN (−4.32) pairs have negative HE values meaning these are risky portfolios and risk cannot be minimized by investing in these portfolios in the proportion suggested by optimal portfolio allocation in Table 13. During COVID-19, the results are qualitatively same with a few exceptions. However, during the Russia-Ukraine war some of the values are big negative, indicating high risk associated with those pairs during the crisis of Russia-Ukraine war. Table 14 also reports HE values for optimal dynamic hedge ratios of the pairs. However, in terms of risk minimization these are not much effective as evident by low HE values. Our Findings for the Islamic sectoral markets and Sukuk markets, harmonies with the outcomes of previous research which demonstrate that portfolios consisting of Islamic stocks and Sukuks offer diversity (Balcilar, Gabauer, and Umar 2021, Billah et al., 2024; Billah et al., 2023; Hasan et al., 2022).

Conclusion

As Islamic markets are emerging as large markets with huge investments and underlying assets, various aspects of these markets are under active investigation. One such area is its role in financial stability (Aysan and Ozturk 2018; Pirgaip, Arslan-Ayaydin, and Karan 2021; Rabbani et al. 2023). We contribute to this line of research by investigating the tail risk spillovers between Islamic sectoral equity markets and country-specific Sukuks in both short (high) and long (low) term (frequency). To shed more light on risk management and portfolio diversification, we also calculate optimal hedge ratios, portfolio weights and hedging effectiveness. In addition to the full sample, two sub-samples representing COVID-19 and Russia-Ukraine war are also utilized for investigation.

The study found that the connectedness and spillover effects are much stronger in the tails than in the median, with the industrial sector of Islamic stock markets being a consistent transmitter of risk shocks. Moreover, Islamic stock markets play a vital role in transmitting negative shocks to Sukuk markets, while the latter are generally net receivers of such shocks. The short-term connectedness and spillovers were found to be stronger than the long-term ones. The COVID-19 pandemic and the Russia-Ukraine war also caused stronger and more extensive connectedness and spillover effects, with some changes in the roles of net transmitters and receivers.

The portfolio analyses also provide useful insights. Usually, the long positions in sectoral stock indices can be hedged by taking short positions in Sukuks, with a few exceptions where there is negative correlations between the two assets. During Russia-Ukraine war, the values of the hedge ratios falls, meaning a 1-dollar long position in sectoral stocks can be hedged with less amount of Sukuks. The optimal portfolio weight shows that the share of stocks in the portfolio decreases during COVID-19 but increases during the Russia-Ukraine war. The calculation of hedging effectiveness shows that for most of the cases the hedging effectiveness values for the pairs with optimal portfolio weights are positive and close to 1, indicating significant risk reduction if investors invest in these bivariate portfolios.

The findings of the study provide a better understanding of the co-movement between the shariah-compliant financial assets and help global investors invest in these assets for portfolio diversification benefits. It also provides information on Islamic financial market integration for the market participants interested in such markets. Such information on connectedness and spillover should also help policy makers who would like to facilitate and regulate the development of Islamic markets. The findings could also help policy makers in formulating and evaluating plans during extreme market

conditions by providing them with information on tail-connectedness.

Future research could further expand the sample of countries. A comparison of the connectedness of Islamic stock and Sukuk markets between developed and emerging economies would also be interesting. Future studies can also investigate the factors that contribute to the connectedness of Islamic stock and Sukuk markets.

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