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ASYMMETRIC SPILLOVERS AND VOLATILITY CONNECTEDNESS IN GLOBAL SUKUK MARKETS: A NETWORK-BASED ANALYSIS OF SYSTEMIC RISK AND INTEGRATION

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Abstract

The article examines the dynamic and asymmetric relationships of global sukuk markets using a network-based perspective, drawing on Diebold and Yilmaz's (2014) framework. The study utilises daily return and volatility data from 21 sukuk-issuing countries from 2016 to 2021 to decompose return spillovers into positive and negative components, describing investor asymmetries and behavioural changes in response to market shocks. The results show that negative returns spillovers are significantly more intense than positive ones, indicating that systemic risk is greater when markets are at their lowest. It is also found that volatility connectedness is high, especially during times of crisis, such as the COVID-19 pandemic, which heightened inter-market relationships. The regression analysis determines that global financial stress, commodity prices, uncertainty about economic policies, and investor sentiment are the determinants of sukuk market integration. The findings suggest that the sukuk market is becoming increasingly interdependent, and asymmetric spillovers play a significant role in determining systemic risk. This body of knowledge carries significant implications for investors, regulators, and policymakers seeking to enhance financial stability and risk management in Islamic finance.

Keywords: *Asymmetric spillovers, Volatility, Sukuk, Systematic Risk*

1. Introduction

The Sukuk market, a cornerstone of Islamic finance, has experienced significant growth over the past few years, offering investors a Shariah-compliant alternative to traditional fixed-income instruments. The instruments of Sukuk are designed to produce returns without contradicting the Islamic prohibitions against interest (riba), uncertainty (gharar), and speculation (maysir). They are especially popular in areas where Islamic financial markets are well-developed and among ethical investors worldwide. Nonetheless, the systemic nature and interconnectedness of sukuk markets have not been thoroughly researched, particularly in terms of how shocks are transmitted across borders and the asymmetrical responses of market participants to various types of information. The following paper aims to address this gap by identifying the structure of interconnectedness in the sukuk market in terms of returns spillovers and volatility transmission, with a focus on asymmetric effects, i.e., the same sukuk market's response to positive and negative returns shocks.

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This study is based on multiple branches of economic theory. To begin with, the financial contagion theory states that a shock in any market can be transmitted to other markets through various channels, such as investor behaviour, macroeconomic linkages, and institutional interdependencies. This is particularly applicable in the sukuk market, where issuers and investors are located across various regions, differing in terms of market development and regulation. Second, the interdependence theory posits that financial markets do not exist in isolation but are components of a complex global network, where co-movements and spillovers are triggered by collective exposure to global risk factors, such as commodity prices, monetary policy, and geopolitical events. Third, the asymmetric information theory explains the different market reactions to good and bad news. Loss aversion, amplification of uncertainty, and behavioural biases tend to affect investors more negatively, which causes disproportionate Volatility and systemic risk when the market is in a recession.

The approach employed in this paper, derived from the connectedness framework of Diebold and Yilmaz (2014), provides a robust and interpretable method for quantifying spillovers in terms of generalized forecast error variance decomposition (GFEVD) within a vector autoregressive (VAR) model. Although other models might have also been used to reduce interdependencies (e.g., DCC-GARCH, dependence structure defined using copulas, or wavelet coherence), the Diebold-Yilmaz model is best suited for dynamic analysis and high-dimensional data. It enables building directional spillover indices and network graphics that show the topology of market relations. This is offset by the fact that the Gephi software is used to analyze the network structure, making the results more interpretable to academic and policy readers.

One of the main innovations of the current study is to decompose return spillovers into negative and positive components, as the reactions of investors are asymmetric. The rationale for this deconstruction relies on behavioural finance and evidence from traditional markets. Investors are generally more likely to exhibit loss aversion, where they respond even more strongly to adverse news than to favourable news. The net effect of this is asymmetric Volatility in that bad news produces bigger and more sustained market movements. Such asymmetries can be even more pronounced in the framework of the sukuk market, which is also a relatively new market, with retail or less sophisticated investors often predominating. Furthermore, during times of crisis or increased uncertainty, such as the COVID-19 pandemic, negative spillovers are likely to become more severe, exposing vulnerabilities in the market structure and investor sentiment.

Volatility connectedness is also examined in the paper, where range-based measures are used to assess the transmission of uncertainty across markets. Systemic risk is a significant indicator of Volatility, and the spill-over effects of Volatility can disclose the hidden linkages and channels of contagion, which cannot be reflected in the returning data on its own. The paper further analyses the factors of sukuk market integration through regression models that incorporate the world financial stress indices, commodity prices, policy uncertainty in an economy, and investor sentiment proxies, including the Google search Index. This makes it

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possible to gain a subtle insight into the macro-financial forces that promote market interdependence and systemic behaviour.

In short, the paper provides an analytical study of the sukuk market connectedness in a comprehensive and theoretically sound manner. It contributes to the literature by proposing an asymmetric spillover decomposition, utilizing dynamic network analysis on a large cross-section of sukuk markets, including the transmission of Volatility and the determinants of integration, both macroeconomic and behavioural. These contributions will be beneficial to investors, regulators, and policymakers who want to understand the systemic nature of Islamic financial markets and how to develop risk management, market development, and financial stability strategies.

2. Literature review

2.1 Theoretical Background

When studying spillovers, volatility transmission, and asymmetric market behaviour in sukuk markets, it is necessary to build on a set of related theoretical models. The combination of these theories describes why financial shocks cross borders, why markets differ in their reaction to positive and negative information, and why systemic risk is a phenomenon found in globally integrated markets.

The first theory that can be used to analyse cross-market spillovers is the financial contagion theory. In this theory, it is assumed that shocks generated in one market can be transmitted to another via investor behaviour, liquidity constraints, macroeconomic linkages, and common exposure to global risks, among others. The contagion theory would apply to sukuk markets, which span several jurisdictions with different levels of financial development, and would explain how turmoil in one jurisdiction could lead to instability in another. Since sukuk are frequently concentrated in the hands of internationally diversified investors, rapid changes in global risk sensitivity or stress levels may lead to correlated responses and market-wide shock propagation.

To supplement this, there is the theory of financial market interdependence, which holds that modern markets do not exist in isolation as independent units but are part of a globally integrated financial system. The interdependence is based on trade connections, shared macro-financial factors, the international monetary environment, and coordinated investor attitudes. In the case of sukuk markets, increased interdependence with global capital markets implies spillovers expressed through structural linkages and time-varying co-movements. This theory provides a rationale for why sukuk markets can be modelled as a network composed of interconnected nodes in which shocks propagate in various directions, which is in line with connectedness networks like those of Diebold and Yilmaz (2014).

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Asymmetric information and behavioural finance theory are the third theoretical pillars, leading to the empirical finding that markets respond more strongly to negative shocks than to positive ones. Asymmetric information, where there is more bad news than good news, creates greater uncertainty than the other way round. The behavioural theories, specifically prospect theory and loss aversion, propose that investors value losses more than equivalent gains. As a result, negative returns are more likely to create greater volatility, more significant spillovers, and higher systemic fragility. Such asymmetric reactions tend to be stronger in less developed, less sophisticated markets, such as sukuk, where retail investors usually dominate.

Finally, the volatility transmission theory associate's uncertainty, market stress, and systemic risk. Volatility is sometimes viewed as a measure of market uncertainty, and volatility spillovers between markets indicate how much risk is shared or transmitted between financial systems. These dynamics can be captured effectively by range-based volatility measures, such as the Garman-Klass estimator used in this study. Volatility spillovers are more pronounced during periods of increased stress, i.e., during the COVID-19 pandemic, confirming the theoretical assumption that systemic risk is higher when the system is in crisis.

Collectively, the theories support the analysis of the present study, which focuses on return spillovers, volatility connectedness, and asymmetry across sukuk markets. They also endorse the methodological decision to adopt a network-based connectedness structure, which is in line with the conceptualisation of markets as interdependent systems in which contagion, behavioural asymmetry, and time-varying systemic risk exist.

2.2 Sukuk Market Literature

Sukuk market literature has grown in tandem with the rapid expansion of Islamic finance, but it remains relatively young compared to the extensive literature on traditional financial products. Being asset-backed securities designed in compliance with Islamic principles, Sukuk have drawn interest in terms of their ability to diversify portfolios, improve financial inclusion, and provide a buffer during periods of market stress. The initial works focused on sukuk issuance topics, primarily at the legal and structural levels. However, the recent ones have focused their attention on the financial behaviour of sukuks, their incorporation into the world market, and their vulnerability to systemic risk.

A part of the strands that form the basis of sukuk market research relates to their co-movement with the conventional bonds and Islamic equities. Hassan et al. (2018) investigated the factors influencing the co-movement of sukuk and conventional bonds, and this study found that market maturity, liquidity, and rating quality are key determinants of co-movement. On the same note, Muharam et al. (2019) examined the connection between the advancement of the sukuk market and the macroeconomic indices, including trade transparency and economic development, especially in the economies of Southeast Asia. Such studies highlight the increasing topicality of the sukuk market in global finance, yet they tend to prefer simple correlation metrics, which do not reflect the dynamic and directional essence of market interrelationships.

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The financial market connectedness literature, in general, provides a substantive theoretical and methodological foundation for the study of spillovers and systemic risk. Diebold and Yilmaz (2014, 2016) proposed a connectedness framework based on generalised forecast error variance decomposition (GFEVD), which enables the quantification of directional spillovers between financial assets. This has been extensively applied to equity markets, commodities, and cryptocurrencies, and it has been found that financial systems exhibit time-varying asymmetric spillovers, particularly during periods of increased uncertainty. This framework was further developed by Ji et al. (2018) using network causality structures. Barunik et al. (2016) and Ben Saida (2019) highlighted the significance of separating good and bad volatility, such as asymmetric connectedness.

The use of these sophisticated econometric methods in Islamic finance is not widespread but is on the rise. The study by Bahloul and Khemakhem (2021) examined the dynamic return and volatility connectivity of commodities and Islamic stock indices, and the authors found that spillovers and asymmetries had a significant impact. Tuna (2019) examined the relationship between Islamic stock markets and precious metals, where the price of the commodity is a key factor in determining the behaviour of investors and the market. These researchers have demonstrated that Islamic financial instruments are vulnerable to global shocks, and their integration into conventional markets is a complex and dynamic process.

Asymmetric spillovers are also a concept that is most applicable in sukuk markets. Prospect theory and loss aversion motivation theories are behavioural financial theories that imply that investors are more sensitive to bad news than to good news. This gives rise to disproportionate volatility and systemic risk when the market is down. This intuition has been confirmed by empirical studies in traditional markets, which have revealed that adverse shocks produce larger and longer-lasting spillovers. Asymmetric connectedness was reported in equity and energy markets by Barunik et al. (2016) and Apergis et al. (2017). In contrast, Ftiti and Hadhri (2019) found that economic policy uncertainty and investor sentiment affect Islamic stock returns asymmetrically. Nonetheless, this aspect has not been researched in detail in the sukuk market; yet, the market has specific investor characteristics and a structure that can mitigate such asymmetries.

Another important dimension of systemic risk that is gaining increasing attention is volatility connectedness. Garman and Klass (1980) developed range-based volatility statistics that provide more efficient estimates than conventional close-to-close statistics. Diebold and Yilmaz (2016) applied their connectedness framework to volatility spillovers and found that volatility transmission frequently predicts the appearance of return spillovers and can be an early indicator of market stress. Research has demonstrated that the sukuk market in Islamic finance is vulnerable to the global uncertainty factors (Naifar et al., 2017; Balli et al., 2020). The results indicate that volatility connectedness is a crucial element in the emergence of sukuk markets, particularly during times of crisis.

The financial market connectedness has been further emphasised by the COVID-19 pandemic, which warrants further analysis. Adekoya and Oliyide (2020) and Bissoondoyal-

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Bheenick et al. (2020) reported increased volatility transmission and heightened spillovers across asset classes during the pandemic, attributed to the effects of investor panic, policy actions, and macroeconomic disruptions. A study by Yarovaya et al. (2021) investigated the characteristics of Islamic financial instruments during the crisis period, revealing that the sukuk markets exhibited greater interdependence and systemic risk. These studies are consistent with the broader literature on crisis contagion and the need for dynamic and asymmetric analysis of market behaviour.

The existing knowledge on financial market connectedness is broad, although its application to sukuk markets is still scarce and scattered. This paper builds upon the existing literature by extending a strong and explicable connectedness model to a comprehensive set of sukuk indexes across 21 countries. It presents asymmetric spillover decomposition, the transmission of volatility, and macro-financial determinants of integration, making a timely and substantive contribution to Islamic finance research. The study situates sukuk markets within the context of global financial interdependence and systemic risks, making it a valuable resource for investors, regulators, and policymakers seeking to enhance market resiliency and stability.

3. Methodology

3.1 Data Source and Data Collection

Obtained from Bloomberg Professional Service, the dataset used in this research comprises daily returns from 21 countries sukuk indices of 6 GCC countries, viz., Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates; Turkey from Western Asia; Brunei, Hong Kong, Indonesia, Malaysia, and Singapore from Southeast Asia; Bangladesh, Pakistan from South Asia; Egypt, Gambia and Nigeria from Africa; Cayman Islands, Ireland, Jersey and the United Kingdom from Europe; for the period 1 January 2016 to 15 February 2021. The rationale for choosing this period was to examine the influence of global shocks on sukuk market integration. The use of a broad sample of countries also enabled the researchers to examine intra- and inter-regional spillover effects. Data only for the liquid sukuk, which has regular daily data, were used, the reason being that these are fully negotiable and, moreover, that it is possible to trade then in the secondary markets. Data availability is a key consideration that informed country selection. Hence, the researchers established country sukuk indices for such instruments, adopting the Bloomberg methodology used by Hassan et al. (2018) and criteria for minimising selection bias. The criteria needed by Bloomberg indices informed the choice of sukuk instruments: firstly, maturity of a minimum of 12 months; secondly, outstanding amount surpassing USD 200 million; and thirdly, a minimum of one rating availability from S&P, RAM, MARC, or Moody's.

For the purpose of limiting currency effects, the decision was made to focus exclusively on USD-denominated sukuk, which represents a majority within this market. From those countries, 161 sukuks and the number of sukuks in each country were evaluation, which contributed to the compilation of the sukuk given in Table 1. To investigate the determinants

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of spillovers, referring to the existing literature, global financial factors (Ji et al., 2018; Bouri et al., 2017a, b & c; Bahloul & Khemakhem, 2021), US uncertainties (Wahyudi & Sani, 2014; Bouri et al., 2017a & b; Balli et al., 2020; Ftiti & Hadhri, 2019) and major commodity markets (Tuna, 2019; Chang et al., 2020; Godil et al., 2020) are chosen in this study.

Table 1. Composition of the Sukuk Index

	Country	Sukuk
GCC Countries	Bahrain	4
	Kuwait	5
	Oman	4
	Qatar	7
	Saudi Arabia	5
	United Arab Emirates (UAE)	16
Asian Countries	Bangladesh	1
	Brunei	2
	Hong Kong	1
	Indonesia	35
	Malaysia	47
	Pakistan	5
	Singapore	5
African countries	Egypt	2
	Gambia	1
	Nigeria	3
European Countries	Cayman Islands	2
	Ireland	2
	Jersey	1
	Turkey	10
	United Kingdom (UK)	3

Note: We used the weekly return of Sukuk data available on the Bloomberg database, for the period from 01 January 2016 to 15 February 2021. To construct country sukuk indices we use the same methodology of Bloomberg Index.

3.1.1 Connectedness Framework

The methodological framework of this study for constructing connectedness measures follows the lines of Diebold and Yilmaz (2014). Specifically, positive/negative return and volatility connectedness networks are built. Furthermore, regression models are used to identify the drivers of the degree of integration of the various sukuk markets. First of all, we measure pairwise return spillovers using Diebold and Yilmaz's (2014) spillover index.[1] In turn, we use Gephi open-source software to show the pairwise spillover directions in a network diagram.

[1] The main advantage of this approach is its capacity to quantify the sizes and impacts of spillovers with certainty.

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The spillover index is underpinned by a forecast error variance decomposition (FEVD) applied to the generalized vector autoregression model developed by Koop et al. (1996) and Pesaran and Shin (1998).

It is possible to impute the size of the forecast error variance of one sukuk market x_i $(i = 1, 2, \dots, N)$ to the shock in another sukuk market x_j $(j = 1, 2, \dots, N), i \neq j$. In accordance with this, the H-step-ahead FEVD can be expressed as: $\theta_{ij}^{g}(\mathrm{H}) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' A_h \Sigma e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' A_h \Sigma A_h' e_i\right)}$, where Σ is the variance matrix of the error vector ε_t, σ_{jj} is the standard deviation of the error for the j_{th} term, e_i is the opted vector (1 to the i_{th} element, 0 otherwise), and A_h is the moving average coefficient as of the forecast at time t. It is possible to normalize the unit of the decomposition matrix (Baruník et al. 2016) by the row sum as: $\tilde{\theta}_{ij}^{g}(H) = \frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{N} \theta_{ij}^{g}(H)}$, by construction, $\sum_{j=1}^{N} \tilde{\theta}_{ij}^{g}(H) = 1$ and $\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{g}(H) = N$. In this way, the total spillover index, which shows the average contribution of spillovers from shocks across 21 sukuk markets, can be expressed as follows:

$$S^{g}(H) = \frac{\sum_{i,j=1, i \neq j}^{N} \tilde{\theta}_{ij}^{g}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{g}(H)} \times 100 = \left(\frac{\sum_{i,j=1, i \neq j}^{N} \tilde{\theta}_{ij}^{g}(H)}{\mathrm{N}} \right) \times 100 \quad (1)$$

So, the direction of return spillover that is given by market i to all other markets j as:

$$S_{i\cdot}^{g}(H) = \frac{\sum_{j=1, j \neq i}^{N} \tilde{\theta}_{ij}^{g}(H)}{\sum_{j=1}^{N} \tilde{\theta}_{ij}^{g}(H)} \times 100 = \left(\frac{\sum_{j=1, j \neq i}^{N} \tilde{\theta}_{ij}^{g}(H)}{\mathrm{N}} \right) \times 100 \quad (2)$$

The direction of return spillover that is taken by market i from all other markets j as:

$$S_{\cdot i}^{g}(H) = \frac{\sum_{j=1, j \neq i}^{N} \tilde{\theta}_{ji}^{g}(H)}{\sum_{j=1}^{N} \tilde{\theta}_{ji}^{g}(H)} \times 100 = \left(\frac{\sum_{j=1, j \neq i}^{N} \tilde{\theta}_{ji}^{g}(H)}{\mathrm{N}} \right) \times 100 \quad (3)$$

Subsequently, the exact variation from eq. 2 and eq. 3 is the net spillover specified as:

$$S_{i}^{g}(H) = S_{\cdot i}^{g}(H) - S_{i\cdot}^{g}(H) \quad (4)$$

3.3 Various connectedness network measures

In addition to returns connectedness, we investigate asymmetry in the connectedness of sukuk markets. In the broad empirical findings, asset markets usually present asymmetry effects in response to good news and bad news (e.g., Apergis et al., 2017; Barunik et al., 2016). However, there is thus far no clear evidence in the sukuk market to confirm this rule. In addition, sukuk is a newly developed in Islamic financial product, made possible by the improvement of blockchain technology. The future of the sukuk market is uncertain due to its applications, policy regulations and whether traders in the sukuk market are sensitive to volatility. Therefore, it is useful to analyse the asymmetric return spillovers among sukuk markets in order to well

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understand the systemic risk of this system. For simplicity, we build positive- and negative-returns connectedness networks, respectively. The positive and negative returns series are measured as follows:

$$R(+) = \begin{cases} R_t, & if\ R_t > 0 \\ 0, & otherwise \end{cases} \quad (3)$$

$$R(-) = \begin{cases} R_t, & if\ R_t < 0 \\ 0, & otherwise \end{cases} \quad (4)$$

$$R_t = R(+) + R(-) \quad (5)$$

We also consider volatility connectedness. Referring to Diebold and Yilmaz (2016) and Garman and Klass (1980), we use daily range-based volatility to estimate volatility connectedness. The detailed estimation equation is as follows:

$$V = 0.511(h-l)^2 - 0.019[(c-o)(h+l-2o) - 2(h-o)(l-o)] - 0.383(c-o)^2, \quad (6)$$

where h, l are the log daily high price and low price and o, c are the log opening price and close price, respectively.

3.4 Determinant modelling for total connectedness index

We build regression models to identify the determinants that can influence the integration degree of the sukuk market system. Referring to the existing literature, global financial factors (Ji et al., 2018c; Bouri et al., 2017a, b & c; Bahloul & Khemakhem, 2021), US uncertainties (Wahyudi & Sani, 2014; Bouri et al., 2017a & b; Balli et al., 2020; Ftiti & Hadhri, 2019) and major commodity markets (Tuna, 2019; Chang et al., 2020; Godil et al., 2020) are chosen in the following regression:

$$S^g(H)_{t,l} = \alpha + \sum_{i=1}^{p} \beta_i GFF_i + \sum_{j=1}^{q} \delta_j GCM_j + \sum_{h=1}^{m} \phi_h UF_h + \varepsilon_t, \quad (7)$$

where $S^g(H)_{t,l}$ denotes the dynamic total connectedness of the sukuk market system for returns, positive returns, negative returns and volatility. GFF_i denotes global financial factors represented by the Global Financial Stress Index (GFSI) and MSCI World stock index. GCM_j indicates global commodity market factors that are represented by the GSCI Energy index, Gold Bullion index and Oil price. UF_h denotes the influence of uncertainty factors as represented by US economic policy uncertainty (EPU), US VIX and Google search index (GSI).

4. Empirical Analysis

Having used the previous sections to detail this study's methods and database, this section's focal point is the study's results. For the countries in the dataset, Table 2 shows the descriptive statistics for the extracted sukuk indices. The daily values were close to zero for every series, and standard deviations exceeded the average values by several orders of magnitude (Table 1). In Egypt, Kuwait, Qatar, Singapore and Turkey, mean and standard deviation were inconsistent, especially in view of the fact that they were linked to the lowest return and the highest risk. Negative skewness was identified in all sukuk issuing countries except for Bahrain, Cayman Islands, Nigeria, and Saudi Arabia, indicating that the length of the

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distribution's left tail exceeded the right tail. In addition, the Jarque-Bera (JB) test consistently rejected the normality of the unconditional distribution. For every index, the kurtosis statistic was greater than 3, indicating that the tails of those countries were thicker and longer. In many cases, the central peak's sharpness and height is greater. In addition, the augmented Dickey-Fuller (ADF) test demonstrated the stability of every sequence and also showed that each one satisfied modelling conditions. The DY approach helps us to capture the development of the spillover index over time. Therefore, we start with network analysis of sukuk market connectedness via return spillovers and volatilities, and we consider asymmetric effects (i.e., positive and negative return spillovers) separately. As observed in Figures 1-5, the empirical results for returns and volatilities showed strong/weak interdependence among 21 sukuk markets. It implies that these sukuk markets impact on each other (magnitudes) is different. Therefore, we turn our attention to simple regression analysis to check the effect of risk-related variables on spillovers.

Table 2: Descriptive statistics and unit-root test

	Mean	Max	Min	SD	Skew	Kurt	JB	ADF
BAHRAIN	0.045	0.214	-0.082	0.009	14.418	328.061	5968223.000***	-34.58***
BANGLADESH	0.006	0.009	-0.034	0.002	-5.489	93.915	469967.900***	-13.61***
BRUNEI	0.000	0.081	-0.096	0.006	-1.981	115.019	704108.400***	-14.28***
CAYMAN ISLANDS	0.000	0.012	-0.011	0.002	0.450	12.815	5444.143***	-29.98***
EGYPT	-0.004	0.090	-0.124	0.008	-1.809	67.232	231945.200***	-41.17***
GAMBIA	0.001	0.015	-0.063	0.003	-6.544	130.336	918284.300***	-44.17***
HONG KONG	0.002	0.026	-0.174	0.005	-25.546	841.781	39574569.000***	-37.56***
INDONESIA	0.001	0.009	-0.042	0.002	-6.510	132.335	946945.700***	-37.67***
IRELAND	0.014	0.008	-0.033	0.001	-23.163	685.236	26204609.000***	-13.61***
JERSEY	0.010	0.496	-0.888	0.066	-3.236	54.360	150178.700***	-18.37***
KUWAIT	-0.001	0.026	-0.042	0.003	-3.727	91.461	441655.800***	-34.16***
MALAYSIA	0.001	0.051	-0.037	0.004	-0.736	46.207	104742.500***	-15.71***
NIGERIA	0.080	0.950	-0.030	0.026	36.261	1325.084	98250322.000***	-37.29***
OMAN	0.018	0.400	-0.503	0.021	-3.153	369.540	7531516.000***	-36.42***
PAKISTAN	0.000	0.030	-0.065	0.004	-4.861	83.762	370824.400***	-12.31***
QATAR	-0.003	0.009	-0.040	0.002	-6.817	135.242	990465.400***	-23.50***
SAUDI ARABIA	0.002	0.026	-0.021	0.002	1.329	44.703	97859.870***	-38.28***
SINGAPORE	-0.050	0.398	-0.425	0.021	-2.813	233.461	2978281.000***	-36.51***

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TURKEY	-0.001	0.070	-0.097	0.006	-1.813	96.624	491964.200***	-36.53***
UAE	0.003	0.021	-0.054	0.002	-12.234	310.720	5340219.000***	-37.07***
UK	0.017	0.129	-0.147	0.006	-4.983	590.081	19321103.000***	-23.50***

Note: This table provides the descriptive statistics for the sukuk of the sample countries under study. Max, Min, SD, Skew, Kurt, JB, and ADF represents Abbreviation, Maximum, Minimum, Standard Deviation, Skewness, Kurtosis, Jarque-Bera, and Augmented Dicky-Fuller test, respectively. *** Indicates significance at 1%.

4.1 Static connectedness-network analysis

We find that the total spillover index is roughly 40%, which implies a medium level of unexplained variation in the returns across the 21 sukuk markets in our sample. Noticeable and significant directional spillovers are present in the spillover network, as shown in Figure 1. We notice most of the European sukuk markets are deeply connected, indicating a high integration level. This is in line with the conventional bond markets phenomenon (Kim et al., 2006). In contrast, the Asian and GCC sukuk markets exhibit weak connectedness, with some exceptions (i.e., Bangladesh, Brunei, Hong Kong, Qatar and UAE). Most African and European sukuk markets are net transmitters in net terms, whereas the Asian and GCC markets are net recipients of return spillover shocks. In particular, Gambia, Jersey, the UK and Nigeria are the largest net transmitters, and Bahrain, Hong Kong, Pakistan, and Saudi Arabia are the largest net recipients of return shocks. We fail to find significant return spillovers from the Malaysia sukuk market to the sukuk markets of non-Islamic nations except for Jersey. Additionally, Bahrain, Cayman Islands, Egypt, Hong Kong, Ireland, Kuwait, Oman, Pakistan, Saudi Arabia, Singapore and Turkey are the highest to lowest net recipients. Interestingly, these sukuk markets have the smallest spillover impacts and are nearly isolated from the other sukuk markets, suggesting potential diversification benefits. The previous analysis considered the return spillovers among sukuk markets. However, it is possible that positive returns and negative returns are perceived differently by market participants and that spillovers may exhibit asymmetries. We decompose returns into positive and negative returns to address this potential asymmetry and present the resulting spillovers network in Figure 2 (a).

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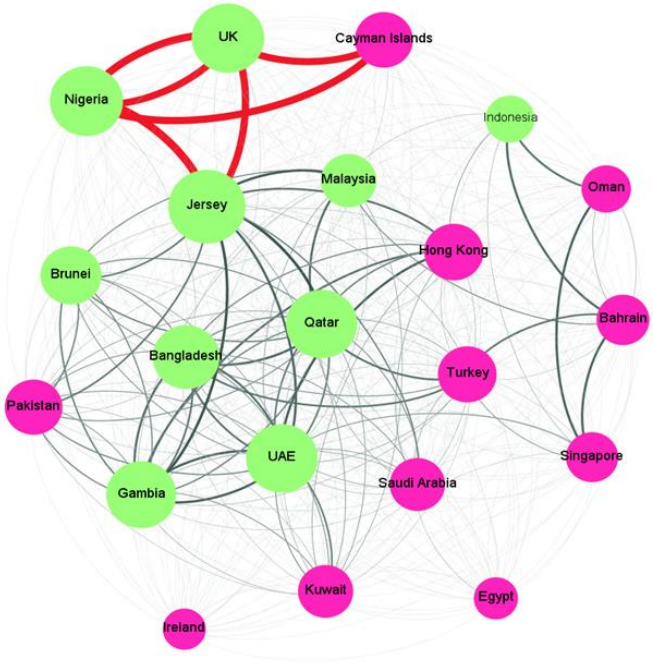

Fig. 1: Network diagram of connectedness table using DY (2014). Lags 2 based on AIC. Forecast horizon of 100 days.

Moving to the connectedness structure between positive returns, a weaker spillovers network emerges between positive returns (Figure 2a). European sukuk markets are highly integrated at the network, and the Cayman Islands surprisingly exhibits a more important spillover role than any other sukuk markets. Additionally, most Asian sukuk markets are the largest transmitters of spillovers except for Hong Kong, Indonesia and Pakistan, whereas African and GCC sukuk markets are the largest receivers. Interestingly, Asian and African sukuk markets are the least connected to the other markets, especially with the lack of direct connectedness between Asian and GCC and European markets, suggesting diversification and hedging possibilities.

The network diagram of pairwise spillovers using negative returns of sukuk markets is shown in Figure 2 (b). Hong Kong, Qatar, Nigeria, Jersey, UAE and the UK are the most significant transmitters of adverse shocks, whereas Brunei, Kuwait, Saudi Arabia and Turkey the greatest receivers of negative shocks. The pair African/European sukuk markets have the strongest connectedness, followed by African/Asian. The lowest connectedness is reported for the pairs European/GCC and African/GCC sukuk markets. Although Malaysia is first in market value, it has almost no influence on other, smaller sukuk markets (European and African markets). In contrast, smaller sukuk markets (African and European) transmit negative shocks to larger sukuk markets (Asian and GCC countries). Notably, the total spillover index of negative returns is almost 2.3 times stronger than that of positive returns, highlighting an intensified connectedness during the downturn state of sukuk markets.

To summarize, the overall spillovers, including spillovers' strength, among negative returns, are more substantial than across positive ones, suggesting that return spillovers due to negative shocks materialize more frequently. Therefore, in terms of return spillovers, sukuk

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investors are not attuned to positive signals only. The structure of volatility connectedness is shown in Figure 3. Contrary to its position in return spillovers, Bangladesh, Gambia, Hong Kong, Qatar, Turkey, and UAE are the most influential sukuk markets and transmit volatility spillovers to each of the 14 sukuk markets. Also important is Gambia, Qatar, and UAE's role as a large volatility transmitter, especially to Asian and European sukuk markets. Most of the twenty-one sukuk markets are interconnected, with substantial differences in the volatility spillovers' degree and magnitude. Jersey is the largest receiver of volatility spillovers, followed by, Brunei, Nigeria and the UK. Cayman Islands, Ireland, Egypt, Oman and Malaysia are the least influential in the network of connectedness, offering potential diversification benefits if combined in a portfolio with each other Sukuk markets. The total volatility spillover across the six sukuk is 60%. That is quite dissimilar to that of returns in Figure 1. Intuitively, the spillover index indicates a sizable degree of connectedness among the sukuk markets in the period under study, during which all of them experienced substantial price volatility.

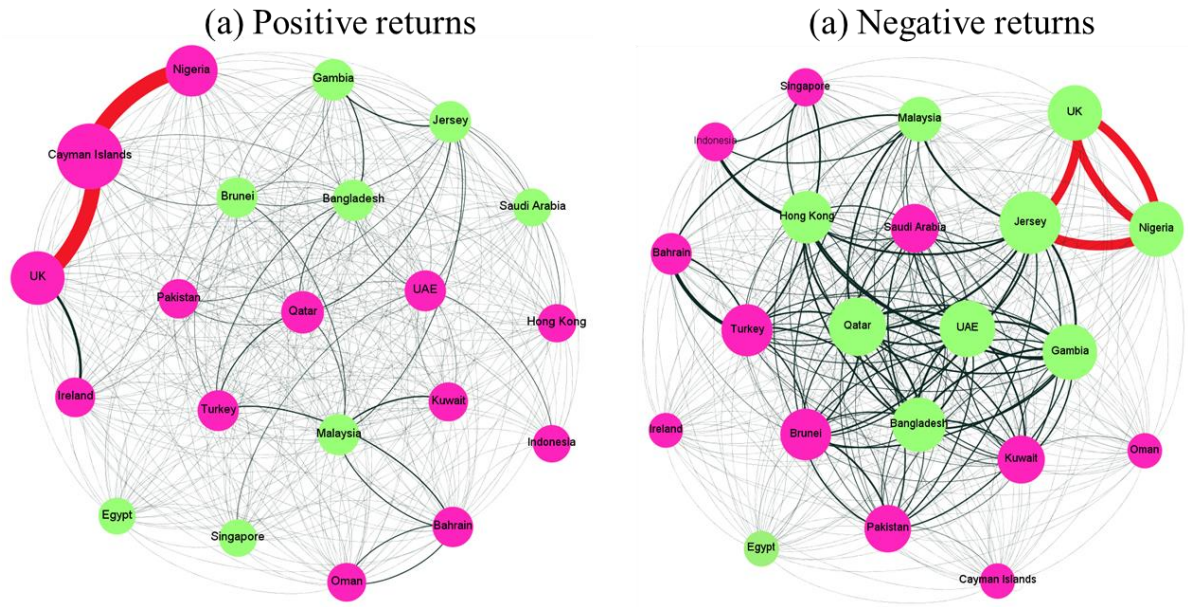

Fig. 2: Directional positive and negative-returns spillovers network over the full sample.

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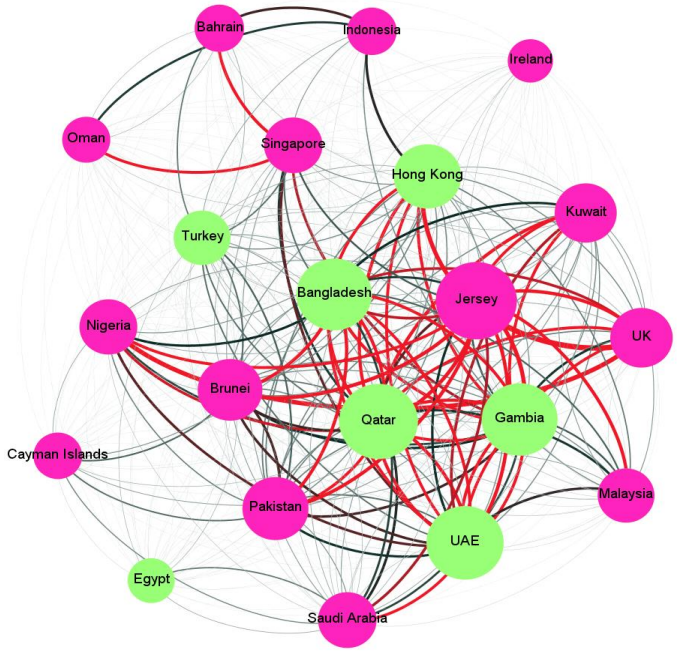

Fig. 3: Directional-volatility spillovers network over the full sample.

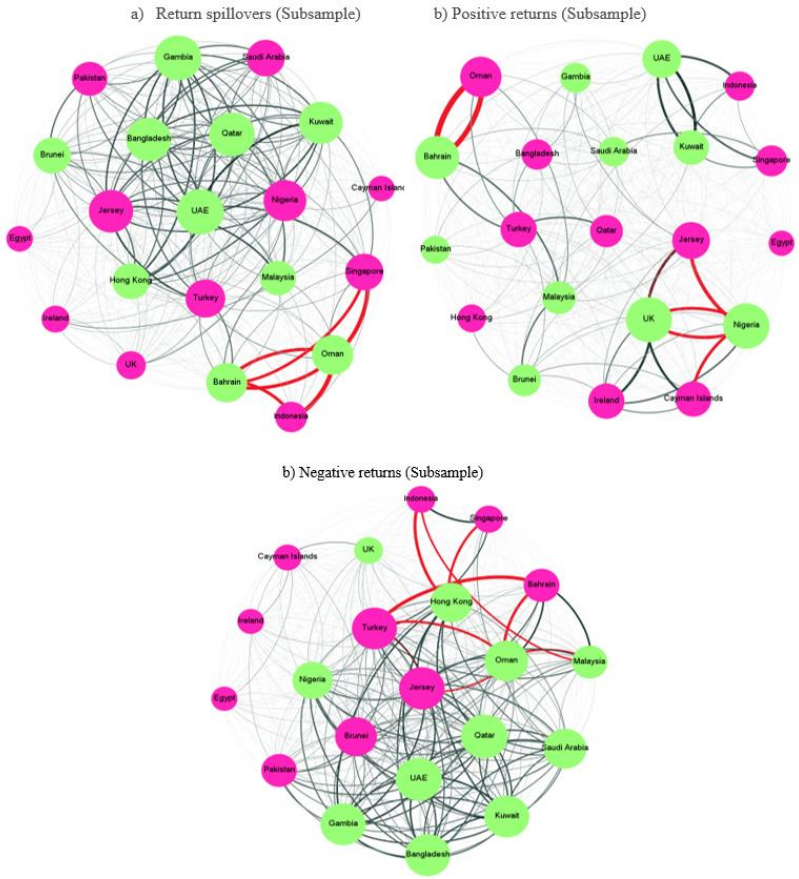

Fig. 4: Network diagram of directional returns, positive and negative returns table using DY (2014).

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4.2 Impact of the COVID-19 outbreak

Our full sample period includes the 2020 COVID-19 outbreak, which may increase the spillovers because of the strong market interest towards all the sukuk markets. Accordingly, we analyze the static connectedness between Sukuk indices between 31 December 2019 and 26 February 2021. Figure 4 shows directional spillovers across global sukuk over the COVID-19 pandemic, in the original returns, positive and negative returns. Given the market becomes more dependent on the original/negative returns, their relative importance for shock transmission changes dramatically. Figure 4a shows that the net receivers of shocks include the European and African sukuk markets, while Asian and GCC plays the principal role in shock transmission. Contrastingly, in the positive returns (Figure 4b), the main shock transmitter being the Bahrain, Nigeria, the UK, Malaysia and UAE markets.

Interestingly, most of the Asian and GCC markets are the main shock transmitters are associated with the negative return spillovers, as shown in Figure 4c. Notably, the sole transmitter for every return is Asian markets, even though connectedness varies across the returns. It is consistent with expectations because the leading sukuk markets are included in Asian regions (Muharam et al., 2019). Moreover, these findings are consistent with our full-sample results, which show the stability of interdependence among sukuk markets. Another similar conclusion is that connectedness via original/negative returns is also largely stronger than via positive ones during the COVID-19. For example, Fig 4b indicates strong connections between several sukuk markets (Bahrain, Oman, Jersey, Nigeria and the UK sukuk market) and comparatively weak relationships for others.

Nevertheless, the shock transmission increased significantly at the original/negative returns, whereas more substantial shocks occurred in the Asian and GCC sukuk markets. This result suggests that, in crisis periods, sukuk markets are more likely to transmit risks (bad volatility). Negative spillovers suggest that uninformed traders dominate the whole system, and lousy spillover tends to transmit at a larger magnitude (Ben Saida, 2019). The most considerable difference between the full and COVID-19 sample is the original returns and volatility (Fig. 5) connectedness intensity in the sukuk markets. The overall spillovers in the returns and volatility (Fig. 5) spillover networks are around 40% and 60% in the entire sample. The total spillovers in the returns and volatility connectedness networks are relatively higher in the subsample, reaching about 61% and 81%. It indicates that the connectedness tightness among sukuk markets had strengthened mainly since 2020, when the sukuk markets entered into a pandemic period. Sharp price rise and active market trading have increased the co-movement of sukuk returns. These results are potentially consistent with reduced global economic activity following the COVID-19 outbreak. This caused sukuk markets to suffer a decline and react to extreme price movements linked to the public health emergency to the COVID-19 situation (Adekoya and Oliyide 2020; Bissoondoyal-Bheenick et al., 2020; Yarovaya et al., 2020).

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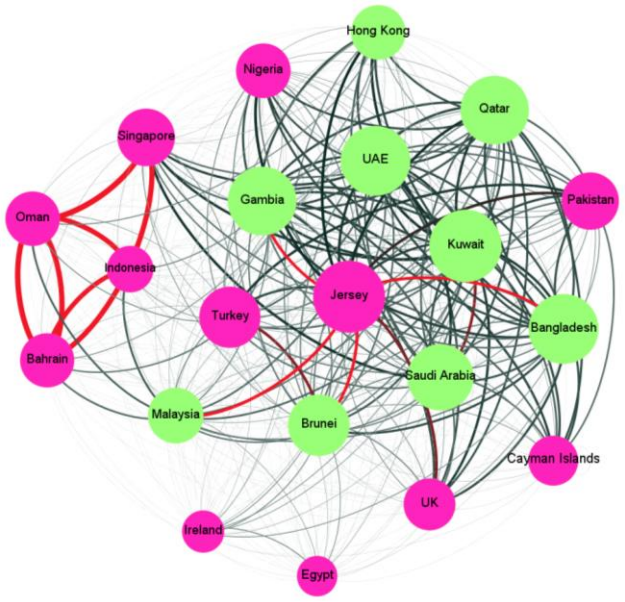

Fig. 5: Network diagram of directional volatility spillovers table using DY (2014).

4.3 Dynamic-connectedness network analysis

Given the dynamic and evolving nature of financial markets over time, connections and interdependencies between markets also evolve, usually according to cyclical and structural trends (Kang, McIver, & Yoon, 2017; Mensi et al., 2017). A static measure cannot capture every such movement; hence return spillovers are estimated using a 260-day rolling window. Fig. 6 illustrates the dynamic total connectedness for sukuk returns, showing substantial variation throughout the sample period. In particular, total return spillovers were relatively high from over 40 to around 53 at the end of 2016, whereas they fell to around 35 and then oscillates between 35 and 24 before peaking at around 54 at the end of 2019. Downward spillover trends in the period from 2017 to mid of 2019, along with reduced capital flows, asset prices, and trade, may be associated with the slow economic recovery following the global financial crisis and, in turn, the European debt crisis (Shahzad et al., 2017). Total connectedness for sukuk returns decreased significantly during 2017, 2018, and mid-2019, which could account for the more significant diversification benefits in these markets in crisis periods (e.g., OPEC price reduction agreement and ongoing Sino-US and global trade tension) (Liow and Song, 2020). After the COVID-19 pandemic in Q3 of 2019, dynamic spillovers increased to approximately 88. The is consistent with the interdependent and interlinked nature of financial markets (Morales and Andreosso, 2012) and how global sukuk market interdependence tends to increase in crisis periods. The ongoing COVID-19 pandemic's outbreak and rapid spread globally could have substantial economic impacts, inducing changes in investor sentiment, decisions, and, resultantly, sukuk market prices.

The above analyses do not consider potential asymmetries in the return spillovers, and previous studies suggest that return spillovers are highly dynamic and evolve. Accordingly, we differentiate between positive and negative returns to uncover the asymmetries in return, connectedness within Diebold and Yilmaz's framework (2016). The results of the dynamics of

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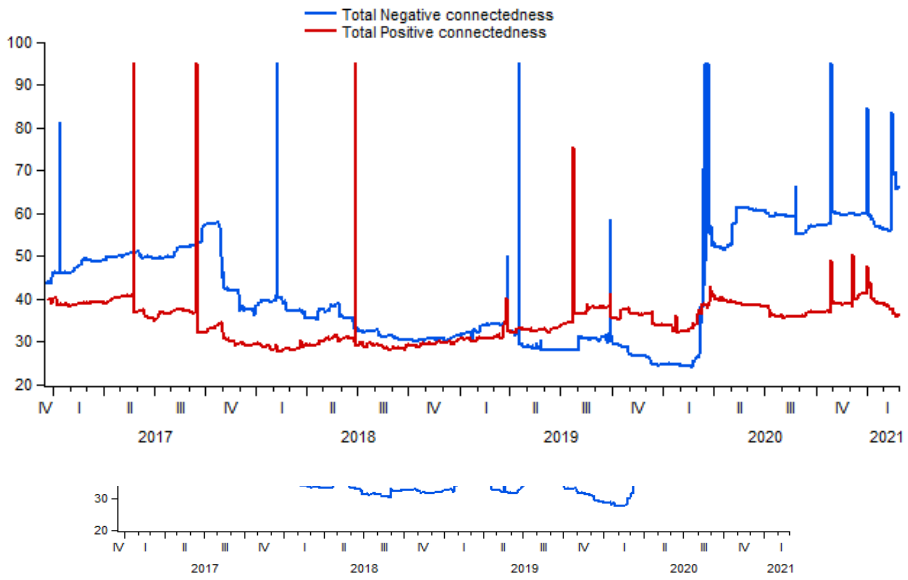

Fig. 6: Dynamic total connectedness for sukuk returns using DY (2014). Note: Window length 260 days.

To provide evidence for the intuition that returns movement among sukuk markets is asymmetrical in response to positive and negative information shocks, the dynamic total connectedness and asymmetry indicators for sukuk positive and negative returns are presented in Fig. 8. The asymmetry indicator is measured by total negative connectedness/total positive connectedness. A total negative connectedness/total positive connectedness of larger than 1 indicates that bad news contributes more to system risk than good news. Fig. 8 clearly shows the overall presence of an asymmetric effect.

The dynamic total connectedness of sukuk volatilities (Fig. 9) fluctuates sharply between 50 and over 90, confirming a notable time-varying feature. Compared to total connectedness of sukuk returns (Fig. 6), total connectedness of sukuk volatilities (Fig. 9) exhibit similar patterns; in fact, it appears that the return spillovers index is closely tracking the volatility spillovers index. However, the magnitude of volatility spillovers is higher than return spillovers throughout the sample, except in 2017 and 2020. Precisely, at the end of 2020, the peaks correspond to the fact that the outbreak of the coronavirus pandemic and its fast-spreading around the world may bring down economic trends and induces negative changes in investor's sentiments that strongly affect their investment decisions and, consequently, sukuk market prices. The total connectedness of sukuk returns and volatilities resemble similar drifts.

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Fig. 7: Dynamic total connectedness for positive and negative returns using DY (2014). Note: Window length 260 days

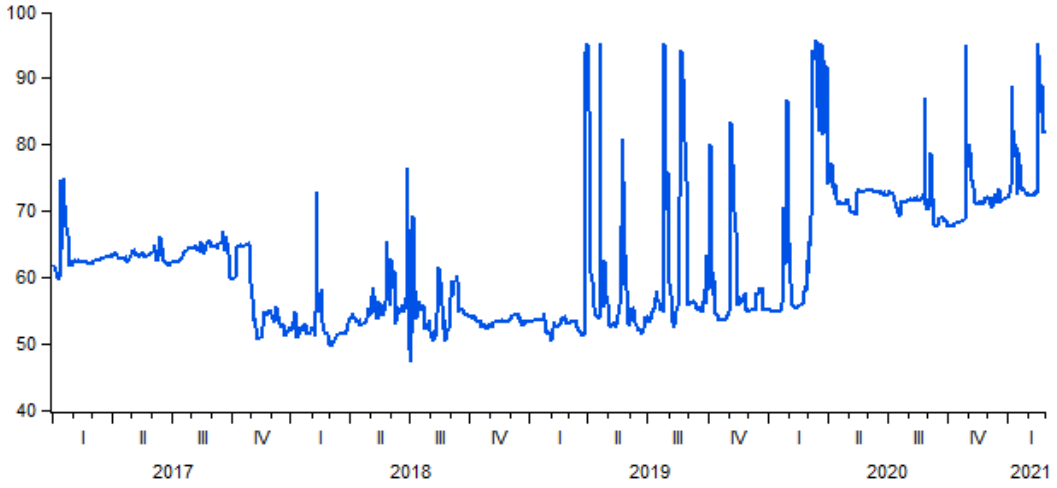

Fig. 8: Dynamic total connectedness and asymmetry indicators for sukuk positive and negative returns using DY (2014). Note: Window length 260 days.

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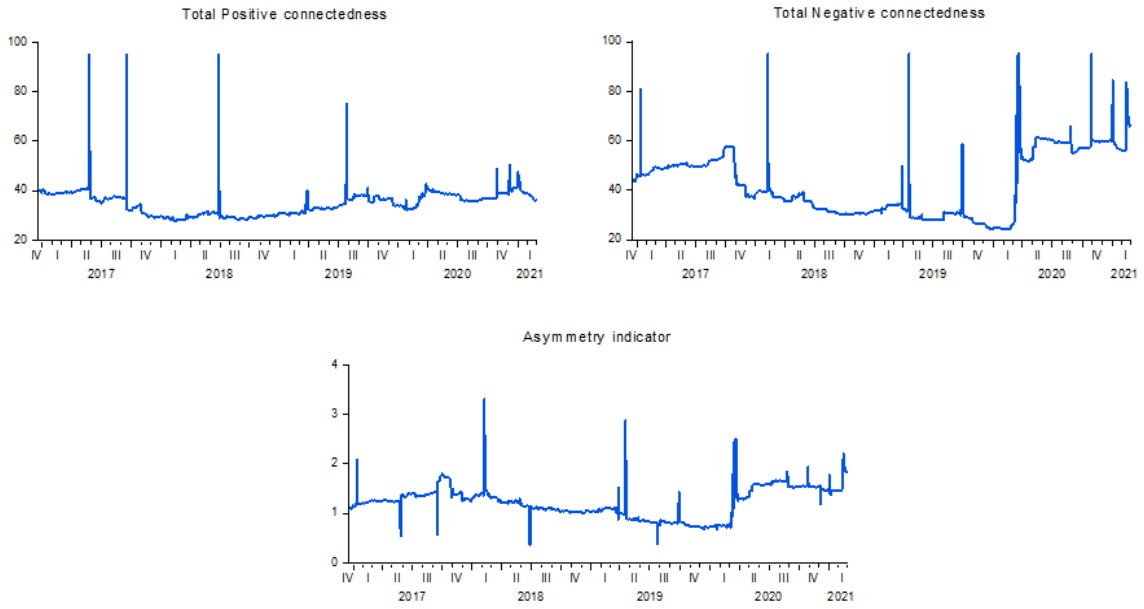

Fig. 9: Dynamic total connectedness for sukuk volatilities. Note: Window length 260 days.

4.4 Determinants of sukuk market integration

We consider the sukuk market's returns and volatility connectedness determinants by considering a set of financial, economic, and other variables.[2] As indicated in the methods section, our choice for these explanatory variables depends on prior studies.

Results from the OLS regressions are reported in Tables 2-5. 12 Tables 2-5 report the regression coefficients for returns, positive returns, and negative returns, respectively, while table 5 reports the volatility results. The results reveal that the coefficient of global financial effect, which represents global financial stress and world equities, positively affects sukuk market spillovers for both returns and volatility. The finding indicates that the sukuk markets still lack transparency, and the major traders are young and inexperienced individual investors. EPU has a positive effect, and that regardless of the type of returns and volatilities considered. The finding is in line with existing literature. Balli et al. (2020) found evidence that the EPU index is sensitive to sukuk market, and sukuk markets are negatively correlated with the EPU index. Therefore, sukuk can serve as a hedging tool against EPU.

However, the picture is different for the explanatory role of gold prices, energy price, oil prices and VIX. Oil prices and energy prices have a negatively significant effect when considering aggregate-, positive- and negative- return spillovers, whereas VIX exhibits a

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positive impact on all types of return spillovers. It indicates that a decrease in gold price will increase demand for sukuk markets, strengthening the return connectedness of return spillover for the sukuk market. The finding is consistent with existing literature, where Yarovaya et al. (2020) found evidence that gold price is a strong predictor of sukuk market. Furthermore, the positive relationship between sukuk and VIX can be explained by the risk aversion of investors; then, if financial market uncertainty decreases, investors anticipate an increase in sukuk markets' returns, increasing prices and returns of sukuk. This result is consistent with Naifar, Mroua, & Bahloul (2016), who found a significant relationship between VIX and sukuk markets.

Moreover, our results show that the hedge effect occurs in sukuk market, making its returns connectedness more vital for all return spillovers. Internet search data can describe individuals' interest, as recently advocated by Da et al. (2011). Therefore, we use daily search query data to measure the impact of the aggregate sukuk market. The result shows that GSI is statistically significant and has negative coefficients for aggregate, positive and negative sukuk returns spillovers. The results indicate an increase in web search queries is followed by a decrease in spillovers among sukuk markets. In conclusion, the magnitude of the effect, as measured by the level of the coefficient associated with the explanatory variables, indicates that global financial stress, world equities, energy, EPU, VIX, gold prices and GSI are the most influential on sukuk market integration, with some nuanced differences between negative- and positive-return spillovers.

Table 3. Determinants of dynamic total connectedness for returns.

Coefficient		Model 1	Model 2	Model 3	Model 4
Global financial effect	GFSI	7.08***			-0.08**
		(9.11)			(-1.92)
	MSCI World	0.01***			0.002***
		(5.68)			(-2.50)
Global commodity market effect	GSCI Energy		-0.09***		0.002***
			(-12.65)		(-7.88)
	Gold Bullion		0.01***		0.001***
			(6.94)		(4.91)
	Oil		-0.07***		0.001***
			(-6.51)		(-5.11)
Uncertainty effect	EPU			0.03***	0.001***
				(9.78)	(2.21)
	VIX			0.12**	0.001
				(2.39)	(0.38)
	GSI			-0.09*	0.001
				(-1.85)	(-0.15)

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R^2(%)		13.4	37.6	19.0	38.0
N		1094	1094	1094	1094

Note: T-statistics are printed in parenthesis. *, ** and *** show that the relevant coefficient is significant at the 10%, 5% and 1% level respectively.

Table 3. Determinants of dynamic total connectedness for Positive returns.

Coefficient		**Model 1**	**Model 2**	**Model 3**	**Model 4**
Global financial effect	GFSI	4.40***			6.30***
		(11.10)			5.72
	MSCI World	0.002***			0.001
		(3.86)			0.18
Global commodity market effect	GSCI Energy		-0.06***		-0.05***
			(-13.97)		-6.25
	Gold Bullion		0.00***		0.01***
			(4.78)		3.62
	Oil		-0.04***		-0.02***
			(-5.00)		-1.73
Uncertainty effect	EPU			0.02***	-0.01****
				(8.89)	-2.34
	VIX			0.16***	-0.17***
				(4.46)	-3.67
	GSI			-0.22***	-0.15***
				(-6.66)	-4.78
R^2(%)		10.2	28.0	18.0	33.5
N		1094	1094	1094	1094

Note: T-statistics are printed in parenthesis. *, ** and *** show that the relevant coefficient is significant at the 10%, 5% and 1% level respectively.

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Table 4. Determinants of dynamic total connectedness for Negative returns.

Coefficient		Model 1	Model 2	Model 3	Model 4
Global financial effect	GFSI	12.88***			-5.98***
		(13.85)			(-2.44)
	MSCI World	0.01***			-0.02***
		(7.42)			(-3.44)
Global commodity market effect	GSCI Energy		-0.15***		-0.11***
			(-16.36)		(-6.51)
	Gold Bullion		0.02***		0.03***
			(10.95)		(5.07)
	Oil		-0.11***		-0.13***
			(-6.71)		(-5.08)
Uncertainty effect	EPU			0.05***	0.02***
				(12.28)	(4.28)
	VIX			0.15***	0.16
				(1.84)	(1.54)
	GSI			-0.10	0.02
				(-1.25)	(0.27)
R^2(%)		16.2	42.0	25.18	44.0
N		1094	1094	1094	1094

Note: T-statistics are printed in parenthesis. *, ** and *** show that the relevant coefficient is significant at the 10%, 5% and 1% level respectively.

Table 5. Determinants of dynamic total connectedness for Volatilities.

Coefficient		Model 1	Model 2	Model 3	Model 4
Global financial effect	GFSI	11.21***			2.87
		(17.66)			1.60
	MSCI World	0.02***			0.01***
		(15.16)			2.76
Global commodity market effect	GSCI Energy		-0.07***		-0.09***
			(-10.27)		-7.75
	Gold Bullion		0.02***		0.01***
			(16.49)		2.33
	Oil		-0.03**		-0.07***
			(-2.37)		-3.43
Uncertainty effect	EPU			0.03***	0.002
				(8.40)	-0.80
	VIX			0.39***	0.22***
				(6.53)	2.99

GSI			-0.20***	-0.19***
			(-3.58)	-3.76
R^2(%)	29.05	44.53	26.2	46.0
N	1094	1094	1094	1094

Note: T-statistics are printed in parenthesis. *, ** and *** show that the relevant coefficient is significant at the 10%, 5% and 1% level respectively.

As for the determinants of the total volatility spillovers (Table 5), it is interesting to see that most of the explanatory variables substantially impact sukuk markets. In particular, global financial stress, world equities, EPU, gold, and VIX have a significant positive effect, whereas energy, oil prices, and GSI negatively impact. These results are quite similar to that reported for the determinants of dynamic total connectedness for returns (Table 2), suggesting that the same factors (global financial effect, investment-substitution effect and uncertainty effect) drive both return and volatility spillovers sukuk market.

The COVID-19 pandemic has pushed the world's economies and financial markets to the deepest recession since 2008. Therefore, we further conduct the regression analysis to investigate the impact of well- known risk-related determinants on the spillovers between sukuk markets during the COVID-19 pandemic. The result shows that the COVID-19 is a significant positive determinant of the aggregate and positive return spillovers of sukuk market (Table 6). This means the COVID-19 has a strong relation with return spillover of sukuk from December 2019 through February 2021 (Yarovaya et al., 2020). Further, the coefficient of global financial effects has a positive relationship with sukuk markets, implying that the global financial impact gets higher during the COVID-19 sukuk return spillovers. Looking over the global commodity market effect, energy and oil prices are positive and significant, implying that the return spillovers of the sukuk market decrease as those commodities prices get higher. Additionally, the VIX that captures the level of risk, fear, or stress in the market is a significant determinant of the sukuk markets regardless of any return spillovers, which is the opposite of the results reported for the EPU index offering diversification benefits. Finally, GSI, which determines the value of different search terms and keywords, cannot predict any sukuk returns during the COVID-19 pandemic.

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Returns

Coefficient		Model 1	Model 2	Model 3	Model 4	Model 5
Global financial effect	GFSI	17.90***				18.64***
		(9.67)				(5.06)
	MSCI World	0.03***				0.02**
		(6.81)				(2.16)
Global commodity market effect	GSCI Energy		0.07***			0.14***
			(6.52)			(4.15)
	Gold Bullion		-0.04***			-0.02***
			(-8.34)			(-3.21)
	Oil		0.08***			0.05**
			(4.79)			(2.19)
Uncertainty effect	EPU			-0.01		0.001
				(-1.47)		(-0.36)
	VIX			0.56***		0.08
				(7.38)		(0.70)
	GSI			-0.28***		-0.34***
				(-3.03)		(-4.15)
Pandemic effect	COVID_19				0.001*	0.001***
					(-1.75)	(-3.25)
R^2(%)		32.0	42.52	25.0	4.00	52.0
N		259	259	259	259	259

Positive returns

Model 1	Model 2	Model 3	Model 4	Model 5
9.09***				0.14***
(5.34)				(2.80)
0.01***				0.002*
(2.96)				(1.76)
	0.01			0.001
	(0.93)			(0.73)
	-0.03***			0.002***
	(-4.18)			(-2.94)
	0.01			0.002
	(0.62)			(-1.20)
		0.00		0.001
		(-1.14)		(-0.01)
		0.30***		0.002
		(5.97)		(0.43)
		-0.04		0.002
		(-0.59)		(-0.46)
			0.001***	0.001**
			(-2.79)	(-1.83)
32.0	19.0	17.0	3.00	26.0
259	259	259	259	259

Negative returns

Coefficient		Model 1	Model 2	Model 3	Model 4	Model 5
Global financial effect	GFSI	26.59***				18.49***
		(10.17)				(4.58)

Volatility

Model 1	Model 2	Model 3	Model 4	Model 5
5.22***				1.45
(7.80)				(0.94)

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	MSCI World	0.04***				0.01	0.01***				0.002
		(6.59)				(0.42)	(7.58)				(0.47)
Global commodity market effect	GSCI Energy		26.59***			0.17***		0.03***			0.04**
			(10.17)			(3.82)		(6.87)			(2.56)
	Gold Bullion		0.04***			-0.03***		0.001			0.001
			(6.59)			(-5.79)		(-0.84)			(0.75)
	Oil		26.59***			0.07***		0.04***			0.02**
			(10.17)			(2.72)		(5.42)			(2.12)
Uncertainty effect	EPU			-0.01		0.001			0.002*		0.00
				(-1.39)		(-0.73)			(-1.84)		(1.07)
	VIX			0.69**		-0.04			0.01		0.06
				(7.36)		(-0.37)			(0.46)		(1.20)
	GSI			-0.23***		-0.29***			0.09**		0.02
				(-2.04)		(-3.20)			(2.55)		(0.65)
Pandemic effect	COVID_19				0.002	0.001				0.002***	0.002
					(0.76)	(-0.03)				(3.89)	(-0.41)
R^2(%)		32.0	52.0	27.0	0.20	58.0	20.0	17.40	8.20	4.20	24.0
N		259	259	259	259	259	259	259	259	259	259

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As stated in Table 6, most of the risk related variables positively affects sukuk volatility during the COVID-19 pandemic (December 2019- February 2021). These variables and sukuk volatility also show the same reaction before the pandemic (January 2016-February 2021). Thus, it can be concluded that in the presence or absence of the COVID-19 pandemic, volatility variables will still positively affect sukuk market's volatility. This means, as the market's risk rises, the sukuk market volatility will increase as well, vice versa.

5. Conclusion

The following paper provides an elaborate discussion of spillovers in returns and volatility transmission, as well as asymmetric connectedness across 21 international sukuk markets, offering a novel understanding of the systematic behaviour of Islamic fixed-income instruments. The analysis, based on the Diebold and Yilmaz (2014) connectedness framework with a decomposition of positive and negative returns, shows that sukuk markets exhibit a highly consistent pattern of interdependence, and the intensity of spillovers differs across regions and market conditions. The findings indicate that the European and African sukuk markets can be seen as net transmitters of shocks, whereas the Asian and GCC markets (though larger in size) were observed as net recipients of both return and volatility spillovers.

One important contribution of the present study is the identification of strong asymmetric spillovers: negative return shocks produce significantly stronger and longer-lasting cross-market transmissions than positive shocks. Such a result can be attributed to behavioural finance theories, which hold that investors are more responsive to negative information, especially when uncertainty is high. The dynamic analysis also indicates that connectedness is even stronger during critical times of crisis, and the COVID-19 pandemic is one of the most potent examples of the vulnerability of sukuk markets to the impacts of global financial stress and their interconnection with global risk transmission networks.

These trends are complemented by the regression results, which indicate that global financial stress, policy uncertainty, commodity market conditions, and investor sentiment are important predictors of sukuk market integration. These results support the perception that sukuk markets, though operating within a Shariah-compliant framework, are also influenced by macro-financial trends worldwide. For policymakers and regulators, this highlights the need to monitor cross-border spillovers, enforce stronger liquidity conditions, and improve risk-management frameworks to enable a stable financial environment in the Islamic finance ecosystem.

Although the analysis offers strong evidence on the interrelatedness and volatility behaviour of sukuk markets, it also highlights several limitations that should be considered. A way to overcome these constraints, including expanding the dataset to cover local-currency sukuk, investigating alternative modelling approaches, and incorporating institutional or regulatory aspects, offers avenues for future studies. Further, these innovations in sukuk markets (including green sukuk, digital issuance, and broader globalisation) will transform the

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way sukuk market structures evolve, so future research can investigate how these changes affect spillover structures, integration, and systemic weaknesses. This research contributes to the analysis of systemic risk and interdependence in international sukuk markets by showing the existence of asymmetric spillovers, high volatility and connectivity, and clear macro-financial integration motives. These lessons can be useful to investors seeking diversification, regulators seeking to increase market stability, and theorists seeking to understand the intricate relationship between Islamic financial products and the broader financial environment.

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