INTRODUCTION

The importance of risk management and optimal financial asset allocation during crisis periods involves a complete understanding of the different securities’ dynamics in a portfolio. In such a context, recent empirical studies advocate for international investors to include Islamic financial securities in their portfolios during crisis times. Islamic finance investments have grown substantially during recent decades. At the end of 2019, the total value of Islamic finance assets was estimated at the U.S. $2.88 trillion and the approximately U.S. $3.69 trillion at the end of 2024 (The Islamic Finance Development Report 2020). Sukuk (Islamic bonds) represent one of the most successful and attractive products in Islamic finance. The term “Sukuk” is the plural of “Sak,” which has various meanings, such as title deed, bill, or certificate. Sukuk are Islamic financial tools that conform to Islamic law (commonly known as Sharia). Sukuk include the rights of possession of a specified class of assets that borrowers provide to lenders as evidence of ownership. Unlike bonds, Sukuk deliver profits instead of fixed interest. Further, Islamic products prevent managerial appropriation through contractual
engagements (Abdul Halim et al., 2017; Haque et al., 2017). Although Sukuk are analogous to conventional bonds in their relationship with cash flows and risk, their unique settings make them better than traditional bonds (Bhuiyan et al., 2018; El Mosaic & Bouiti, 2014; among others). When an issuer defaults, Sukuk owners have direct access to underlying assets (Afshar, 2013; Aziz & Gintzburger, 2009). Besides, Sukuk are open to numerous risks, namely market risk, credit risk, and operational risk. The Sharia principles are followed from issuance to maturity (Nanaeva, 2010; Tariq & Dar, 2007).

Recently, global financial markets have confronted enormous risks owing to the recent outbreak of COVID-19. The more recent literature focuses on the impact of the COVID-19 pandemic on Islamic finance. Yarovaya, Elsayed, et al. (2020) examine the effect of the COVID-19 pandemic on spillover between conventional and Islamic stock and bond markets. The empirical findings show that the Islamic bonds (Sukuk) reveal safe haven properties during the recent pandemic. In contrast, the spillovers between conventional and Islamic stock markets become stronger during the coronavirus period. Yarovaya, Mirza, et al. (2020) investigate the risk-adjusted performance of conventional and Islamic equity funds during the COVID-19 pandemic. They find that Islamic equity funds are more resilient to COVID-19 shock since they outperformed non-Islamic counterparts during the peak months of the pandemic. Ashraf et al. (2020) investigate whether Islamic equity indices provide insurance and portfolio diversification benefits during the COVID-19 pandemic for global, U.S., and European markets. They find that Islamic equity indices provide hedging benefits and diversifying opportunities during crisis times, supporting the decoupling hypothesis. Sherif (2020) examines the reaction of Islamic stock market indices to the uncertainty caused by the COVID-19 pandemic as compared to the FTSE100 conventional index. Empirical results show negative impact on the Islamic stock market index. Erdogan et al. (2020) study the reaction of conventional and Islamic stock returns to the COVID-19 pandemic in Turkey. Using the DCC-GARCH model, empirical results show that Islamic stock indices are more stable than the conventional stock indices during the coronavirus period. Salisu and Sikiru (2020) test if the Asia-Pacific Islamic stock market provides a good hedge against uncertainty during pandemics and epidemics. Empirical results confirm the resilience of the Islamic equity market to crises compared to the conventional equity market. Shahzad and Naifar (2021) investigate the static and dynamic dependence within Islamic and conventional equity sectors during the COVID-19 pandemic. They find that the dependence effect between conventional equity returns is stronger than Islamic equity returns. Furthermore, Islamic and conventional equities behave differently in terms of industry-level dependence during the coronavirus period.

Although the interest in examining the impact COVID-19 pandemic on Islamic finance has increased, relatively few papers examined the impact of the recent pandemic of Sukuk prices (Naeem et al., 2021; Naifar, 2022). In this study, two facts have motivated the study of the time–frequency co-movement and the lead–lag relationship between Sukuk prices and global economic and risk factors for the global and Malaysian Sukuk markets. The first fact relates to the instability and decline in Sukuk prices during March 2020. During the past years, the global Sukuk market experienced fewer downside risks relative to other global fixed income benchmarks, and lower drawdowns during periods of market stress provided downside protection for investors. However, the coronavirus pandemic combined with oil price movement shocks and alarming increases in global uncertainty can affect the global Sukuk market differently. The second fact shows that no comprehensive empirical studies exist that explain the variations in global and sovereign Sukuk prices with global and economic risk factors at different frequencies and specific periods.

In this study, the impact of the recent spread of the COVID-19 pandemic and global economic and uncertainty factors on the dynamics of Sukuk prices over time and at different frequencies is investigated. In this study, the following unanswered questions are answered: Do global and Malaysian Sukuk markets move in the same way during the COVID-19 pandemic? What is the strength of the co-movement between Sukuk markets and global risk factors? Are the relationships among Sukuk prices, oil prices, and global risk factors stable or variant over time and across scales?

This study adds to the present literature in four different ways. First, the joint impact of the COVID-19 epidemic, global financial risk and uncertainty factors, and oil prices on Sukuk prices are explored for the global and Malaysian Sukuk markets. The theoretical literature suggested a possible joint link between the variables; however, no empirical studies studied this issue for the COVID-19 pandemic period. Second, the time–frequency relationship between Sukuk prices and explanatory variables is examined using wavelet coherency and phase differences. These methodologies allow for an exploration of the co-movement and lead–lag connection for the frequency components of Sukuk prices at various frequencies and different phases. Wavelet coherency allows us to capture the heterogeneity effects and extreme events at both time and frequency scale in relation to the strength of localized correlation in the time series (Balli, de Bruin, et al., 2020). Also, the wavelet methodology can be used to overcome problems inherent in the non-stationarity of the time series (Aloui et al., 2015c). Third, partial wavelet coherency and phase differences are used, which allow for an analysis of the co-movements and the lead–lag association between Sukuk prices and each considered time series while controlling for the influence of the other global risk and uncertainty factors. Fourth, the study’s sample period includes specific
events (e.g., the World Health Organization’s [WHO] announcement on March 12 of COVID-19 as a global epidemic, the imposition of movement control order in Malaysia on March 18, the oil price crash on April 20) that can lead to different time–frequency co-movements between Sukuk prices and the explanatory variables. Finally, our results are robust because the method used is insensitive to the sample size, which makes the findings reliable. This paper is the first study of its kind in the context of Sukuk prices, COVID-19, and economic uncertainty at diverse time scales.

The findings of this study show that the co-movements between Sukuk prices and the explanatory variables are time and frequency varying for the global and Malaysian Sukuk markets. During the study period, the co-movement between Sukuk prices (both global and Malaysian Sukuk) and COVID-19-infected cases is found to be more robust in the short term (in the 1–2-day frequency band). The partial coherency and partial phase differences disclose that both the global and the Malaysian Sukuk markets react more to global financial distress and global financial uncertainty (embodied in the VIX index) than the other variables. Analyzing the dynamics of the co-movement between Sukuk markets and global economic and risk factors is essential in finance and portfolio management because international and faith-based investors can minimize risk through optimal diversification strategies.

The remainder of this paper is organized as follows. Section 2 exposes the related literature. Section 3 discusses the research methodology. Section 4 defines the data and some preliminary results. Section 5 discusses the empirical findings. Section 6 provides the conclusion.

2 LITERATURE REVIEW

Multiple studies on Sukuk included theoretical studies and have mainly focused on clarifying Sukuk structures with a focus on legal deliberations (Vishwanath & Azmi, 2009). Sukuk serve as central tools for resource mobilization and prime products for the Islamic capital market’s progress (Wilson, 2008). Multiple studies on Sukuk included financial theories, such as the pecking order/tradeoff theory, the Fama and French model, signaling theory, and agency theory, and endeavor to determine whether the purported Islamic product works like a conventional financial product (e.g., Alam et al., 2013). Other studies revealed that Sukuk and bonds are similar financial tools because Sukuk have several traits that mirror the features of bonds (Al Trad & Bhuyan, 2015, among others). These investigations found that Sukuk mimicked conventional bond features, given a fixed-term maturity, the yield–price relationship, and a contractual profit rate.

Furthermore, the yield and return between bonds and Sukuk exhibited no substantial variance (Krasicka & Nowak, 2012). Another set of studies investigated the interrelatedness of conventional/Islamic equity markets and Sukuk/conventional bond markets. Multiple studies revealed that Sukuk market movements are linked to stock market settings (e.g., Alaoui et al., 2015; Aloui et al., 2015a, 2015b; Godlewski et al., 2014, 2016, among others).

Recent studies demonstrated the stability of Sukuk prices and returns during financial turmoil. Jobst et al. (2008) stated that the need for Sukuk has increased since the recent global financial crisis because financial institutions seek financial tools that are more stable than bonds. Multiple studies also highlighted the advantages of adding Sukuk during periods of turmoil. Similarly, Boumediene (2015) and Hassan et al. (2018) revealed the price stability of Sukuk, and Alaoui et al. (2015) suggested switching from equities to Sukuk during turmoil because Sukuk are less risky than equities. Maghyereh and Awartani (2016) revealed substantial volatility spillover from the Sukuk market to the stock market specifically during crisis periods. Balcilar et al. (2016) presented a parallel observation and displayed that Sukuk witnessed a negative correlation with stock markets during the financial crisis (2007–2009). Alam et al. (2013) uncovered that stock market reactions to Sukuk declarations in major Islamic financial markets were negative before and during the global financial crisis. Akhtar and Jahromi (2017) highlighted the stability of Islamic financial markets relative to their conventional counterparts during periods of turbulence. Aloui et al. (2015b) demonstrated that fluctuations in Sukuk prices have a considerable influence on the probability of transmission through regimes. Dewandaru et al. (2013) covered multiple Islamic products including Sukuk and reported that the U.S. subprime crisis created both long- and short-term shocks for all Islamic products.

New research papers investigated the impact of global economic and risk factors on Sukuk markets. Naifar and Hammoudeh (2016) revealed that global uncertainty, oil price volatility, and risk factors are the central ingredients that affect Sukuk yields in the GCC sphere. Balli, Billah, et al. (2020) revealed the impact of economic policy uncertainty and the U.S. and E.U. macroeconomic news on Sukuk and bond markets. These studies documented that global macroeconomic declarations and economic policy uncertainty have a stronger influence on conventional bonds than on Sukuk markets. Paltrinieri et al. (2019) present a bibliometric review of sukuk literature through a quali–quantitative approach, using bibliometric citation analysis and content analysis. They explore three research topics: (1) sukuk overview
and growth, (2) sukuk and finance theory, (3) sukuk and stock market behavior. They find that the top three countries
publishing on sukuk literature are, respectively, Malaysia, Saudi Arabia, and the United States. Recently, Naifar (2022)
investigated the impact of COVID-19-related news (including panic news, media-hype new, fake news, infodemic, and
Stringency measures) on global and Malaysian Sukuk returns. He found that COVID-19 news (panic news, travel bans,
and the percentage of information about the novel COVID-19 pandemic) affects the Sukuk returns only when the sukuk
markets are bearish.

3 | RESEARCH METHODOLOGY

In this paper, the time–frequency relationship among Sukuk prices, the recent spread of the COVID-19 epidemic, oil
prices, and global risk factors are examined using the wavelet coherency approach.

3.1 | The wavelet function

A wavelet can be defined as a function $\psi(\cdot)$ with a zero mean and that is contained in both time ($\Delta t$) and frequency ($\Delta \omega$),
which varies within a restricted period (Fan & Gençay, 2010; Tiwari et al., 2016). The wavelet is presumed to be a square
integral function $\psi(\cdot) \in L^2(\mathbb{R})$. The wavelet is defined as follows:

$$\psi_{s,\tau}(t) = \frac{1}{\sqrt{s}} \psi\left(\frac{t - \tau}{s}\right)$$

(1)

where $1/\sqrt{s}$ is the normalization factor guaranteeing the unit variance of the wavelet function $\|\psi_{s,\tau}\|^2 = 1$. The factor $\tau$
represents the position parameter that provides the exact location of the wavelet, and $s$ represents the scale dilation factor of the wavelet. The upper scale suggests a more strained wavelet that is suitable for discovering lower
frequencies.

3.2 | Morlet wavelet

Numerous types of wavelet functions exist. In this study, the Morlet wavelet approach is used, which is suitable for financial
market investigations because it stretches information on the local phase. To achieve the optimal balance, the Morlet
wavelet can be defined as follows:

$$\psi^M(\eta) = \frac{1}{\pi^{1/4}} e^{\iota \omega_0 \eta} e^{-\eta^2/2}$$

(2)

where $\psi^M(\cdot)$ is the Morlet wavelet function, $\eta$ is the dimensionless time, and $\omega_0$ is the dimensionless frequency. For an optimun balance, $\omega_0 = 6$, as advocated by Barunik et al. (2011) and Tiwari et al. (2016), among others. Moreover, the Morlet
wavelet can be revealed to accomplish an optimum position between the resolution in time and frequency because of its
Gaussian enclose (Tiwari et al., 2016). Following Aguiar-Conraria et al. (2008), the Morlet wavelet is placed in the center at the point $(0, \omega_0/2\pi)$ in the time–frequency domain. Following Tiwari et al. (2016), the wavelet is pushed in time by changing
its scale $s$ such that $\eta = s t$ and is normalized to have unit energy. In the case of the Morlet wavelet, the Fourier period ($\lambda_{\omega t}$) is practically equivalent to the scale $\lambda_{\omega t} = 1.03$.

3.3 | Continuous wavelet transform

The continuous wavelet transform (CWT) is presented as follows:

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

(3)
The function $W_x(s, r)$ is achieved by forecasting the wavelet function $\psi(\cdot)$ on the designated time series $x(t)$. The main contribution of the wavelet transform is the ability to decompose the following function:

$$x(t) = \frac{1}{C_\psi} \int_0^\infty \left[ \int_{-\infty}^{\infty} W_x(s, r) \psi_s(r) \, dr \right] \frac{ds}{s^2}, \quad s > 0 \quad (4)$$

According to Aloui and Hkiri (2014), the energy conservation of the designated time series is the central characteristic of the wavelet transform. This characteristic is used for the power spectrum analysis, which stipulates the variance as follows:

$$\|x\|^2 = \frac{1}{C_\psi} \int_0^\infty \left[ \int_{-\infty}^{\infty} |W_x(s, r)|^2 \, dr \right] \frac{ds}{s^2} \quad (5)$$

### 3.4 Wavelet coherency

The wavelet coherency is used to examine the cross-correlation over time and frequency among Sukuk prices. Following Torrence and Compo (1998), Aloui and Hkiri (2014), the cross-wavelet transform of the two time series $x(t)$ and $y(t)$ with the continuous transforms $W_x(s, r)$ and $W_y(s, r)$ is used as follows:

$$W_{xy}(s, r) = W_x(s, r) W_y^*(s, r) \quad (6)$$

where $r$ denotes the location index, and $s$ denotes the scale. The asterisk (*) indicates the complex conjugate. According to Torrence and Compo (1998), a cross-wavelet can be defined as $|W_{xy}(s, r)|$. The cross-wavelet power indicates the zone in the time-scale universe in which the time series shows high common power. In this study, the cross-wavelet represents the local covariance between Sukuk prices and explanatory variables' time series at every scale. Torrence and Webster (1999) is referenced to present the wavelet coherency between two different time series as follows:

$$R^2(s, r) = \frac{\left| S\left(s^{-1}W_{xy}(s, r)\right) \right|^2}{S\left(s^{-1}|W_x(s, r)|^2\right)S\left(s^{-1}|W_y(s, r)|^2\right)} \quad (7)$$

where $S$ represents the smoothing factor, and $W_{xy}(s, r)$ is the cross-spectrum. Without smoothing, coherency is equally 1 at all scales and times. The squared wavelet coherency coefficient $R^2(s, r)$ ranges from 0 to 1 ($0 \leq R^2(s, r) \leq 1$). Squared wavelet coherence coefficients near zero indicate weak correlation, whereas coefficients near to one indicate a high correlation. The smoothing factor $S$ as a convolution in time and scale can be presented as follows:

$$S(W) = S_{\text{scale}} \left( S_{\text{time}}(W_{xy}(s, r)) \right) \quad (8)$$

where $S_{\text{scale}}$ indicates smoothing along the wavelet scale axis, and $S_{\text{time}}$ indicates smoothing in time. Torrence and Compo (1998) is referenced to conduct the time convolution with a Gaussian and to achieve scale convolution using a quadrilateral window.

### 3.5 Partial wavelet coherence

Partial wavelet coherence allows for the recognition of the resultant wavelet coherence among two-time series after removing the effect of their shared dependency. Aguiar-Conraria and Soares (2011) and Tiwari et al. (2016) are referenced to define the partial CWT for three variables—$X$, $Y$, and $Z$—as follows:

$$R^2(s, r)_{X,Y/Z} = \frac{|Q_{M,Y/X,Y}^M|}{Q_{M,X,X}^M Q_{Y,Y}^M} \quad (9)$$
where $Q_{X,Y}^M$, $Q_{X,X}^M$, and $Q_{Y,Y}^M$ denote the minors linked with the smoothed cross-wavelet transforms $S\left(s^{-1}W_{xy}(s, r)\right)$, $S\left(s^{-1}\left|W_{x}(s, r)\right|^2\right)$, and $S\left(s^{-1}\left|W_{y}(s, r)\right|^2\right)$, respectively, in a $3 \times 3$ matrix $Q$.

## 4 DATA DESCRIPTION

The first dataset comprises daily data for the global DJSI for the period January 2, 2020, to May 28, 2020. The DJSI, launched in 2006, is considered to be the first global Sukuk index. It is regarded as an autonomous benchmark to estimate the return of U.S. dollar-denominated investment-grade Sukuk. The DJSI has been screened for Shariah compliance and has been used as a proxy of global Sukuk markets in many recent empirical studies (e.g., Bhuiyan et al., 2018; Bhuiyan et al., 2019; Mnif et al., 2019; Naifar & Hammoudeh, 2016; Naifar et al., 2017; among others). For comparison purposes, the second dataset in this study consists of daily data from the Malaysian Sovereign Sukuk index. At least two arguments describe the choice of the Malaysian Sukuk market. First, Malaysia is the leading actor in the global Sukuk market, with a five-year cumulative value of domestic and international Sukuk of USD 612 billion. As of December 2017, 90.5% of the total global Sukuk outstanding is represented by five countries: Malaysia (51%), Saudi Arabia (18.2%), Indonesia (10.7%), UAE (7.8%), and Turkey (2.8%). Second, Sukuk issuance in Malaysia was affected by the COVID-19 outbreak. The Securities Commission Malaysia expects the country’s 2020 Sukuk issuance to decrease relative to that in 2019.

The dynamics of the Sukuk price indexes and the COVID-19-confirmed cases indexes are illustrated in Figure 1. Figure 1 shows that the value of the global and Malaysia Sukuk price indexes fell drastically during March 2020, which corresponds to the WHO’s announcement of COVID-19 as a global epidemic. Also, the decrease in the Sukuk price indexes is inversely related to the movement of the COVID-19-confirmed cases index. The COVID-19-confirmed case indexes are downloaded from the Bloomberg database and show that the first COVID-19-confirmed case in Malaysia was on March 11, 2020, and the first global COVID-19-confirmed cases (outside of China) were on January 13, 2020. This paper uses the date of the first COVID-19-confirmed case as the starting date of our analysis (January 13, 2020, for the global Sukuk market and March 11, 2020, for the Malaysian Sukuk market).

The effect of global financial uncertainty on Sukuk prices was proxied by the VIX index (often referred to as the “Fear Index”). The VIX index indicates the implied volatility of a varied series of options contracts built on the S&P 500 index. The VIX index is the world’s best indicator of global financial market uncertainty. The U.S. EPU index is used to account for the effect of global economic uncertainty. This index mirrors the frequency of articles from 2,000 U.S. newspapers that include terms such as “economics,” “policy,” and “uncertainty” (Baker et al., 2020). The global financial distress index for the United States (hereafter, GFSI) is used to account for global financial distress. The Cleveland Financial Stress Index

![Figure 1](image-url)
suggests financial distress. Finally, the West Texas Intermediate (WTI) is used as a proxy for oil prices. Figure 2 displays the time trends of the VIX, EPU, GFSI, and oil price indexes.

Figure 2 indicates that global financial risk and uncertainty factors (VIX, EPU, and GFSI indexes) followed a sharp increase in March 2020 that corresponded with the announcement of COVID-19 as a global pandemic. WTI oil prices declined significantly in April 2020, representing the most significant collapse since the Gulf War (Sharif et al., 2020). Table 1 provides summary statistics and preliminary tests for each series.

Table 1 shows that the WTI series is leptokurtic and has negative skewness. The kurtosis coefficients for Sukuk indexes are greater than 3, and the skewness coefficients are not zero. The Sukuk indexes tend to have heavy tails or outliers. The Jarque–Bera test confirms the rejection of the normality distribution of all return series.

5 | EMPirical FINDING AND DISCUsSION

5.1 | Global Sukuk market findings

In this section, the co-movement and the lead–lag association of the time–frequency framework between the global Sukuk market (proxied by DJSI) and global economic and risk factors are investigated. We first examined the Granger Causality between DJSI and global risk factors. We find unidirectional Granger causality, at 5% significance level, that goes from VIX index, oil and COVID-19 global cases to DJSU, unidirectional Granger causality that goes from DJSI to EPU and bidirectional causality between DJSI and GFSI.5

The wavelet and partial wavelet coherencies between the global Sukuk index and oil prices are conveyed in the upper part of Figure 3. Simultaneously, phase differences are presented in the lower part. Specifically, the results of the phase differences are presented in five frequency bands. The first two bands (1–2 days and 2–4 days) represent the short-term analysis, the following two bands (4–8 and 8–16 days) are associated with the medium-term analysis, and the last band (16–32 days) is associated with the long-term analysis.

Wavelet coherency is a tool that enables us to identify the possible relationship among two variables by determining the frequency bands and the time intervals in which they co-move. A visual inspection of Figure 3(a.1) indicates the presence of vast high coherence areas situated over the first frequency bands (1–2 days) during the sample period. This result implies that the co-movement between Sukuk and oil prices is robust for high frequencies. However, apparent differences in medium-term co-movements between Sukuk and oil prices appear relative to the 1–2-day period. The presence of small and medium islands of robust dependence is noted at the commencement and in the middle of the sample period (mid-February 2020 and mid-March 2020) over the frequency bands 2–4 and 4–8 days. No significant co-movements are observed for the long-term band of 16–32 days. Additionally, the phase difference indicates the intensity of the association and the causality among Sukuk prices and oil prices. The phase difference is within the interval [0,−πl/2] in the very
|                  | Mean    | Median  | Maximum  | Minimum | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | Probability |
|------------------|---------|---------|----------|---------|-----------|----------|----------|-------------|-------------|
| COVID_19_GLOBAL  | 1,480.71| 272.13  | 5,847.44 | 1       | 1,845.05  | 0.976029 | 2.520704 | 16.66606    | .00024      |
| COVID_19_MALAYSIA| 2665.52 | 1030.0  | 7629.0   | 0       | 2885.53   | 0.436697 | 1.475866 | 12.72868    | .001722     |
| DJSI             | 105.04  | 105.87  | 108.65   | 100.61  | 2.252531  | −0.4469  | 1.80585  | 9.229619    | .009904     |
| Malaysia SUKUK  | 106.12  | 105.8   | 110.54   | 104.08  | 1.287687  | 1.233903 | 4.639183 | 36.20506    | .00000      |
| EPU              | 328.69  | 376.48  | 807.7    | 22.25   | 207.47    | 0.10182  | 1.655829 | 7.62409     | .022103     |
| GFSI             | 0.8393  | 0.9163  | 2.6282   | −0.4215 | 0.922395  | 0.073339 | 1.794581 | 6.082514    | .047775     |
| VIX              | 34.78   | 33.29   | 82.69    | 12.1    | 17.7902   | 0.662117 | 2.792266 | 7.112141    | .028551     |
| WTI_OIL          | 34.81   | 32.50   | 58.54    | −37.63  | 16.43484  | −0.6649  | 4.904193 | 22.25158    | .000015     |

Note: The descriptive statistics in the table cover the period from January 2, 2020, to May 28, 2020.
short-term (1–2 day band). This finding discloses a short-term positive relationship, with global Sukuk prices leading oil prices. The rationale behind the relationship between Sukuk prices and oil prices may be because the majority of global sukuk issuer is from the major oil-exporting countries (e.g., Saudi Arabia; Qatar; UAE). So, Sukuk prices might impact and influence the crude oil prices in the short term. However, investors might take the increase in crude oil prices as a positive signal and be motivated to buy global sukuk mainly from the oil-exporting countries. In the medium term (especially for the 8–16-day band), the following four phases are observed: (i) up to the end of January 2020, both times series were positively correlated, and Sukuk prices were leading; (ii) up to the beginning of March 2020, both variables were out of phase and inversely related, and oil prices were leading; (iii) up to the end of March 2020, both time series were positively correlated, and Sukuk prices were leading; and (iv) from the beginning of April 2020, both sets were out of phase and inversely related, and oil prices were leading. However, the evolution of other explanatory variables can affect these findings. Consequently, this study advances to the presentation of partial wavelet coherency, adjusting for the effect of different global factors (the VIX index, EPU index, GFSI index, and global COVID-19-infected cases). Figure 3(b.1) shows a relatively different pattern. First, short-term co-movements are detected only for 2–4 days. Also observed is a medium-term co-movement for 4–8 days and 8–16 days but weaker than in the previous case. Long-term (16–32 days) co-movements in the middle and at the end of the sample period are observed (from February to May 2020). The short- and medium-term partial phase differences were mainly between 0 and \( \rho_i/2 \), indicating that both data sets are in-phase and positively correlated, with the time-series oil prices leading Sukuk prices. Long-term (after the end of March 2020) phase differences were between \(-\rho_i/2\) and \(-\rho_i\), indicating a negative co-movement and that oil prices are leading. Indeed, during this period (April 2020), oil prices faced their largest decline since 1991. This significant decline in oil prices led to a surge in uncertainty and financial market fluctuations, including the Sukuk market.

Figure 4 plots the wavelet and partial wavelet coherences among the global Sukuk Index (DJSI) and the VIX index. A visual inspection of Figure 4(a.1) shows the presence of vast islands of high coherence in all of the sample periods of the study (from January to May 2020) over the first frequency bands (1–2 days). The short-term co-movements between Sukuk prices and the VIX index appear similar to the short-term co-movements between Sukuk prices and oil prices. In the medium term (4–8-day and 8–16-day frequency bands), the small areas of medium dependence are noted. The dependence structure is mainly detected over the long term (up to 16-day frequency bands) during the study’s sample period. The short-term phase differences are between 0 and \(-\rho_i/2\), indicating that both data sets are in-phase and positively correlated, with Sukuk prices leading. In the long term, two different periods are noted: (i) up to the middle of March
NAIFAR et al. 2020 and from May 2020, the phase difference was within $[0, \rho_i/2]$, then the VIX index led Sukuk prices; for April 2020, the phase difference was within $[-\rho_i/2, 0]$, indicating that Sukuk prices were leading. When the impact of oil prices, economic policy uncertainty, global financial distress, and global COVID-19-infected cases variables on global Sukuk prices are isolated, an entirely different picture is detected (Figure 4(b.1)). The short-term co-movements are not detected for 1–2-day period. Robust long-term co-movements can be observed during the study period. The short- and medium-term partial phase differences are between 0 and $\rho_i/2$, demonstrating that both series are in phase and positively correlated.
with the time-series VIX index leading Sukuk prices. In the medium term (especially for the 4–8-day band), two different periods are observed: (i) up to the middle of February 2020, the phase difference was within $[-\rho i/2, 0]$, both time series were positively correlated, and Sukuk prices were leading; and (ii) from the middle of February 2020, Sukuk prices and the VIX index were positively related, and the VIX index was leading. The long-term phase difference is within $[0, +\rho i/2]$, indicating a positive correlation between the time series, and the VIX index was leading. In fact, during March, the VIX index hit its highest intraday level since 2008. The VIX index crowed approximately 300% at its peak on March 10, 2020.\(^6\)

The alarming increase in the global financial uncertainty index created fluctuations in other financial markets, including the global Sukuk market. Therefore, during this period, the VIX index led Sukuk prices. For April and mid-May, the phase coherence was between 0 and $-\rho i/2$, demonstrating that both series were in phase and positively correlated, and Sukuk prices were leading.

The co-movement between global Sukuk prices and global economic uncertainty is further investigated. Figure 5 plots the wavelet and partial wavelet coherences among the DJSI and global economic uncertainty.

Figure 5(a.1) shows the presence of a vast island of high coherence in all of the sample periods over the first frequency bands, corresponding to a higher frequency (1–2 days). The short-term co-movements are not detected for the second frequency band (2–4 days). We also did not observe a medium-term co-movement (for 4–8 day and 8–16-day frequency bands). The phase differences indicate different co-movements in different term periods. The short-term phase differences are within $[-\rho i/2, 0]$, indicating that positive co-movements and Sukuk prices are leading. In the medium term (especially for the 8–16-day frequency bands), positive and negative co-movements between Sukuk prices and the EPU index are observed. In the long term, three different phases are observed: (i) up to the middle of March 2020, the phase difference was within the interval $[0, +\rho i/2]$, representing a positive correlation between time series, and the EPU index was leading; (ii) from mid-March to mid-April 2020, the phase difference was within $[0, -\rho i/2]$, representing a positive correlation between data sets, and the Sukuk index was leading; and (iii) from mid-April 2020, the phase difference was within $[-\rho i/2, -\rho i]$, demonstrating a negative co-movement, and the EPU index was leading. The rationale behind the relationship between Sukuk prices and global EPU may be because the majority of sukuk issuance are denominated in US dollar and a variation in US economy policy uncertainty can affect Sukuk prices. Economic policy uncertainty is closely related to unexpected changes that may affect the economic environment. Economic policy uncertainty can raise expected costs and reduce the long-term investment and output (Jeong, 2002).

Figure 5(b.1) shows the partial wavelet coherence between global Sukuk and EPU indexes. The short-term co-movements were not observed at higher frequencies (1–2 days), can be noticed clearly for the medium term (4–8-day investment horizons), and are principally in the middle of the sample period (March 2020). The EPU moved from approximately 100 in January 2020 to nearly 400 in March 2020. Robust long-term co-movements can be observed during the beginning and middle of the sample period for the 16–32-day investment horizons, indicating a phase relationship, and the Sukuk is leading. The partial phase differences indicate different co-movements in different term periods. The short-term phase differences were within $[-\rho i/2, 0]$ during January and February 2020, meaning positive co-movements, and Sukuk prices are leading. During March and April 2020, the phase differences were within $[0, \rho i/2]$, indicating positive co-movements, and the EPU index is leading. A different picture is observed in the long term. Two distinct periods are observed: (i) up to the end of March 2020, a positive co-movement, and the EPU index was leading, and (ii) from the beginning of April 2020, a positive co-movement, and Sukuk prices were leading.

Figure 6 presents the wavelet and partial wavelet coherences among the Sukuk index and global financial distress.

The wavelet coherence between the global Sukuk market and the global financial distress reported in Figure 6(a.1) discloses vast areas of red, demonstrating a robust co-movement over the 1–2-day frequency bands for the entire sample period. Besides, the presence of small red areas of robust dependence during the entire study period is noticed in the 2–4-day frequency bands. However, a vast red island identified in the middle of the study period and matched to the lower frequencies (8–16- and 16–32-day frequency bands) is observed. Global financial distress affects the normal functioning of financial markets, and the global Sukuk index appears to have been impacted by global financial stress. This outcome is in line with the results of Naifar and Hammouded (2016). They find a co-movement and causality relationship between Gulf Cooperation Council Sukuk returns and global financial distress during bullish periods. The short-term (1–2-day and 2–4-day frequency bands) phase differences are within $[0, \rho i/2]$, indicating positive co-movements among global financial distress and Sukuk prices, and the GFSI index is leading. The same picture is observed for the medium term (especially for the 4–8-day frequency bands). Inverse long-term co-movements are observed between Sukuk prices and

\(^6\) The coronavirus epidemic has generated an enormous increase in uncertainty (including financial and economic uncertainty, among others). The co-movement is mainly observed over the long term (16–32-day investment horizons). The phase differences indicate different co-movements in different term periods. The short-term phase differences are within $[-\rho/2, 0]$, indicating that positive co-movements and Sukuk prices are leading. In the medium term (especially for the 8–16-day frequency bands), positive and negative co-movements between Sukuk prices and the EPU index are observed. In the long term, three different phases are observed: (i) up to the middle of March 2020, the phase difference was within the interval $[0, +\rho/2]$, representing a positive correlation between time series, and the EPU index was leading; (ii) from mid-March to mid-April 2020, the phase difference was within $[0, -\rho/2]$, representing a positive correlation between data sets, and the Sukuk index was leading; and (iii) from mid-April 2020, the phase difference was within $[-\rho/2, -\rho]$, demonstrating a negative co-movement, and the EPU index was leading. The rationale behind the relationship between Sukuk prices and global EPU may be because the majority of sukuk issuance are denominated in US dollar and a variation in US economy policy uncertainty can affect Sukuk prices. Economic policy uncertainty is closely related to unexpected changes that may affect the economic environment. Economic policy uncertainty can raise expected costs and reduce the long-term investment and output (Jeong, 2002).

Figure 5(b.1) shows the partial wavelet coherence between global Sukuk and EPU indexes. The short-term co-movements were not observed at higher frequencies (1–2 days), can be noticed clearly for the medium term (4–8-day investment horizons), and are principally in the middle of the sample period (March 2020). The EPU moved from approximately 100 in January 2020 to nearly 400 in March 2020. Robust long-term co-movements can be observed during the beginning and middle of the sample period for the 16–32-day investment horizons, indicating a phase relationship, and the Sukuk is leading. The partial phase differences indicate different co-movements in different term periods. The short-term phase differences were within $[-\rho/2, 0]$ during January and February 2020, meaning positive co-movements, and Sukuk prices are leading. During March and April 2020, the phase differences were within $[0, \rho/2]$, indicating positive co-movements, and the EPU index is leading. A different picture is observed in the long term. Two distinct periods are observed: (i) up to the end of March 2020, a positive co-movement, and the EPU index was leading, and (ii) from the beginning of April 2020, a positive co-movement, and Sukuk prices were leading.

Figure 6 presents the wavelet and partial wavelet coherences among the Sukuk index and global financial distress.

The wavelet coherence between the global Sukuk market and the global financial distress reported in Figure 6(a.1) discloses vast areas of red, demonstrating a robust co-movement over the 1–2-day frequency bands for the entire sample period. Besides, the presence of small red areas of robust dependence during the entire study period is noticed in the 2–4-day frequency bands. However, a vast red island identified in the middle of the study period and matched to the lower frequencies (8–16- and 16–32-day frequency bands) is observed. Global financial distress affects the normal functioning of financial markets, and the global Sukuk index appears to have been impacted by global financial stress. This outcome is in line with the results of Naifar and Hammouded (2016). They find a co-movement and causality relationship between Gulf Cooperation Council Sukuk returns and global financial distress during bullish periods. The short-term (1–2-day and 2–4-day frequency bands) phase differences are within $[0, \rho/2]$, indicating positive co-movements among global financial distress and Sukuk prices, and the GFSI index is leading. The same picture is observed for the medium term (especially for the 4–8-day frequency bands). Inverse long-term co-movements are observed between Sukuk prices and
the GFSI index during February, March, and April 2020, and positive co-movements were observed during January and May 2020.

To avoid the simultaneous effect of VIX, EPU, oil prices, and COVID-19-infected case indexes, the partial wavelet coherency is computed, and results are presented in Figure 6(b.1). First, the short-term co-movements are not detected for the 1–2-day and are only observed for the 2–4-day frequency bands with a large red island identified in the middle and at the end of the study period. The dependence structure is also detected over the long term (16–32 days) during the period. The short-term (1–2-day and 2–4-day frequency bands) and long-term (up to 16 days) partial phase differences are principally within \([0, \rho_i/2]\), indicating positive co-movements between global financial distress and Sukuk prices, and Sukuk prices are leading. In the medium term, an anti-phase relation (equivalent to negative covariance) during April and May 2020 was perceived, and GFSI was leading.

Figure 7 illustrates the wavelet and partial wavelet coherencies between the global Sukuk index and global COVID-19-infected cases.

Figure 7(a.1) reports the wavelet coherence among the global Sukuk market and global COVID-19-infected cases. Vast areas of red color indicate robust co-movements over the 1–2-day frequency bands for the entire study period. Also identified is the presence of small islands of weak dependence at the end of the study period over the 2–4-day frequency bands. The global Sukuk market appears to respond to the massive increase in the number of COVID-19-infected cases. In February, the number of global cases increased rapidly. However, the absence of the red island for the entire study period for the 8–16-day and 16–32-day frequency bands indicates that no effect is expected on the long-term horizon. The short-term (1–2-day and 2–4-day frequency bands) phase differences are mainly within \([0, \rho_i/2]\), indicating positive co-movements between global COVID-19-infected cases and Sukuk prices, and the COVID-19 index is leading. In the medium term, a positive co-movement was detected between COVID-19-infected cases and Sukuk prices, except for at the beginning of March 2020. The global Sukuk market appears to respond positively to COVID-19 pandemic news, except for at the beginning of March 2020, when the WHO announced the COVID-19 as a global pandemic. A long-term positive co-movement is also detected between Sukuk prices and COVID-19-infected cases.

To keep away the synchronized effect of the other variables, the partial wavelet coherency is computed, and the results are presented in Figure 7(b.1). Observed are short-term (only for the 2–4-day frequency band) and medium-term (for 4–8-day and 8–16-day frequency bands) co-movements with a small red island identified mainly at the
central and end of the study sample. The dependence structure is not observed over the long term (16–32 days’ investment perspectives). The partial phase differences indicate different co-movements in different term periods. The short-term partial phase differences are within \([0, +\rho_i/2]\) during January, February, and March 2020, indicating positive co-movements, and global COVID-19-infected cases were leading. During March and April 2020, the phase differences were in the \([-\rho_i/2, 0]\) interval, showing positive co-movements, and the EPU index was leading. In the long term, two different periods are observed: (i) up to the middle of February 2020, positive co-movements, and Sukuk
prices were leading, and (ii) from the middle of February 2020, a positive co-movement, and COVID-19-infected cases were leading.

The co-movements between global Sukuk prices and global economic and financial risk factors are time and frequency varying and can be summarized as follow. First, global Sukuk market behave differently with the global risk factors (global financial distress, VIX index, and the global economic uncertainty) during the COVID-19 pandemic. Second, only short-term co-movements between global Sukuk prices and COVID-19-infected cases are stronger. Third, the partial coherency and partial phase difference disclose that global Sukuk react more to global financial distress and the VIX index than the other variables. Fourth, co-movements among Sukuk prices and the oil market are found at short-term horizon.

5.2 | Malaysian Sukuk market findings

In this section, the impact of Malaysia COVID-19-infected cases, oil prices, and global risk factors on Malaysia’s sovereign Sukuk prices are investigated. We first examined the Granger Causality between Malaysia’s Sukuk and global risk factors. We find unidirectional Granger causality that goes from oil to Malaysia Sukuk, and bidirectional causality between Malaysia Sukuk, VIX index and GFSI. Figure 8 plots the wavelet and partial wavelet coherences between the Malaysian Sovereign Sukuk index and oil prices.

The wavelet coherence among the Malaysia Sukuk market and oil prices illustrated in Figure 8(a.1) discloses vast areas of red color, showing strong co-movements over the 1–2-day frequency bands for the entire study period. We also notice the presence of small regions of robust dependence at the commencement of the study period over the 4–8-day frequency bands. However, the absence of long-term co-movements is observed between the Malaysia Sukuk market and oil prices. The partial wavelet coherence between Malaysian Sovereign Sukuk prices and the EPU index is presented in Figure 8(b.1). Short-term co-movements are not detected in the higher frequency (1–2-day). They can be clearly noticed for the medium term (4–8-day investment horizons) and are principally at the beginning of the study period. The long-term partial phase differences vary over time. They are in the $[0, +\pi/2]$ interval up to the end of March 2020, indicating positive co-movements among oil prices and Malaysian Sukuk prices, and oil prices were leading. They are in the $[0, -\pi/2]$ interval during April and May 2020, indicating a positive co-movement, and the Malaysian Sukuk prices were leading.

Figure 9 plots the wavelet and partial wavelet coherences between the Malaysian Sovereign Sukuk index and the VIX index.

The wavelet coherence between the Malaysia Sukuk market and the VIX index presented in Figure 9(a.1) reveals the presence of vast zones of high coherence throughout the study period over the first frequency bands (1–2 days). For the 2–4 days, the presence of small islands of medium dependence is noted. The dependence structure is mainly detected over the long-term (up to 32 days) during the entire sample period. Figure 9(b.1) shows a relatively different pattern. First, short-term (only for the 2–4-day frequency band) and medium-term (4–8-day and 8–16-day frequency bands) co-movements are observed. In the long term for the 16–32-day band, significant co-movements are observed mainly in the middle and at the end of the study. The long-term partial phase differences vary over time. They are in the $[0, +\pi/2]$ interval during January and May 2020, indicating positive co-movements between global financial uncertainty and Malaysian Sukuk prices, and the VIX index was leading. They were in the $[\pi/2, \pi]$ interval during March, April, and May 2020, indicating a negative co-movement (anti-phase relation), and the Malaysian Sukuk prices were leading.

Figure 10 plots the wavelet and partial wavelet coherences between the Malaysian Sovereign Sukuk index and global economic uncertainty.

The wavelet coherence between the Malaysian Sukuk market and global economic uncertainty, as reported in Figure 10(a.1), discloses vast areas of red color, which indicates robust co-movements over the 1–2-day frequency bands for the entire study sample. Also noticed is the presence of minor red islands of strong dependence at the commencement, the middle, and the end of the sample period over the 2–4-day frequency bands. However, a vast island is identified in the middle of the sample period and is matched to lower frequencies (8–16-day and 16–32-day frequency bands). The short-term (1–2-day and 2–4-day frequency bands) phase differences fluctuate within $[0, -\pi/2]$ and $[0, +\pi/2]$, indicating positive co-movements between global economic uncertainty and Malaysian Sukuk prices. The Malaysian Sukuk prices led during March 2020, and the EPU index led during the remaining study period. In the medium term, an anti-phase relation (equivalent to negative covariance) is observed during April and May 2020, with Malaysia Sukuk prices leading.
Figure 10(b.1) presents the partial wavelet coherence between the Malaysian Sovereign Sukuk index and the EPU index. The short-term co-movements are not detected in the higher frequency (1–2-day) but can be noticed clearly for the lower frequency (4–8-day investment horizons) and are principally at the beginning and the middle of the study period. The medium-term partial phase difference varies over time. For the 8–16-day frequency band, the partial phase difference was in the \([-\rho_i/2, -\rho_i]\) interval during April 2020, demonstrating that the time series were out-of-phase (a negative co-movement), and the EPU index was leading. In the long term, the partial phase difference is in
the $[0, +\rho_i/2]$ interval, indicating positive co-movements between global economic uncertainty and Malaysian Sukuk prices, and the EPU index is leading.

The wavelet coherence and the partial wavelet coherency between the Malaysian Sovereign Sukuk index and global financial distress are presented in Figure 11.

The wavelet coherence among the Malaysian Sukuk market and global financial distress reported in Figure 11(a.1) discloses vast areas of red color, showing strong co-movements during the 1–2-day investment perspective for the entire study period. We also notice the presence of small areas of robust dependence at the commencement and the middle of the sample period over the 2–4-day frequency bands. However, a vast red island is identified in the middle of the sample period and matches the 16–32-day frequency bands, indicating that it is anticipated to have a long-term negative impact on Sukuk prices. The partial wavelet coherency presented in Figure 11(b.1) indicates the absence of short-term co-movements for 1–2 days. The co-movement is only observed for 2–4-day, 4–8-day, and 8–16-day frequency bands with small and medium red areas localized mainly at the middle and end of the sample period. The dependence structure is also detected over the long term (16–32 days of investment perspectives). The long-term partial phase differences are in the $[0, -\rho_i/2]$ interval, indicating a positive co-movement between global financial distress and Malaysian Sukuk prices, and the Sukuk prices are leading. The medium-term partial phase differences for the 4–8 frequency bands vary over time: (i) up to the end of March 2020, positive co-movements, and the GFSI index was leading, and (ii) from the beginning of April 2020, a positive co-movement and Sukuk prices were leading.

Figure 12 presents the wavelet and partial wavelet coherencies between the Malaysian Sovereign Sukuk index and COVID-19-infected cases.

The wavelet coherence among the Malaysian Sukuk market and the global coronavirus infected cases are reported in Figure 12(a.1) divulges vast areas of red color, showing robust co-movements over the 1–2-day frequency band for the entire study period. We also identify the presence of a small area of weak dependence in the middle of the sample period over the 8–16 days’ frequency bands. The phase differences in the short- and medium-term are principally in $[0, -\rho_i/2]$, indicating positive co-movements between Malaysian Sukuk prices and COVID-19-infected cases and Sukuk prices are leading.

The partial coherencies (Figure 12(b.1)) capture the co-movement between Malaysian Sukuk prices and COVID-19-infected cases when controlling the other variables. From Figure 12(b.1), we notice the absence of co-movement in the short-term for the 1–2 days. We observe only co-movements for 2–4-day and 4–8-day investment perspectives with small red islands identified mainly at the end of the study period. The dependence structure is seen over the long-term (16–32 days investment horizons) at the end of the study period. The long-term partial phase differences were in the...
interval \([0, +\rho_i/2]\) up to the end of March 2020, indicating positive co-movements between COVID-19-infected cases and Malaysian Sukuk prices with the COVID-19 index is leading. During April and May 2020, the partial phase differences were zero, indicating the absence of a lead–lag relationship.

The co-movements between Malaysian Sukuk prices and global uncertainty factors are time and frequency varying and can be summarized as follow. First, Malaysian Sukuk prices behave differently with the global uncertainty factors during the COVID-19 pandemic period. Second, only the short-term co-movements between Malaysian Sukuk prices and the COVID-19-infected cases are stronger. Third, the partial coherency and partial phase difference reveal that Malaysian Sukuk react more to global financial uncertainty (embedded in the VIX index) than the other uncertainty variables. Finally, the co-movements among Malaysian Sukuk prices and the oil prices are weak at the long-term horizon.

6 | CONCLUDING REMARKS

After the recent global financial crisis, the global Sukuk market has become a progressively more interesting investment as the uncertainty in the global financial markets continues. Sukuk returns have exhibited a low correlation with conventional fixed income investment assets, implying the potential benefits of diversification. However, recent COVID-19 pandemic spreads have indicated significant negative implications for global financial markets. The rapid spread of the coronavirus combined with the recent crash of oil prices and the increasing financial and economic uncertainty are generating different challenges for global financial markets, including Sukuk markets.

In this paper, the time–frequency relationship between Sukuk prices and several factors is investigated, including the speed of COVID-19 transmission, oil prices, economic policy uncertainty, global financial uncertainty, and global financial distress. The DJSI is used as a proxy for the global Sukuk market, and the Malaysian Sovereign Sukuk index is used for comparison because Malaysia is the most significant global player in the sovereign Sukuk market. Using wavelet coherency, partial wavelet coherency, and phase differences, a variety of empirical findings are revealed that can be summarized as follows. First, the co-movements between Sukuk prices (both global and Malaysian Sukuk) and global economic and financial risk factors are time and frequency varying. Second, global and Malaysian Sukuk markets behave differently with the global risk factors during the COVID-19 pandemic. Third, only short-term co-movements between

FIGURE 12 Wavelet and partial wavelet coherencies plot among Malaysian Sovereign Sukuk prices and COVID-19-infected cases in Malaysia. Note: Wavelet coherency (a.1) and partial wavelet coherency (b.1) among Malaysian Sovereign Sukuk prices and COVID-19-infected case index. The x-axis denotes the date, and the y-axis indicates the period (in days). The color for power varies from blue (low power) to red (high power). The black curve describes the 5% significance level. The below left and right figures illustrate phase differences. If the phase difference is within \([0, \rho_i/2]\), the series moves in phase, with the COVID-19-infected case index leads the Sukuk prices. If the phase difference is within \([-\pi/2, 0]\), then Sukuk prices are leading. If the phase difference is within \([\pi/2, \pi]\), then Sukuk prices are leading, and the COVID-19 infected case index is leading if the phase difference is within \([-\pi, -\pi/2]\)
Sukuk prices (both global and Malaysian Sukuk) and COVID-19-infected cases are stronger. Fourth, the partial coherency and partial phase difference divulge that both the global and the Malaysian Sukuk markets react more to global financial distress and global financial uncertainty (embedded in the VIX index) than the other variables. Fifth, primarily short-term co-movements among Sukuk prices, the U.S. economic policy uncertainty, and the oil market are found, and long-term co-movements are weak and less stable.

Understanding the dynamics of the co-movement between Sukuk markets and global economic and financial risk factors in portfolio risk management assists local, international, and faith-based investors in minimizing risk through diversification and optimizing their portfolios in terms of risk and returns. The main finding from the wavelet coherence analysis is that the co-movement between Sukuk and global risk factors varies through frequency and time. This finding indicates that the investors should consider simultaneously the long- and short-run co-movements between sukuk and global uncertainty factors when building their portfolios. Faith-based investors and passive investors are more interested in Sukuk price co-movements at lower frequencies (the long-term co-movement), that is, in the short-run co-movement. They can use information on global financial distress and global financial uncertainty to predict Sukuk price dynamics in long terms and manage downside or upside portfolio risks. However, some other investors (e.g., active traders) are concerned with the higher frequencies (the short-term co-movement). Moreover, the negative co-movement between Sukuk prices and global uncertainty factors during some periods constitutes alternatives for international investors when introducing Sukuk instruments into their portfolios.

ENDNOTES

1 Pecking order theory recommends that capital costs escalate with information asymmetry levels (Myers, 1984; Myers & Majluf, 1984). On another note, tradeoff theory suggests that firms should select optimum debt levels (Modigliani & Miller, 1963).

2 https://www.icmr.my/data/Sukuk_market.html

3 https://www.thedegemarke.com/article/2020-corporate-bond-Sukuk-issuance-seen-rm90b-rm100b

4 The correlation between global sukuk and global COVID-19-confirmed cases is negative and equal to −0.2266. The correlation between global sukuk and global COVID-19-confirmed cases is also equal to −0.2239.

5 Null Hypothesis: VIX, GFSI, EPU, oil, and COVID-19 global cases do not cause DJSI. The values in brackets represent p-value DJSI ← VIX (0.0008); DJSI ← Oil (0.0033); DJSI ← GFSI (0.0000); DJSI ← COVID-19 (0.0031); DJSI ← EPU (0.4537).

6 https://www.marketwatch.com/story/this-chart-of-the-stock-markets-fear-index-in-2020-illustrates-how-unhinged-markets-have-been-over-coronavirus-compared-to-the-2008-crisis-2020-03-10

7 Null Hypothesis: VIX, GFSI, EPU, oil, and COVID-19 global cases do not cause Malaysia Sukuk (MSUK). MSUK ← VIX (0.0113); MSUK ← Oil (0.0062); MSUK ← GFSI (0.0000); MSUK ← COVID-19 (0.2627); MSUK ← EPU (0.8629).

REFERENCES

Abdul Halim, Z., How, J., & Verhoeven, P. (2017). Agency costs and corporate Sukuk issuance. Pacific Basin Finance Journal, 42, 83–95. https://doi.org/10.1016/j.pacfin.2016.05.014

Afshar, T. A. (2013). Compare and contrast Sukuk (Islamic Bonds) with conventional bonds, are they compatible? Journal of Global Business Management, 9(1), 44.

Aguiar-Conraria, L., Azevedo, N., & Soares, M. J. (2008). Using wavelets to decompose the time-frequency effects of monetary policy. Physica A: Statistical Mechanics and its Applications, 387, 2863–2878. https://doi.org/10.1016/j.physa.2008.01.063

Aguiar-Conraria, L., & Soares, M. J. (2011). Oil and the macroeconomy: using wavelets to analyze old issues. Empirical Economics, 40(3), 645–655.

Akhtar, S., & Jahromi, M. (2017). Impact of the global financial crisis on Islamic and conventional stocks and bonds. Accounting & Finance, 57(3), 623–655. https://doi.org/10.1111/acfi.12136

Al Trad, S., & Bhuyan, R. (2015). Prospect of Sukuk in the fixed income market: A case study on Kuwait financial market. International Journal of Financial Research, 6(4), 175–186.
Alam, N., Hassan, M. K., & Haque, M. A. (2013). Are Islamic bonds different from conventional bonds? International evidence from capital market tests. *Borsa Istanbul Review, 13*(3), 22–29. https://doi.org/10.1016/j.bir.2013.10.006

Alaoui, A. O., Dewandaru, G., Rosly, S. A., & Masih, M. (2015). Linkages and co-movement between international stock market returns: Case of Dow Jones Islamic Dubai Financial Market index. *Journal of International Financial Markets, Institutions and Money, 36*, 53–70. https://doi.org/10.1016/j.intfin.2014.12.004

Aloui, C., Hammoudeh, S., & Hamida, H. B. (2015a). Global factors driving structural changes in the co-movement between sharia stocks and Sukuk in the Gulf Cooperation Council countries. *The North American Journal of Economics and Finance, 31*, 311–329. https://doi.org/10.1016/j.najef.2014.12.002

Aloui, C., Hammoudeh, S., & Hamida, H. B. (2015b). Price discovery and regime shift behavior in the relationship between sharia stocks and Sukuk: A two-state Markov switching analysis. *Pacific-Basin Finance Journal, 34*, 121–135. https://doi.org/10.1016/j.pacfin.2015.06.004

Aloui, C., Hammoudeh, S., & Hamida, H. B. (2015c). Co-movement between sharia stocks and sukuk in the GCC markets: A time-frequency analysis. *Journal of International Financial Markets, Institutions and Money, 34*, 69–79. https://doi.org/10.1016/j.intfin.2014.11.003

El Mosaid, F., & Boutti, R. (2014). Sukuk and bond performance in Malaysia. *International Journal of Economics and Finance, 6*(2), 226–234. https://doi.org/10.5539/ijef.v6n2p226

Erdogan, S., Gedikli, A., & Cevik, E. I. (2020). The effects of the covid-19 pandemic on conventional and islamic stock markets in Turkey. *bilimname, 2020*(42), 89–110. https://doi.org/10.28949/bilimname.799413

Fan, Y., & Gencay, R. (2010). Unit root tests with wavelets. *Econometric Theory, 26*, 1305–1331.

Godlewski, C. J., Turk-Ariss, R., & Weill, L. (2014). What influences stock market reaction to sukuk issues? The impact of scholars and sukuk types. Available at SSRN: https://ssrn.com/abstract=2397707

Godlewski, C. J., Turk-Ariss, R., & Weill, L. (2016). Do the type of Sukuk and choice of shari'a scholar matter? *Journal of Economic Behavior & Organization, 132*, 63–76. https://doi.org/10.1016/j.jebo.2016.04.020

Haque, M. M., Chowdhury, M. A. F., Buriev, A. A., Bacha, O. I., & Masih, M. (2017). Who drives whom—Sukuk or bond? A new evidence from GCC Islamic equity index based on wavelet analysis. INCEF, 15th Malaysian finance association conference, June 3–5, 2013, Kuala Lumpur, Malaysia. https://mpra.ub.uni-muenchen.de/56980/1/MPRA_paper_56980.pdf

El Mosaic, F., & Boutti, R. (2014). Sukuk and bond performance in Malaysia. *International Journal of Economics and Finance, 6*(2), 226–234. https://doi.org/10.5539/ijef.v6n2p226

Erdogan, S., Gedikli, A., & Cevik, E. I. (2020). The effects of the covid-19 pandemic on conventional and islamic stock markets in Turkey. *bilimname, 2020*(42), 89–110. https://doi.org/10.28949/bilimname.799413

Fan, Y., & Gencay, R. (2010). Unit root tests with wavelets. *Econometric Theory, 26*, 1305–1331.

Godlewski, C. J., Turk-Ariss, R., & Weill, L. (2014). What influences stock market reaction to sukuk issues? The impact of scholars and sukuk types. Available at SSRN: https://ssrn.com/abstract=2397707

Godlewski, C. J., Turk-Ariss, R., & Weill, L. (2016). Do the type of Sukuk and choice of shari’a scholar matter? *Journal of Economic Behavior & Organization, 132*, 63–76. https://doi.org/10.1016/j.jebo.2016.04.020

Haque, M. M., Chowdhury, M. A. F., Buriev, A. A., Bacha, O. I., & Masih, M. (2017). Who drives whom—Sukuk or bond? A new evidence from granger causality and wavelet approach. *Review of Financial Economics, 36*(2), 117–132. https://doi.org/10.1016/j.rfe.2017.09.002

Hassan, M. K., Paltrinieri, A., Dreassi, A., Miani, S., & Scipu, A. (2018). The determinants of co-movement dynamics between Sukuk and conventional bonds. *The Quarterly Review of Economics and Finance, 68*, 73–84. https://doi.org/10.1016/j.qref.2017.09.003

Jeong, B. (2002). Policy uncertainty and long-run investment and output across countries. *International Economic Review, 43*, 363–392.

Jobst, A., Kunzel, P., Mills, P., & Sy, A. (2008). Islamic bond issuance: what sovereign debt managers need to know. *International Journal of Islamic and Middle Eastern Finance and Management, 1*(4), 330–344. https://doi.org/10.1016/j.ijifm.2015.06.004

Krasicka, M. O., & Nowak, S. (2012). Dynamic transmissions between Sukuk and bond markets. *Research in International Business and Finance, 38*, 246–261. https://doi.org/10.1016/j.ribaf.2016.04.016

Mnif, E., Salhi, B., & Jarboui, A. (2019). Herding behaviour and Islamic market efficiency assessment: case of Dow Jones and Sukuk market. *International Journal of Islamic and Middle Eastern Finance and Management, 13*(1), 24–41. https://doi.org/10.1016/j.ijifm.2015.06.004

Modigliani, F., & Miller, M. H. (1958). Corporate income taxes and the cost of capital: A correction. *The American Economic Review, 53*(3), 433–443.

Myers, S. C. (1984). The capital structure puzzle. *Journal of Finance, 39*(3), 575–590.
Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have (No. w1396). National Bureau of Economic Research.

Naeem, M. A., Billah, M., Marei, M., & Balli, F. (2021). Quantile connectedness between Sukuk bonds and the impact of COVID-19. Applied Economics Letters, 1–10. https://doi.org/10.1080/13504851.2021.1934384

Naifar, N. (2022). Sukuk returns dynamics under bullish and bearish market conditions: Do COVID-19 related news and government measures matter? Applied Economic Letters. https://doi.org/10.1080/13504851.2022.2027860

Naifar, N., Hammoudeh, S., & Al dohaiman, M. S. (2016). Dependence structure between Sukuk (Islamic bonds) and stock market conditions: An empirical analysis with Archimedean copulas. Journal of International Financial Markets, Institutions and Money, 44, 148–165. https://doi.org/10.1016/j.intfin.2016.05.003

Naifar, N., Mroua, M., & Bahloul, S. (2017). Do regional and global uncertainty factors affect differently the conventional bonds and Sukuk? New evidence. Pacific-Basin Finance Journal, 41, 65–74. https://doi.org/10.1016/j.pacfin.2016.12.004

Nanaeva, Z. K. (2010). How risky Sukuk are: Comparative analysis of risks associated with Sukuk and conventional bonds. Doctoral dissertation, The British University in Dubai (BUiD).

Paltrinieri, A., Hassan, M. K., Bahoo, S., & Khan, A. (2019). A bibliometric review of sukuk literature. International Review of Economics & Finance. https://doi.org/10.1016/j.iref.2019.04.004

Salisu, A. A., & Sikiru, A. A. (2020). Pandemics and the Asia-Pacific Islamic stocks. Asian Economics Letters, 1(1), 17413. https://doi.org/10.46557/001c.17413

Shahzad, S. J. H., & Naifar, N. (2021). Dependence dynamics of Islamic and conventional equity sectors: What do we learn from the decoupling hypothesis and COVID-19 pandemic? The North American Journal of Economics and Finance, 59, 1–12.

Sherif, A., Aloui, C., & Yarovaya, L. (2020). COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the U.S. economy: Fresh evidence from the wavelet based approach. International Review of Financial Analysis, 70, 101496.

Sherif, M. (2020). The impact of Coronavirus (COVID-19) outbreak on faith-based investments: An original analysis. Journal of Behavioral and Experimental Finance, 28, 100403. https://doi.org/10.1016/j.jbef.2020.100403

Tariq, A. A., & Dar, H. (2007). Risks of Sukuk structures: Implications for resource mobilization. Thunderbird International Business Review, 49(2), 203–223. https://doi.org/10.1002/tie.20140

Tiwari, A., Albulescu, C., & Gupta, R. (2016). Time–frequency relationship between U.S. output with commodity and asset prices. Applied Economics, 48(3), 227–242.

Torrence, C., & Compo, G. P. (1998). A practical guide to wavelet analysis. Bulletin of the American Meteorological Society, 79, 61–78.

Vishwanath, S. R., & Azmi, S. (2009). An overview of Islamic Sukuk bonds. The Journal of Structured Finance, 14(4), 58–67. https://doi.org/10.3905/JSF.2009.14.4.058

Wilson, R. (2008). Innovation in the structuring of Islamic Sukuk securities. Humanomics, 24, 170–181.

Yarovaya, L., Elsayed, A., & Hammoudeh, S. (2020). Searching for Safe Havens during the COVID-19 Pandemic: Determinants of spillovers between Islamic and Conventional Financial Markets. Available at SSRN: https://ssrn.com/abstract=3634114

Yarovaya, L., Mirza, N., Rizvi, S. K. A., Saba, I., & Naqvi, B. (2020). The resilience of Islamic equity funds during COVID-19: Evidence from risk adjusted performance, investment styles and volatility timing. Investment Styles and Volatility Timing.

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