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# Impact of COVID-19 pandemic on stock markets: Conventional vs. Islamic indices using wavelet-based multi-timescales analysis

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## ABSTRACT

We empirically explore the effect of the COVID-19 pandemic on Islamic and conventional stock markets from a global perspective. We also explore the co-movement between Islamic and conventional stock markets. Two comparable pairs of conventional and Islamic stock indices – Dow Jones Index and FTSE Index are considered in this study. Employing Wavelet-based multi-timescales techniques on the daily data from 21st January to 27th November 2020, our findings indicate that the pandemic creates identical volatility in both stock markets. Our findings further suggest that both markets are strongly associated and tend to co-move highly during our sample period, rebutting the decoupling hypothesis of the Islamic stock market from the conventional market. However, the Shariah screening process fails to provide immunity to Islamic stock markets against financial crises. Our findings suggest that investors should be aware that Islamic stocks' conservative features do not present a superior investment alternative, especially in economic turmoil.

## 1. Introduction

The 'Black Swan'<sup>1</sup> events can have an adverse effect on stock markets, as these events create sudden shock and fear among investors, which leads to uncertainty (Burch, Douglas, & Michael, 2016; He, Liu, Wang, & Yu, 2020). For example, the Persian Gulf War in 1991, the Asian financial crisis in 1997, the 9/11 terrorist attacks in 2001, and the global financial crisis (GFC) in 2008 all had significant adverse effects on stock markets (Chen, Chen, Tang, & Huang, 2009; Karunanayake, Valadkhani, & O'Brien, 2010). Previous studies have also revealed that stock markets are closely associated with epidemics, for instance, Severe Acute Respiratory Syndrome (SARS) epidemic (Chen et al., 2009; Hsieh, 2013; Chen, Lee, Lin, and Chen, 2018) and Ebola Virus Disease (EVD) epidemic (Giudice and Paltrinieri, 2017; Ichev and Marinč, 2018). The recent outbreak of coronavirus disease (COVID-19) pandemic is also being treated as a Black Swan event. However, the pandemic has created unprecedented panic and uncertainty over the global business activity, which has, in turn, churned financial markets and driven the global economy toward depression (Choi, Levine, and Malone, 2020; Yarovaya, Matkovskyy, and Jalan, 2020).

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E-mail address: [mhassan@uno.edu](mailto:mhassan@uno.edu) (M.K. Hassan).<sup>1</sup> The term "Black swan" was first introduced by Taleb (2007), which later popularly uses to address unexpected and unprecedented events affecting stock markets (Yarovaya, Matkovskyy, and Jalan, 2020).<https://doi.org/10.1016/j.najef.2021.101504>

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Though the COVID-19 is a health crisis, it has increasingly transmuted into a severe economic crisis, leading to an unmatched world economic and financial turmoil (Baldwin and Mauro, 2020; Yarovaya et al., 2020). As a result, stock markets have been struck by fears of a sharp escalation of the COVID-19 crisis. Such concerns induce shareholders to react immediately with a largely pessimistic attitude and then start withdrawing their holdings from the stock markets, resulting in a sharp drop in stock prices. For instance, global stocks lost market value by nearly USD 6 trillion in just a single week (February 24th to 28th, 2020), based on S&P Dow Jones Indices, as investors feared a recession due to the COVID-19.<sup>2</sup> For the same period, the U.S. S&P 500 wiped off about USD 5 trillion (Ozili and Arun, 2020). The pandemic has severely affected some other regional stock markets too. For example, Europe's EURO STOXX, UK's FTSE, France's CAC 40, and Japan's NIKKEI225 all lost their market values by 30 to 42 percent, down to fears generated by the pandemic (Yarovaya et al., 2020). Thus, it seems that the COVID-19 may have spillover effects on different sectors of the global economy, particularly on the stock markets (Ozili and Arun, 2020; Hasan, Mahi, Sarker, and Amin, 2021). Surprisingly, it is observed that these stock market indices show dissimilarity in their recovery toward equilibrium (Yarovaya et al., 2020), which requires being explored further.

Plausibly, it is early to determine the appropriate influence of stock markets associated with the COVID-19 pandemic; however, several researchers have already investigated the issue to support the investors and policymakers. The existing studies attempt to explore the impacts of COVID-19 on stock markets from different viewpoints; however, most of these studies have found a negative effect of COVID-19 (for example, Ashraf, 2020; Sharif, Aloui, and Yarovaya, 2020; Al-Awadhi, Alsaifi, Al-Awadhi, and Alhammadi, 2020; Zhang, Hu, and Ji, 2020; He et al., 2020; Yilmazkuday, 2020; Baker, Bloom, Davis, Kost, Sammon, and Viratyosin, 2020; Ramelli and Wagner, 2020; Ozili and Arun, 2020; Mazur, Dang, and Vega, 2020, Hasan et al., 2021; Li, 2021; Yarovaya, Elsayed, and Hamoudeh, 2021; Uddin, Chowdhury, Anderson, and Chaudhuri, 2021; among others) with some exceptions that reported mixed results (Onali, 2020). However, one significant gap evident in the existing literature is that these studies focused on the shock of the COVID-19 pandemic exclusively from the perspectives of conventional stock markets. Although, some recent studies compared the riskiness of different investment opportunities (i.e., equity vs. bitcoin) to recognize whether the wealth allocation to alternative assets helps to reduce the downside risk exposures during the pandemic crisis (Conlon, Corbet, and McGee, 2020; Conlon and McGee, 2020); a comparative investigation is still missing regarding the relative volatilities and co-movement of the Islamic and conventional stock markets during this pandemic crisis.

The evaluation of the effect of COVID-19 on Islamic stock markets is crucial for several reasons. First, in recent years, Islamic finance has recorded an unprecedented growth of an average of about 6% per annum, with a total assets value of US\$ 2.44 trillion.<sup>3</sup> Second, this kind of growth is supported by both Muslim and non-Muslims investors (Aarif et al., 2019). In recent times, non-Muslim investors, particularly ethical investors, tend to choose Islamic products for their portfolios due to the attractive risk-return characteristics and ethical issues of such Islamic products.<sup>4</sup> The Islamic financial system's underlying principles necessitate the returns to be earned in an ethical and socially responsible manner from investments (DeLorenzo, 2000). Third, even though the portfolio size of the Islamic stock markets is smaller than the conventional markets,<sup>5</sup> the Islamic indices have empirically shown their outperformance over their conventional counterparts, especially in times of crisis, attributable to their conservative nature (for example, Hussein and Omran, 2005; Ho et al., 2014; Al-Khazali, Lean, and Samet, 2014; Alexakis, Pappas, and Tsikouras, 2015; Azmi, Ng, Dewandaru, and Nagayev, 2019, among others). Besides, Islamic stock markets are more immune to crises than conventional markets and can, therefore, provide a better avenue for investors to diversify (Alexakis et al., 2015).

On the contrary, some argue that the performance between Islamic and non-Islamic stock markets has no significant difference (Hussein, 2004; Girard and Hassan, 2008; Cevik and Bugan, 2018; Trabelsi, Bahloul, and Mathlouthi, 2020, among others). The resilience showed by the Islamic indices, notably during the GFC as reported in the earlier studies, may not be applicable for the COVID-19 induced scenario. One distinction of the impact of COVID-19 compared to the earlier crisis period could be the different macro-economic scenarios. Markedly, while the global economy and financial markets are in chaos, the recent oil price crisis during this period has made the condition graver. Karim (2010) argues that Islamic financial markets showed better resiliency during the GFC predominantly due to the higher oil price in that period. However, during the COVID-19 pandemic, reduced demand for oil has donated to plummeting prices and declining production, especially in the wake of the Russia-OPEC price war (Mylenska and Novyk, 2020; Hasan et al., 2021). This may create an additional challenge for the Islamic markets since a substantial number of oil companies belong to Middle East countries, and these companies, as constituents, occupy a significant portion of Islamic indices. Thus, the unprecedented fall of oil prices may have a severe impact on the Islamic finance industry. The contrasting views in the literature, as well as the emergence of a unique scenario, indicate that regardless of its appealing principle of risk-sharing, the feasibility of Islamic equity as an alternative asset class in practice is a subject of debate (Nagayev, Disli, Inghelbrecht, and Ng, 2016). Another important issue regarding Islamic stock markets is its decoupling hypothesis from conventional stock markets, resulting in hedging opportunities, although this hypothesis has mixed findings in the literature (Foglie and Panetta, 2020).

Therefore, based on the above discussions, several research questions can be raised. First, does the COVID-19 hit the Islamic stock

<sup>2</sup> <https://www.nasdaq.com/articles/global-markets-coronavirus-panic-wipes-%246-trillion-off-world-stocks-this-week-2020-02-28>.

<sup>3</sup> Islamic Finance Development Report 2018. Available at: <https://repository.salaamgateway.com/images/iep/galleries/documents/20181125124744259232831.pdf>.

<sup>4</sup> Islamic Finance Development Report 2018. Available at: <https://repository.salaamgateway.com/images/iep/galleries/documents/20181125124744259232831.pdf>.

<sup>5</sup> Since many stocks are screened out in the Shariah-screening process, the size of the portfolio of Shariah index is generally smaller compared to the conventional counterparts.

markets in the same way as conventional markets? Second, if so, do both stock markets have identical volatility during COVID-19? Third, do the Islamic stock markets show more immunity to COVID-19 shock than the conventional ones? Finally, is the decoupling hypothesis of Islamic stock markets from conventional markets valid during this crisis period? These questions offer new dimensions of research and need further investigations to slim down the current knowledge gaps. We endeavor to answer these questions by evaluating the effect of COVID-19 fatalities on the global conventional and Islamic stock market indices.

For better comprehension, we have considered two pairs of global conventional and Islamic stock market indices. One pair is from the Dow Jones index series, namely Dow Jones Global Index (DJGI) and Dow Jones Islamic Market Index (DJIMI), and the other one is from the FTSE index series, namely FTSE All-World Index (FAWI) and FTSE All-World Shariah Index (FAWSI). We have employed wavelet-based multi-timescales analysis on the data from 21st January to 27th November 2020. Our results show that both Islamic and conventional stock markets are analogously impacted by the COVID-19 pandemic. Our results further suggest that conventional and Islamic stock markets are strongly associated and tend to highly co-move during our sample period, rebutting the decoupling hypothesis of Islamic stock markets from conventional stock markets.

Our findings have some important implications and offer some notable contributions to the prevailing literature. First, to understand the effect of the COVID-19 pandemic in financial markets, we consider Islamic stock market indices in addition to the conventional market indices. To the best of our knowledge, we are the first to look into the issue empirically, thus contributes to the emerging body of literature in this area. We add further novelty by comparing the volatility of the two markets, which provides a better understanding of their relative standing during the crisis period. The second contribution of our study is that our study tests the decoupling assumption of Islamic stock markets from conventional ones during the COVID-19 crisis and is among the first studies to do so. This leads to the third contribution of our study as it adds knowledge to the financial crisis literature by demonstrating how the non-financial issues or non-economic issues may generate volatility in the stock markets. Fourth, unlike traditional time series analyses, we analyze the data in multi-timescales with wavelet methods. The method contains information from both time and frequency domains and does not require strong assumptions regarding the data-generating process for the series; hence, the findings offer greater insights in comprehending the volatilities. Fifth, our results are of great benefit to Islamic portfolio managers and investors regarding investing and hedging strategies during financial crises like COVID-19. Finally, the results have policy implications for both policymakers and government regarding dynamics between COVID-19 and stock markets, which would help them allocate financial stimulus packages more efficiently and ensure prudential supervision of the markets.

The remainder of the paper, however, is structured as follows. [Section 2](#) presents related literature. The research methodology and data are presented in [Section 3](#). [Section 4](#) discusses the results of our analysis, and finally, [Section 5](#) concludes the study by providing practical and policy implications and outlining for future research.

## 2. Literature review

A small but growing body of literature has investigated the effect of the COVID-19 pandemic on different aspects. Some of the literature precisely considers the shocks on stock markets. For example, [Zhang et al. \(2020\)](#) found that COVID-19 has significantly amplified the risks of global financial markets. Individual stock markets are also impacted by the severity of the outbreaks in their respective countries. They also analyzed the potential effects of policy interventions and feared that the policies such as unlimited quantitative easing adopted by the US government could generate further uncertainties, which could lead to long-run problems. [Ashraf \(2020\)](#) examined the stock market reactions in 64 countries against the increase in cases of COVID-19 between 22nd January 2020 and 17th April 2020. The study showed that the stock markets responded adversely to the cases of COVID-19. The author also revealed that negative market responses were stronger in the early phases of the COVID-19. [He et al. \(2020\)](#) examined the effects and spillovers of COVID-19 in the stock markets of the eight most affected countries. Their results revealed that stock markets were adversely impacted by COVID-19 in the short run. They also showed that there were bidirectional spillover impacts of COVID-19 between Asian countries and European and American countries. [Ozili and Arun \(2020\)](#) analyzed the effect of social distancing caused by COVID-19 in the stock market indices of four continents. They highlighted that the stock indices were significantly influenced by the various social distancing measures undertaken because of COVID-19.

Moreover, [Sharif et al. \(2020\)](#) investigated how the US stock markets reacted to the COVID-19 pandemic during the first quarter of 2020 and reported a significant negative impact using wavelet methods. Similarly, [Baker et al. \(2020\)](#) and [Yilmazkuday \(2020\)](#) also documented a significant inverse link between COVID-19 and stock returns of the US stock market. [Baker et al. \(2020\)](#) further claimed that the COVID-19 pandemic has had a greater impact on the stock market than any earlier pandemic in history. In contrast, [Onali \(2020\)](#) reported mixed results in this regard. The author found a significant negative linkage between the COVID-19 and stock returns of the US stock market based on the VAR model.

In contrast, their GARCH (1, 1) model surprisingly found no significant connection between the same. [Al-Awadhi et al. \(2020\)](#) showed that both cases and deaths of COVID-19 had significant negative impacts on the stock returns of all firms of the Chinese stock market. [Mazur et al. \(2020\)](#) performed sectoral analysis allied with COVID-19, and the findings suggested that the stock prices of food, natural gas, software, and healthcare sectors gained momentum. In contrast, the stock prices of the entertainment, hospitality, petroleum, and real estate sectors declined sharply during COVID-19. They also added that the loser stocks showed severe asymmetric volatility.

Lately, researchers continue examining COVID-19's impact on financial markets from diverse aspects, especially volatility spillovers. For instance, [Li \(2021\)](#) analyzed the time-scale and asymmetric volatility spillovers across global stock markets using high-frequency datasets. The author showed that global stock markets are closely associated, and volatility is mainly transmitted from developed markets to emerging markets. Volatility spillovers are time-divers, crisis-sensitive, and asymmetric, with extremely high-

level volatility spillovers observed in the COVID-19 periods. Likewise, [Yarovaya et al. \(2021\)](#) found strong spillovers between Islamic and conventional stock markets in the COVID-19 period. They added that the Islamic bonds (Sukuk) are relatively less affected by the pandemic, exhibiting safe haven properties. The spillover effects of COVID-19 on three significant areas of the economy were investigated by [Hasan et al. \(2021\)](#). They showed that the energy sector had a greater impact, whereas COVID-19 has severe impacts on the economic activity, stock market, and energy sectors. Besides, they found significant volatility spillovers from economic activity to stock markets and energy sectors.

Similarly, [Laborda and Olmo \(2021\)](#) investigated the volatility spillover between seven significant sectors of the US economy in different crises, including COVID-19. The analysis showed that the banking and insurance industries were the main routes of shock transmissions to the rest of the economy in the 2008 GFC, while the energy and technology sectors were the main drivers during COVID-19. On the other hand, [Uddin et al. \(2021\)](#) unveiled significant stock market volatility caused by COVID-19. They also analyzed country-level economic characteristics and factors (economic resilience, intensity of capitalism, level of corporate governance, financial development, monetary policy rate, and quality of health system) to determine whether they can mitigate pandemic-driven stock market volatility. Interestingly, they found that these factors contribute to the reduction of volatility.

Hence, a growing body of literature has investigated the impacts of the COVID-19 pandemic considering different aspects of stock market dynamics. It is now well established that the pandemic has had significant negative impacts on stock markets locally and globally. However, the influence of COVID-19 on the Islamic stock markets has remained unclear. Hence, we make a humble endeavor to examine the effects of COVID-19 on the Islamic stock markets and compare the market reaction with comparable conventional stock markets to comprehend the market reactions in a better way.

### 3. Data and methodology

#### 3.1. Data

We use daily data of global death counts of COVID-19 and four different stock market indices from 21st January to 27th November 2020. We consider 21st January as our starting date for the sample since the human-to-human transmission was first confirmed provoked a massive outbreak of fears as millions traveled for the holiday of China's New Year.<sup>6</sup> The Dow Jones Global Index (DJGI) and FTSE All-World Index (FAWI) are used to proxy the conventional stock market. In contrast, Dow Jones Islamic Market Index (DJIMI) and FTSE All-World Shariah Index (FAWSI) are used to proxy the movement of Islamic stock markets. We have obtained the stock market indices data from Thomson Reuters Eikon and World Street Journal (WSJ) and the COVID-19 death counts from the work of [Roser, Ritchie, Ortiz-Ospina, and Hasell \(2020\)](#), which compiles the real-time data of the COVID-19 pandemic.

We calculate the daily returns of the time series data by finding the difference between two consecutive values following [Goodell and Goutte \(2020\)](#) as follows:

$$R_t = P_t - P_{t-1}, \quad (1)$$

where  $R_t$  denotes the return value of stock market indices (i.e., DJGI, DJIMI, FAWI, and FAWSI) and the change in global daily death counts from COVID-19. The return value is essentially the difference between the closing price of stock market indices (and COVID-19 daily death counts) at time  $t$  ( $P_t$ ) and  $t-1$  ( $P_{t-1}$ ).

#### 3.2. Continuous wavelet transform (CWT)

We primarily follow the study of [Grinsted, Moore, and Jevrejeva \(2004\)](#) to estimate wavelet decomposition, which applies the wavelet coherency in the form of the continuous wavelet transform on the return series to capture co-movement in time–frequency space. Specifically, we use the continuous wavelet transform (CWT), which is delineated as the integral overall time of the signal multiplied by scaled, shifted versions of the wavelet function  $\psi$  ([In and Kim, 2013](#)). This can be represented as follows:

$$C(\text{scale}, \text{position}) = \int_{-\infty}^{\infty} x_t \psi(\text{scale}, \text{position}, t) dt \quad (2)$$

The results of the CWT are many wavelet coefficients  $C$ , which are a function of scale and position. The scale and position can take on any value compatible with the region of the time series,  $x_t$ . The CWT maps the series correlations in a two-dimensional figure that allows easily identifying and interpreting patterns or hidden information ([Najeeb, Bacha, and Masih, 2015](#)). The wavelet power spectrum is defined as:

$$W_x(u, s) = |W_x(u, s)|^2 \quad (3)$$

This gauges the relative contribution at each time and each scale to the time series' variance.

Subsequent to the approach of [Torrence and Compo \(1998\)](#), we define the cross wavelet transform of two time-series  $x(t)$  and  $y(t)$  using their cross wavelet spectrum of  $W_n^x(u, s)$  and  $W_n^y(u, s)$  as:

<sup>6</sup> Timeline: How the new coronavirus spread by Al Jazeera (Available at: <https://www.aljazeera.com/news/2020/01/timeline-china-coronavirus-spread-200126061554884.html>).

$$W_n^{xy}(u, s) = W_n^x(u, s) * W_n^y(u, s) \quad (4)$$

In Eq. (4),  $W_n^x(u, s)$  and  $W_n^y(u, s)$  are wavelet transforms of two time series  $x(t)$  and  $y(t)$ ; where  $u$  is associated with the location and  $s$  to the scale and  $*$  denotes the complex conjugate. We denote the cross-wavelet power as  $|W_n^{xy}(u, s)|$ , which portrays the local covariance between two time-series at each time and frequency.

In contrast, to become normalized by the power spectrum of the two-time series is the major advantage of wavelet coherency. According to Torrence and Webster (1999), the wavelet coherence capturing the co-movement between the two-time series is delineated as:

$$R^2(u, s) = \frac{|S(s^{-1}W^{xy}(u, s))|^2}{S(s^{-1}|W^x(u, s)|^2)S(s^{-1}|W^y(u, s)|^2)} \quad (5)$$

where  $S$  is a smoothing operator over time as well as scale and  $0 \leq R^2(u, s) \leq 1$  (Rua and Nunes, 2009). The value of  $R^2(u, s)$  is in a range between 0 and 1, with a high (low) value representing a strong (weak) co-movement. Hence, by inspecting the contour plot of the above measure, we can spot the regions in time–frequency space where the two-time series move together and, exclusively, appraise both time and frequency varying features of the co-movement.

However, dissimilar to the classical correlation of two-time series, wavelet squared coherence is confined to positive values; hence, it cannot differentiate positive or negative co-movement or between positive and negative correlation (Goodell and Goutte, 2020). To resolve the difficulty, the phase difference approach suggested by Torrence and Compo (1998), can be used to capture the two possible co-movements: positive and negative. By calculating the phase difference, we can get information about the possible delays of the oscillations of the two series as a function of time and scale/frequency (Dewandaru, Rizvi, Masih, Masih, and Alhabshi, 2014). Moreover, in the spirit of Granger causality testing, this graphical presentation of the wavelet squared coherence can provide us the causal relationships between the two-time series (Goodell and Goutte, 2020). The phase difference can be denoted as:

$$\varphi_{xy}(u, s) = \tan^{-1} \left( \frac{\text{Im}\{S(s^{-1}W^{xy}(u, s))\}}{\text{Re}\{S(s^{-1}W^{xy}(u, s))\}} \right) \quad (6)$$

where  $I_m$  and  $R_e$  are the imaginary and real parts of the smoothed cross-wavelet transform, respectively. The information about the signs of each part is to determine the value of  $\varphi_{xy} \in [-\pi, \pi]$ . Black arrows indicate phases on the wavelet coherence plots. A phase difference of zero is consistent with time series moving together. Arrows pointing to the right (left) indicate time series, which are in-phase (out of phase) or are positively (negatively) correlated. An arrow pointing upward signifies that the first time series leads the second by  $\pi/2$ , whereas a downward pointing arrow implies that the second time series leads the first by  $\pi/2$ .

#### 4. Empirical results

Fig. 1 displays the dynamics of the daily time-series data of the two pairs of global conventional and Islamic stock market indices and the global COVID-19 death counts. In early March, we notice that the number of deaths caused by COVID-19 began to rise rapidly, which continued until mid-April and then remained steady with an overall increasing trend. Conversely, the stock market indices began to decline quickly from the same time and continued to fall to record lows since December 2008, then corrected and began to increase gradually. Interestingly, in our initial observations, we notice that the four stock market indices showed almost identical patterns in their daily prices during the sample periods of COVID-19. The initial illustration indicates the negative impacts experienced by the stock markets down to COVID-19. To understand the nature of the financial markets' volatilities due to COVID-19, we analyze the data in the time and frequency domain presented in the subsequent sections.

##### 4.1. Continuous wavelet transforms

For each variable, the continuous wavelet transforms (CWT) plots are illustrated in Fig. 2. The CWT shows the movements of each variable in the time scales and frequency bands. The horizontal axis presents the time component, while the vertical axis shows the frequency component. The values range from scale 1 (a day) up to scale 64 (more than two months), where the lower scale represents the high-frequency nature of the data and vice versa. We gauge the statistical significance of wavelet power against the null hypotheses of a stationary process with a background power spectrum. As estimated by Monte Carlo simulations using phase randomized surrogate series, the thick black contour in regions designates the 5% significance level (95% confidence level) against red noise. The cone of influence (COI), signaling distortion of the picture by edge effects, is exhibited with a lighter shade. The range of power is from blue (low power) to red (high power).

Fig. 2 shows that the COVID-19 deaths have a high-volatility regime starting around the second week of March (3/10/2020), mostly in 4–8 days frequency band and significantly persistent throughout the entire period under analysis. Besides, we notice the existence of some scattered volatile regions in the higher frequency band (1–4 days); however, the presence of such market volatility is

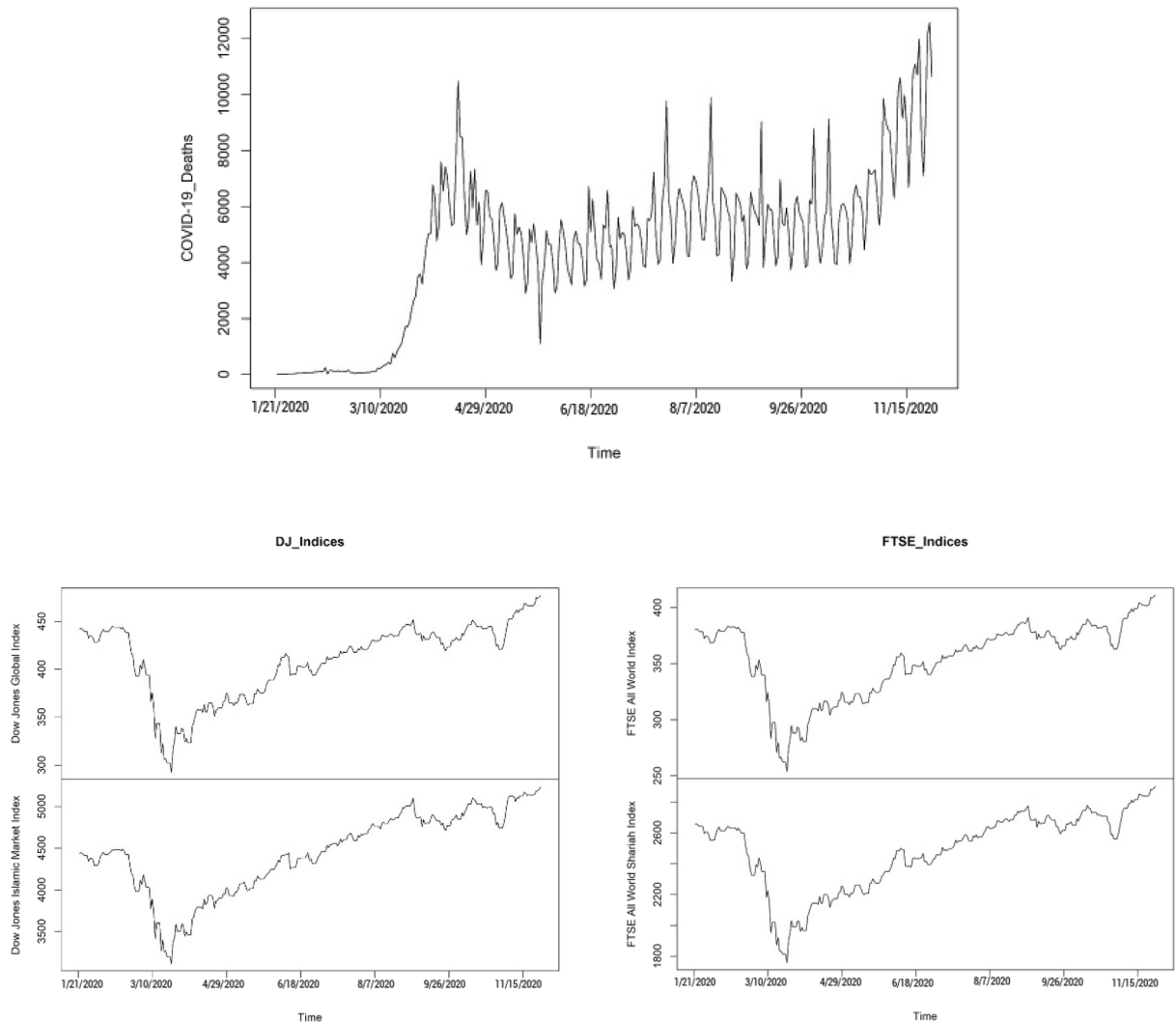


Fig. 1. Evolution of the dynamics of COVID-19 death counts and stock market indices.

not common for all the indices. The illustrations imply market reactions towards a rapid rise of death tolls throughout the world, specifically in European countries and the USA.<sup>7</sup> In general, the indices show comparable volatility at different frequencies. The volatilities of the indices are more significant in the high-frequency band compared to the medium and low frequencies as we notice warmer regions at a lower scale. However, the medium frequency volatilities are more enduring covering nearly a 40-day window, starting from the early of March (before 3/10/2020) and end around mid-April (before 4/29/2020) for both Dow Jones indices. Besides, we notice a small island of volatile at 8–16 days frequency band for the DJMI around mid-November (11/15/2020), which is negligible for the conventional index. Perhaps, the market volatility is attributable to the US presidential election that took place on the first week of November. We notice comparable volatility for the FAWI and FAWSI in terms of frequency and duration. However, the late market volatility is relatively negligible for both of the FTSE indices than DJMI.

Overall, the CWT transformation graphs reveal that the stock market indices started showing more volatility from the beginning of March 2020 during the pandemic periods. The volatility, however, began to smooth out from the mid of April. The evidence suggests notwithstanding the number of fatalities kept growing, but the initial shock by the outbreak induced higher volatility. The findings are conceivable, as the sudden fear due to the pandemic has created huge uncertainty in the stock markets – both conventional and Islamic.

<sup>7</sup> Spain's daily death toll hits highest level yet; China to test asymptomatic cases. Retrieved from: <https://www.cnbc.com/2020/03/31/coronavirus-live-updates-global-cases-continue-to-climb.html>.

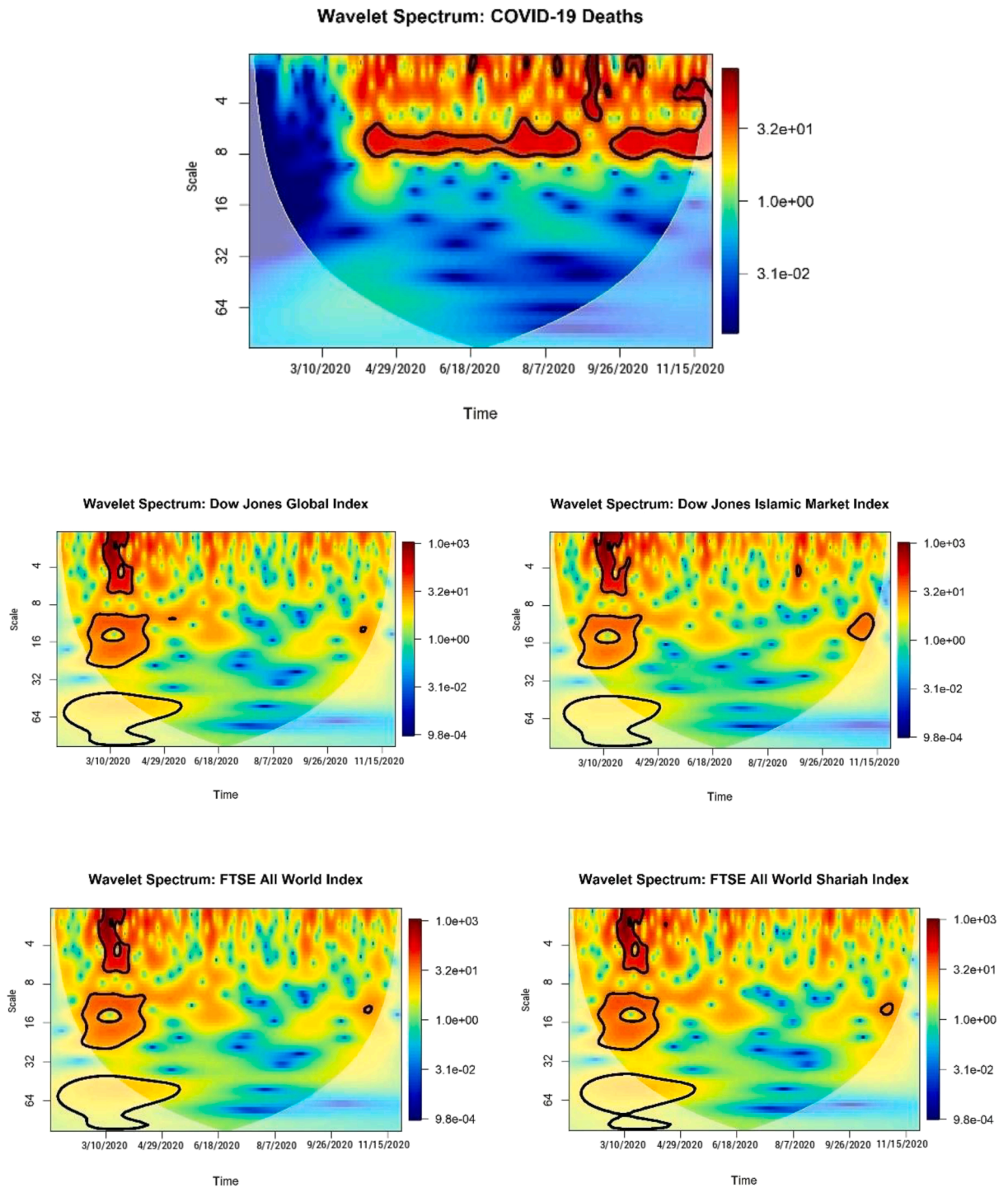


Fig. 2. CWT plots for the COVID-19 death counts and stock market indices.

#### 4.2. Wavelet coherence analysis

To further comprehend the relative volatility concerning the interactions between global COVID-19 death counts and selected market indices, we analyze wavelet coherences of each pair of variables, illustrated in Fig. 3. The color on the right side of the charts indicates the level of correlation; the warmer the color (moving from cool (blue) to warm (red)), the higher the absolute correlation value for  $R^2(u, s)$ .



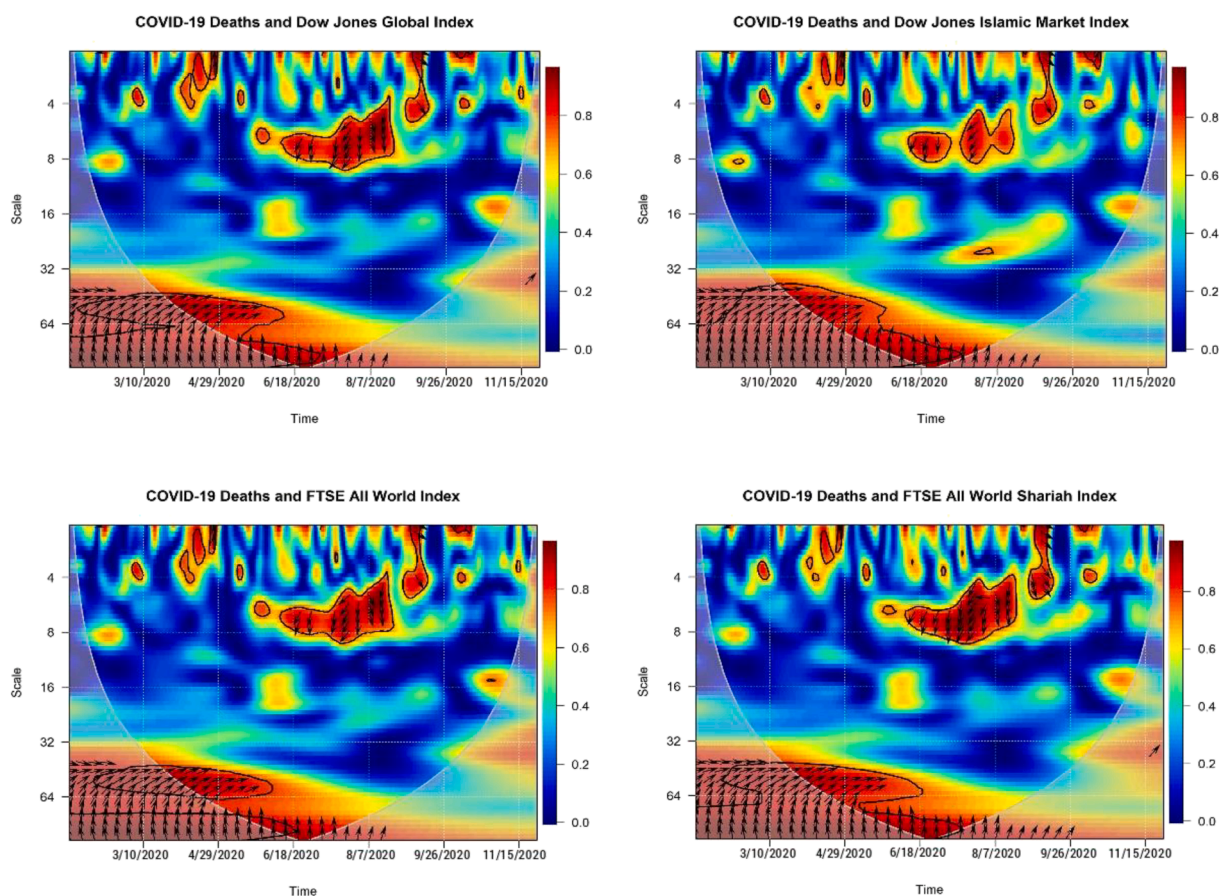


Fig. 3. Wavelet Coherency between COVID-19 deaths and stock market indices.

In Fig. 3, we notice the presence of tiny islands of strong dependence at the beginning, in 4–8 day frequency bands for all the stock market indices. We further notice a small but significant co-movement of COVID-19 deaths and both conventional indices before mid-June (6/18/2020). The significant co-movement continued for approximately 80 days period and smoothed out around the end of August. The considerable co-movements are visible for the conventional and Islamic stock markets during the same period; however, the effect is marginally lower for the DJMI. Moreover, we notice significant co-movement of COVID-19 death counts and market indices in a low-frequency band (between 32 and 64 days) for all the market indices co-movement remains persistent in the markets for a more extended period (from mid-March to mid-July). The prolonged period of co-movement in the long frequency band indicates that COVID-19 appears to have strong implications on the stock markets – both Islamic and conventional. Even though the market indices corrected in the later period, the COVID-19 established a lasting impact in the stock markets.

Our findings oppose the hypothesis that Islamic finance is comparatively less volatile in times of crisis than their conventional pairs, attributable to the conservative nature of the Shariah-compliant instruments included in the Islamic finance (e.g., Beck, Demirgüç-Kunt, and Merrouche, 2013; Farooq and Zaheer, 2015; Azad, Azmat, Chazi, and Ahsan, 2018; Abduh, 2020). The financial crisis caused by COVID-19 is somewhat more critical than prior crises and has hit harder all the sectors and assets, including Islamic-compliant ones, of an economy (Ji, Zhang, and Zhao, 2020). On the other hand, oil prices have plummeted sharply in early 2020, down to the oil price war between Russia and Saudi Arabia. The oil prices have further plummeted by the COVID-19 pandemic since the oil demand has significantly declined by the locking down measures undertaken to avert the spread of COVID-19. The majority of oil companies belong to Middle East countries, and these companies, as constituents, occupy a substantial part of our sample Islamic indices. Therefore, the Islamic indices too are impacted by the COVID-19.

For Shariah compliance, a considerable number of poor-performing companies are screened out from Islamic indices, which are still included in conventional benchmarks, resulting in better performance of Islamic indices than conventional indices. On the other hand, for the same reason, the size of Islamic indices portfolios is smaller than its conventional counterparts. The higher costs of Islamic compliant portfolio selection led to the underperformance of the Islamic than conventional indices. Hence, the benefits of Islamic indices are offset by their costs. All of these may lead to comparable volatility between conventional and Islamic stock markets during the crisis period. Nonetheless, our findings are supported by several studies (e.g., Abbes, 2012; Miniaoui et al., 2015; Cevik and Bugan, 2018; Trabelsi et al., 2020). Our findings are also in accord with those of the recent studies such as Sharif et al. (2020), Ashraf (2020), Al-Awadhi et al. (2020), and Zhang et al., 2020, in terms of the negative effect of stock markets caused by COVID-19.

Furthermore, to understand the co-movement between Islamic and conventional stock indices, we perform the wavelet coherency for each pair of the market indices. The analysis of co-movement of the market indices helps us to detect the contagion between the markets. Moreover, we notice the lead-lag association between the markets through the phase-difference to understand the nature of the causality (i.e., positive or negative). Phases are designated by black arrows on the wavelet coherence figures. The arrows pointing to the right indicate a positive association between the variables (in-phase), while arrows pointing to the left imply a negative association between the variables (out-of-phase). Besides, if the arrows are horizontal (phase difference = zero), both variables move together towards the same direction but no lead-lag relationship. An arrow pointing downward-right or upward-left suggests that the first variable (i.e., conventional market index) in the equation leads the second one (i.e., Islamic market index) and vice versa. The results are presented in Fig. 4.

From Fig. 4, it is evident that the co-movements between conventional and Islamic markets are highly significant for all frequency bands. Also, the arrows largely pointing to the right indicate the existence of a positive connection between the market indices for both Dow Jones and FTSE. However, we notice that the relationship remains dynamic as we notice the changes of direction of the arrows along the periods. At first, the conventional index leads at 1–4 days frequency for a short period for Dow Jones indices. However, the Islamic market index started becoming the leading index around the end of April (4/29/2020). The changes in such a lead-lag relationship are more pertinent for the Dow Jones indices compared to FTSE indices. Again, the conventional index becomes the lead market index in the later period (late June) and remains the same for most periods until the end of August, particularly at the 16–32 days frequency band. However, the lead-lag relationship changes more frequently between the FTSE indices.

On the other hand, at the 32–64 days frequency band during the same period, we notice little evidence of phase differences for the stock markets for both sets of market indices under consideration. Lately, the DJMI becomes the lead variable, mostly at the 8–16 days frequency band. We notice slightly lower lead-lag relationship changes for the FTSE indices as the arrows indicate zero phase difference for most of the periods. However, during the phase difference periods, the FAWSI index leads mostly over the FAWI. For Dow Jones market indices, we notice inconsistent changes in the lead-lag relationship. However, the inconsistency is more visible at the 16–32 days frequency band than the 32–64 days in Dow Jones market indices.

Overall, the high co-movement and consistently positive correlation between the indices indicate a significant integration between the Islamic and conventional stock markets. The results are expected, as the Islamic indices are a subset of their conventional counterparts. The spillover of COVID-19 is transmitted from one market to another, as shown by the lead-lag association between the conventional and Islamic equity markets. It further indicates that the Islamic stock markets are not disconnected from the conventional stock markets. Thus, the Islamic stock indices do not offer any hedging or safe haven benefit for investors. Besides, akin to conventional equity markets, Islamic equity markets too are exposed to financial crises like COVID-19. Hence, the Shariah screening process conducted for the Islamic stock markets does not provide any immunity against the sudden market shock caused by COVID-19; instead, they behave analogously to their conventional counterparts, which has accordance with the recent findings by Foglie and Panetta (2020) and Hassan, Hoque, Gasbarro, and Wong (2020). Therefore, our findings discard the decoupling hypothesis of Islamic stock markets from conventional stock markets, which is in accord with the results of several recent studies such as Hammoudeh, Mensi, Reboredo, and Nguyen (2014), Nazlioglu, Hammoudeh, and Gupta (2015), Majdoub, Mansour, and Jouini (2016), Shahzad, Ferrer, Ballester, and Umar (2017), and Foglie and Panetta (2020).

## 5. Conclusions

Recent studies have found pieces of evidence that the COVID-19 has significantly and negatively impacted the traditional stock markets. However, to our knowledge, none has analyzed the Islamic stock markets associated with COVID-19. In this study, we evaluate the effect of COVID-19 in the stock markets considering both Islamic and conventional stock market indices from global perspectives. Besides, we investigate if the volatilities of Islamic and conventional stock markets are different from each other during

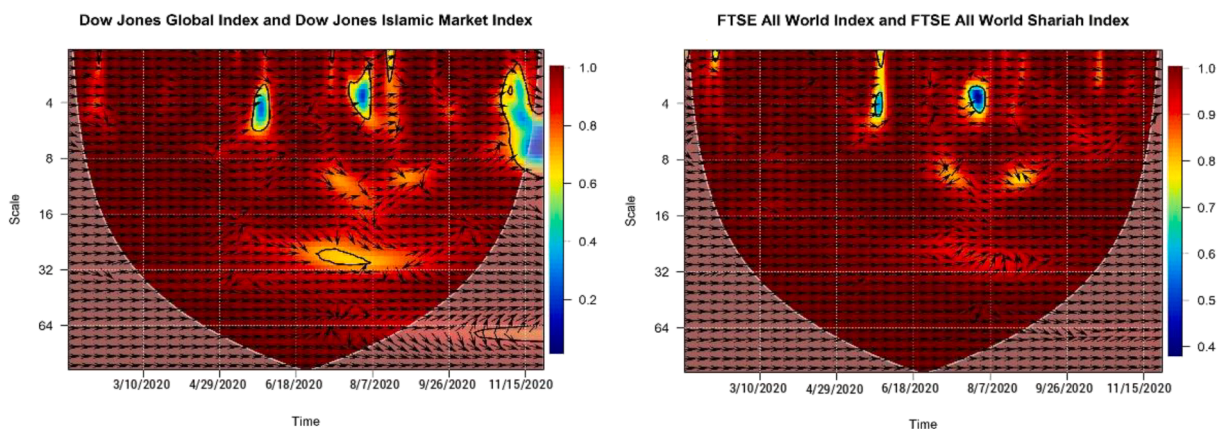


Fig. 4. Wavelet coherency between stock market indices.

the COVID-19 crisis. The co-movement of Islamic and conventional stock indices is also explored during the same period. We provide empirical evidence using two pairs of global conventional and Islamic stock indices (i.e., DJGI-DJIMI and FAWI-FAWSI) with daily data from 21st January to 27th November 2020 with wavelet-based methods. Our findings suggest that both stock markets started to show more volatility since the beginning of March when COVID-19 was affirmed a global pandemic. The volatility, however, began to stabilize from mid-April. The sudden panic caused by the pandemic has similarly created huge uncertainty in both stock markets. Findings further indicate that the Islamic and conventional stock markets are strongly associated and tend to highly co-move during our sample period. Therefore, Islamic stock markets do not present any hedging or safe haven benefit for investors. The Shariah screening process fails to provide immunity to Islamic stock markets against financial crises like COVID-19. Thus, Islamic stock markets do not offer a viable investment alternative for investors to hedge their investments against conventional stock markets. Our overall findings suggest that the decoupling hypothesis of Islamic stock markets from conventional stock markets is rejected.

Our results provide valuable insights for the Islamic portfolio managers and stock market investors when undertaking investment and hedging strategies in times of crisis like the COVID-19 pandemic. Investors are suggested to be aware that the conservative features of Islamic stocks do not offer hedging opportunities, or superior investment alternatives, especially during crisis periods. Furthermore, our study has some important implications for policymakers and governments regarding the dynamics between COVID-19 and financial markets. Governments are suggested to become more precautionous in taking preventive measures against COVID-19 so that stock markets do not go into a deeper crisis later. The findings can also help them allocate the recovery stimulus package to support the economy by boosting the market confidence more efficiently.

To get more robustness about the results, we could use diverse instruments of Islamic financial markets, rather than just focusing on the stock market indices. We suggest future researchers take more Islamic instruments on a large data sample to perceive its more precise connection with the COVID-19 crisis, perhaps, in the ex-post COVID-19 impact analysis.

### Availability of data and materials

The data sources are given in the data and methodology section. The datasets can be provided upon reasonable request.

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### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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