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Risk transmissions between sectoral Islamic and conventional stock markets during COVID-19 pandemic: What matters more between actual COVID-19 occurrence and speculative and sentiment factors?

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Abstract

Being the health pandemic with the highest impact on the global financial market, the recent COVID-19 pandemic has led to significant risk transmissions across stock markets. Although an increasing number of studies have examined the effects of the pandemic on financial markets, we provide novel insights into the volatility connectedness between conventional and Islamic stock markets. First, the analysis is conducted at the sectoral level, considering nine sectors for each category. Second, a greater novelty is applied by determining if the actual COVID-19 occurrence or speculations or sentiments raised by it is responsible for the connectedness. Summarily, findings show that markets are strongly connected. In addition, the Technology and Utilities sectors of both stock market types, and the Oil and Gas conventional stocks are the net receivers of volatility shocks. On average, however, Islamic markets tend to be more immune to the pandemic than conventional markets. Finally, both causal factors considered significantly affect the connectedness measures, although the effect is heterogeneous and stronger for the speculative/sentiment indicators. These findings provide appropriate policy clues for both investors and policy makers.

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1. Introduction

During any economic, financial, or health crisis, investors always experience the fear of bearing losses in their investments. Vulnerable assets tend to be more susceptible to shocks compared with stable assets, which can, to some extent, be resilient to adverse stress, at least in the short term. This fear often triggers intense interactions across different markets because risk-averse and profit-maximising investors tend to either sell their stocks or search for hedging assets in their investment portfolios.

The recent COVID-19 pandemic is a crisis that has exerted severe detrimental effects on global, regional, and country-specific financial markets. These detrimental effects resulted from the implementation of untimely policy interventions in different countries and the eventual restriction of labour movement. One of the earliest studies performed during the COVID-19 pandemic reported that even the Spanish Flu, which resulted in the death of approximately 2% of the global population, did not affect stock markets as much as COVID-19 did (Baker et al., 2020). Furthermore, Salisu and Vo (2020) indicated that Australian and South Korean stock prices...
were falling by 5% daily, and Chinese stock prices by 3%. OECD (2020) reported that stock prices recorded the lowest values since the previous 10 years and were still nosediving at the time when the report was published. The Nikkei index fell by approximately 20% from its high value in December 2019 (Bloomberg, 2020). As such, Salisu and Vo (2020) reported that many investors took drastic steps to sell off their stocks because of the aforementioned conditions.

Owing to the increasing integration among financial markets globally, a higher degree of risk transmission among markets is a major issue that characterises the periods of extreme market stress. Hence, an increasing number of studies have examined the performance and connectedness of financial markets during the COVID-19 pandemic (McKibbin and Vines, 2020; Hung, 2020; Adekoya & Oliyide, 2020b; Adekoya et al., 2020; Fasanya et al., 2020, 2021a; Fasanya et al., 2021; Aslam et al., 2021).

Empirical conclusions regarding which conventional and Islamic markets outperform others remain uncertain. Despite the prominence and unprecedented growth of the global Islamic finance in the past few years, Sherif (2020) argued that the common critique and perception facing general faith-based investments proceed from their departure from the efficient portfolio principle of Markowitz (1952) that was highlighted by Drymes (2017). This makes faith-based investments to be viable only in the short term. In the long term, these investments underperform others because they are merely subsets of the overall market portfolio and devoid of adequate diversification (Goodchild et al., 2002; Bauer et al., 2005). Investors are often discouraged to hold assets for long because they attempt to diversify their portfolio with alternative assets to mitigate risks and increase returns (Sherif, 2020). However, another study did not agree with the claim that faith-based assets underperform compared with conventional assets (Sensoy et al., 2015). This discrepancy in results can be based on other intrinsic features of Islamic finance including the profit and sharing principle, low leverage, and increasing size.

Recent studies have examined the performance of Sharia-compliant markets compared with that of conventional markets during the COVID-19 pandemic (Yarovaya et al., 2020; Erdogan et al., 2020; Sherif, 2020). Although these studies have provided useful insights (see section 2), the literature is still limited in many aspects. First, available studies are based on aggregate indices rather than sectoral analysis, except for the study conducted by Sherif (2020) who focused only on the United Kingdom. Second, studies have focused inadequate attention to dynamic connectedness between global conventional and Islamic stock markets during the pandemic because the existing studies have basically assessed the stability of each market. To fill these gaps, this study examines dynamic connection between Islamic and conventional stock markets.

We provide one of the most robust insights into dynamic connectedness between Islamic and conventional stock markets in numerous aspects. First, we analyse global markets by using the Dow Jones stock indexes rather than country-specific indexes, which might not reflect the global market performance. Second, the present study is conducted at the sectoral level in which nine different sectors are considered for each Islamic and conventional stock market. This results in a robust set of 18 stock series examined in the large connectedness framework to ensure that all global financial sectors are included.

Third, following recent empirical studies (Adekoya & Oliyide, 2020b; Albulescu et al., 2019), we extend the knowledge by determining factors that cause volatility spillovers among financial markets. Because the COVID-19 pandemic resulted into several policy actions by the governments of nations, leading to the shutdown of businesses and stock markets, we first determine whether the COVID-19 incidence is crucial for risk transmission. We examine the incidence of COVID-19 in countries, namely the United States, China, Saudi Arabia, and Nigeria, considering their roles in global and Islamic finance. Other set of factors is based on speculation and sentiment. The pandemic increased policy uncertainties in many countries and intensified investors’ sentiments. Thus, we hypothesise that these factors can be more responsible for volatility spillovers across markets compared with the actual COVID-19 occurrence. The speculative or sentiment factors examined include equity market volatility due to infectious diseases, economic sentiments, and the US economic policy uncertainty.

The remainder of this paper is organised as follows. Section 2 presents a brief literature review. Section 3 describes the methodological construct and highlights data description. Section 4 discusses the empirical results. Section 5 draws the conclusion and policy implications.

2. Literature review

Contrasting beliefs exist regarding the viability of Islamic financial markets. Some believe that Islamic stocks only perform well in the short term based on the argument that they are not in line with the efficient market principle and that they provide less diversification benefits (Sherif, 2020; Goodchild et al., 2002; Bauer et al., 2005). By contrast, others are of the opinion that Islamic stocks perform better than conventional stocks owing to their beneficial features including the profit and sharing principle, rising prominence, leverage, and fixed interest-earning principle (Sensoy et al., 2015; Hassan et al., 2018). Because of the lack of consensus, empirical studies have been increasingly focusing on the interaction between Islamic markets and other forms of financial markets.

Studies focusing on the dynamic relationship between stocks and different Islamic finance instruments, such as sukuk and stocks, have indicated the presence of volatility spillover (Sliper et al., 2016; Aloui et al., 2015; Ahmed & Elsayed, 2018; Maghayer and Awartani, 2016; Nazlioglu et al., 2015; Haddad et al., 2020). These studies have been performed across different countries and regions. Rather
than examining a country-specific analysis, some studies have examined the connection of the global Islamic market with commodity markets. These studies have shown that Islamic stocks are strongly linked with different commodities (Khan and Masih, 2014; Khan et al., 2015; Nagayev et al., 2016; Meni et al., 2017b; Trefalski, 2020).

Few studies have investigated the connectedness of the Islamic market with other financial markets during the recent COVID-19 pandemic. These studies were based on the empirical finding of previous studies that Islamic stocks tend to either perform better or have stronger connectedness during crisis periods. For instance, Yarovaya et al. (2020) reported that in addition to Islamic bonds (sukuk) exhibiting a safe behaviour, an intensified spillover was observed between Islamic and conventional stock markets during the COVID-19 period. Erdogan et al. (2020) examined the comparative effect of the COVID-19 outbreak in Turkey and found that the stability of Islamic stock markets was higher than that of conventional stock markets. An industry-level study by Sherif (2021) hypothesise that the connectedness would be driven by the occurrence of the pandemic and speculative factors.

We conclude this section by highlighting a few observations from previous studies. First, although an increasing number of studies have examined the connectedness of the Islamic market with other financial markets in recent years, most of them have focused on either country-based or global indices with less consideration of the sectoral performance of the faith-based market. Second, the performance of the Islamic market has largely been examined during extreme market stress caused by financial crisis; however, little empirical evidence is available during the current pandemic. Three, most studies examining the connectedness of Islamic markets with other markets do not report likely factors responsible for the strong interaction. On the basis of these identified gaps, this study addresses a fundamental question yet to be sufficiently addressed in the literature: Are sectoral Islamic stocks dynamically connected with their conventional stocks during the COVID-19 pandemic? We hypothesise that the connectedness would be driven by the occurrence of the pandemic and speculative factors.

3. Methodology and data

3.1. Methodology

3.1.1. The time-varying parameter-vector autoregressive (TVP-VAR) model

In the first part of the analysis, we employ the TVP-VAR based connectedness approach introduced by Antonakakis et al. (2020) to analyse the connectedness and risk spillover between Islamic and conventional sectoral stocks. This framework coalesces the connectedness framework of Diebold and Yilmaz (2012, 2014) with the TVP-VAR approach of Koop and Korobilis (2014) to overcome certain shortcomings of the rolling-window VAR framework of the former.1 We estimate a TVP-VAR(1), which is noted as follows.

\[ y_t = C_0 v_{t-1} + \mu; \mu_t \sim N(0, \tau) \]  
\[ vec(C_t) = vec(C_{t-1}) + \gamma; \gamma_t \sim N(0, \epsilon_t) \]

where \( y_t, v_{t-1} \) and \( \mu_t \) are \( m \times 1 \) dimensional vectors, whereas \( A_t, C_t, \) and \( \tau_t \) are \( m \times m \) dimensional matrices. \( vec(C_t) \) and \( \gamma_t \) follow the dimensional vectors of order \( m^2 \times 1 \), whereas \( \epsilon_t \) is an \( m^2 \times m^2 \) dimensional matrix. To compute the generalised forecast error variance decomposition (GFEVD) of Koop et al. (1996) and Pesaran and Shin (1998), it is crucial to transform the TVP-VAR to its vector moving average (i.e., TVP-VMA) representation through the Wold representation theorem. \( y_t = \sum_{i=1}^p C_{it} z_{t-i} + \mu_t = \sum_{j=0}^\infty A_{jt} \mu_{t-j}, \) which further helps to retrieve \( A_t \) and \( \tau_t \). Our choice of the GFEVD is hedged on the basis that it is totally invariant of the ordering of variables.2 Therefore, we mathematically formulate the GFEVD as follows:

\[ \theta_{ij,t}(H) = \frac{R_{ij} \sum_{k=1}^H \langle I{A_i}S_i I{A_j} \rangle^2}{\sum_{k=1}^H \sum_{s=1}^H \langle I{A_i}S_i I{A_j} \rangle^2} \cdot \tilde{\theta}_{ij,t}(H) = \sum_{j=1}\theta_{ij,t}(H) \]

where \( k=1, \sum_{j=1}^k \theta_{ij,t}(H) = k \) and \( I \) is a zero vector with unity on the \( j \)th position. Intuitively, GFEVD(\( \tilde{\theta}_{ij,t}(H) \)) is interpreted as the effect a shock in a variable \( j \) has on variable \( i \) in terms of its forecast error variance.

The approach reported by Antonakakis et al. (2020) allows us to derive various connectedness measures for Islamic and conventional stocks. Although we utilise only the net total directional connectedness for causality tests, to clearly analyse the process and follow the literature, we document all connectedness measures. In particular, this framework helps to derive the total connectedness index, the total directional connectedness to others, the total directional connectedness from others, the net total directional connectedness, and the net pairwise directional connectedness. The total connectedness index is formulated as follows:

\[ TCI = k^{-1} \sum_{j=1}^k TO_{ij} = k^{-1} \sum_{j=1}^k FROM_{ij} \]

where \( TO_{ij} = \sum_{i=1}^k \tilde{\theta}_{ij,t}(H) \) and \( FROM_{ij} = \sum_{j=1}^k \tilde{\theta}_{ij,t}(H). \) As explained earlier, since \( \tilde{\theta}_{ij,t}(H) \) measures the effect a shock in a

1 The strength of the novel TVP-VAR approach is well documented in the studies of Antonakakis et al. (2020), Antonakakis et al. (2018), and Antonakakis and Gabauer (2017).

2 Wiesen et al. (2018) further indicated that the GFEVD model should be given the utmost preference over the orthogonalised forecast error variance decomposition in cases when the theoretical framework which helps to identify the error structure is unavailable.
stock \( j \) has on stock \( i \), \( TO_{ij} \) measures the combined or aggregated effect a shock in stock \( j \) has on all other stocks. Therefore, \( TO_{ij} \) represents the total directional connectedness to others. In the same vein, \( FROM_{ij} \) denotes the combined or aggregated effects of all other stocks on stock \( j \). Thus, \( FROM_{ij} \) represents the total directional connectedness from others. The total connectedness index, as formulated in equation (3), can be considered as the effect of one stock on all other stocks (or the effect of all other stocks on one stock) such that a high (low) total connectedness index implies that the propagation or spreading of a shock in a stock to all other stocks is high (low), which further implies a high (low) connectedness between Islamic and conventional stocks.

Apart from the aforementioned total connectedness index, the net spillover from each of the stock should also be examined to determine whether a stock is a net transmitter or receiver of volatility shocks or information. We performed this by subtracting the effect of stock \( j \) on other stocks from the effect of other stocks on stock \( j \). We define this as the net total directional connectedness, which is specified as follows:

\[
NET_{ij} = TO_{ij} - FROM_{ij}
\]  

While other components remain as defined, \( NET_{ij} \) represents the net total directional connectedness that indicates whether a given stock is a net transmitter or receiver of the risk or shocks from other stocks. Therefore, a stock is considered to be a net transmitter of shocks when \( NET_{ij} > 0 \) and a net receiver when \( NET_{ij} < 0 \).

Finally, a component of the connectedness measure examines the bilateral relationship between Islamic and conventional stocks through the net pairwise directional connectedness as specified below:

\[
NPDC_{ij} = \tilde{\theta}_{ij}(H) - \tilde{\theta}_{ji}(H)
\]  

\( NPDC_{ij} \) indicates whether stock \( i \) is driven by (or drives) stock \( j \), such that \( NPDC_{ij} < 0 \) (or \( NPDC_{ij} > 0 \)) denotes that stock \( j \) is dominated by (or dominates) stock \( i \) in terms of the spillover effect.

3.1.2. Nonparametric causality-in-quantiles (nonlinear) test

After the derivation of the net directional connectedness measure for Islamic and conventional stocks, we further analyse the causal effects of COVID-19 cases in certain countries, infectious diseases, economic sentiment, and economic policy uncertainty on the derived net connectedness measure. Our proposition is tested using the nonparametric causality-in-quantiles test reported by Balcilar et al. (2016) because the linear causality test performs poorly in the presence of nonlinearity and other undesirable statistical properties that include regime changes and structural breaks. In addition, the test can handle functional misspecification errors and recognise the broad interdependence of series while testing for causality in conditional mean and variance (i.e. causality in the tail area of the joint distribution of series).

Following the basis provided by Jeong et al. (2012), a causal variable \( x_t \) does not Granger-cause another variable \( y_t \), in the \( \theta \)-quantile with regard to the lag vector \( \{y_{t-1}, \ldots, y_{t-p}, x_{t-1}, \ldots, x_{t-p}\} \) if

\[
Q_{\theta} \{y_t | y_{t-1}, \ldots, y_{t-p}, x_{t-1}, \ldots, x_{t-p}\} = Q_{\theta} \{y_t | y_{t-1}, \ldots, y_{t-p}\}
\]  

(7)

However, \( x_t \) Granger-causes \( y_t \) in the \( \theta \) th quantile with regard to \( \{y_{t-1}, \ldots, y_{t-p}, x_{t-1}, \ldots, x_{t-p}\} \) if:

\[
Q_{\theta} \{y_t | y_{t-1}, \ldots, y_{t-p}, x_{t-1}, \ldots, x_{t-p}\} \neq Q_{\theta} \{y_t | y_{t-1}, \ldots, y_{t-p}\}
\]  

(8)

where the \( \theta \) th quantile of \( y_t \) is represented by \( Q_{\theta} \{y_t | \cdot \} \). The conditional quantiles of \( y_t \) depend on \( t \), and range between 0 and 1. If we proceed by making the following delineations: \( Y_{t-1} = \{y_{t-1}, \ldots, y_{t-p}\} \), \( X_{t-1} = \{x_{t-1}, \ldots, x_{t-p}\} \) and \( Z_t = \{X_t, Y_t\} \), then, likewise, the conditional distribution functions of \( y_t \) would be \( F_{Y_t|Z_{t-1}}(y_t | Z_{t-1}) \) and \( F_{Y_t|X_{t-1},(y_t|Y_{t-1})} \) given \( Z_{t-1} \) and \( Y_{t-1} \), respectively. By making assumptions that \( Q_{\theta}(Z_{t-1}) = Q_{\theta}(y_t | Z_{t-1}) \) and \( Q_{\theta}(Y_{t-1}) = Q_{\theta}(y_t | Y_{t-1}) \), then

\[
F_{y_t|Z_{t-1}}(Q_{\theta}(Z_{t-1}) | Z_{t-1}) = \theta
\]  

with the probability being equal to one. Based on these formulations, the causality-in-quantiles test to be tested are as follows:

\[
H_0 = P \{F_{y_t|Z_{t-1}}(Q_{\theta}(Y_{t-1}) | Z_{t-1}) = \theta\} = 1
\]  

(9a)

\[
H_1 = P \{F_{y_t|Z_{t-1}}(Q_{\theta}(Y_{t-1}) | Z_{t-1}) < \theta\} < 1
\]  

(9b)

To show the outcome of the causality-in-quantiles tests, the distance measure \( J = \{\epsilon_t, E(Z_{t-1} f_{\epsilon}(Z_{t-1}))\} \) is used by Jeong et al. (2012), where \( \epsilon_t \) and \( f_{\epsilon}(Z_{t-1}) \) denote the regression error and the marginal density function of \( Z_{t-1} \) respectively. To compute \( \epsilon_t \), the formula is given as follows:

\[
\hat{\epsilon}_t = 1\left\{y_t \leq Q_{\theta}(y_t | Y_{t-1})\right\} - \theta
\]  

(10)

In addition, we continue by estimating the parameter of the \( \theta \)th conditional quantile of \( y_t \), given \( Y_{t-1} \), through the nonparametric kernel method as follows:

\[
\hat{Q}_{\theta}(Y_{t-1}) = \hat{F}^{-1}_{y_t|Y_{t-1}}(\theta | Y_{t-1})
\]  

(11)

where the Nadarya-Watson kernel estimator is given as follows:

\[
\hat{F}^{-1}_{y_t|Y_{t-1}}(y_t | Y_{t-1}) = \frac{\sum_{s=p+1}^{T} L \left( \frac{y_t - y_s}{h} \right) 1 \left( y_s \leq y_t \right)}{\sum_{s=p+1}^{T} L \left( \frac{y_t - y_s}{h} \right)}
\]  

(12)

with \( L(\cdot) \) and \( h \) being the kernel function and bandwidth used in the kernel estimation, respectively.

Now, the rejection of the null hypothesis of causality in the first moment does not necessarily imply non-causality in the second moment. Therefore, we examine the causality in the second moment. For a proper illustration, we consider the model presented as follows:

\[
y_t = h(X_{t-1}, Y_{t-1}) + \mu_t
\]  

(13)

Thus, the second order causality-in-quantiles can be tested using the following equations:
hsquares cross-validation technique, whereas we employ to analyse joint density-weighted nonparametric tests with a lag et al. (2012). We follow the approach of Nishiyama et al. (2011) respectively, to formulate the kernel-based test statistic following Jeong investments, and capital flows. Because the global influence of two countries are known to be the drivers of global finance, is the fastest growing economy in the developing world. These most developed financial market in the world, whereas China national and Islamic financial markets. The United States has the activated by their unique roles in either or both global conven-

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3.2. Data description

This study focuses on dynamic connectedness between conventional and Islamic sectoral stocks during the COVID-19 pandemic period. In addition, this study determines how such dynamic connectedness is driven by COVID-19 pandemic-related factors. Therefore, we obtain data on both the conventional and Islamic Dow Jones stock price indexes of nine different sectors: basic materials (BM), consumer goods (CG), consumer services (CS), financials (FIN), healthcare (HC), industrials (IND), oil and gas (OG), technology (TEC), and utilities (UTIs). COVID-19 pandemic-related indicators whose effects on the connectedness measures are examined in this study are in two folds. The first set of causal variables consist of the growth rates of the COVID-19 reported incidences of selected countries, namely the United States, China, Saudi Arabia, and Nigeria. The choice of these countries is motivated by their unique roles in either or both global conventional and Islamic financial markets. The United States has the most developed financial market in the world, whereas China is the fastest growing economy in the developing world. These two countries are known to be the drivers of global finance, investments, and capital flows. Because the global influence of the United States cannot be denied (Adekoya et al., 2020; Adekoya & Oliyide, 2020b), the population of China renders it as a striking base for investors to commit their funds to the country’s ever-growing industries such as technology, consumer goods, and healthcare. Saudi Arabia is the country with the largest Islamic finance share, accounting for approximately $194.7 billion assets as at 2020 according to the Union of Arab Banks. Nigeria, which has one of the fastest growing Islamic finance institutions, has been a home to the largest population of Islamic devotees in the sub-Saharan Africa. Thus, Saudi Arabia and Nigeria are the representatives of the global Islamic world following their impressive economic expansion in recent years, and happenings in these countries indicate the connectedness between conventional and Islamic stocks.

The other set of causal variables relate to uncertainty-induced factors. As empirically established (Aslam et al., 2020a), the COVID-19 pandemic adversely shaped the economic and investment environments of many countries following the formulation of different policies by their governments, particularly the lockdown order. This further resulted in a significant increase in sentiments and policy uncertainties.

The choice of the three uncertainty-induced factors is now specifically explained. Although the classic volatility index (VIX) has commonly been used as a measure of the stock market uncertainty, it expresses the uncertainty caused by various markets. However, because this study focused on the COVID-19 period, we consider an index of market uncertainty that is specifically driven by health challenges. Hence, the infectious disease-induced equity market volatility (EMVID) is considered a more suitable measure of uncertainty. By contrast, media news dampened hope in some markets, and several public orders made investors pessimistic of the future prospects of their investments, leading to intensified economic sentiments during the pandemic. This further informs the need to examine the effect of economic sentiments on the connectedness among considered markets. Finally, the United States is the country most hit with the pandemic, leading to uncertainties in several economic policy actions. Moreover, the significant role of the country in the global economy and credit flows positions her EPU to instigate financial market connectedness. Accordingly, we obtain data for three different uncertainty measures: EMVID, economic sentiments (SENT), and US economic policy uncertainty (SENT). The data scope ranges from 01 January 2020 to 30 November 2020, and all the data are obtained from different sources.3

Because of space constraints, the summary statistics and graphical trends of the series are provided in the supplementary list (Table S1 and Figs. S1–S2, available online). The maximum returns of all the sectors of conventional stocks, with the exception of the consumer services sector, exceed those of Islamic stocks. Similarly, most sectors with average positive returns perform better for the conventional market than the Islamic market. These combined findings indicate that global conventional stock markets are more developed than Islamic stock markets. However, although most of the sectors in both asset types record average positive returns, Islamic stocks have the largest number of sectors with positive average returns. This suggests a high degree of competitiveness between both asset types and the probable higher stability of Islamic stocks than conventional stocks. Similar trending patterns and high volatility are also observed, especially from February to April. Based on causal variables, the average growth rate of COVID-19 cases is expectedly higher for the United States, followed by Saudi Arabia. In addition, the uncertainty indices reflect the effect of the pandemic because both EMVID and EPU indices show high mean values, whereas the economic sentiment is averagely negative, implying the presence of an undesirable sentimental

3 All Dow Jones stock indexes are sourced from www.investing.com, whereas the COVID-19 incidence cases are obtained from World Health Organization (WHO). Infectious disease-based equity market volatility is sourced from https://www.policyuncertainty.com/infectious_EMV.html, whereas economic sentiment indices are obtained from https://www.frbsf.org/economic-research/indicators-data-daily-news-sentiment-index/. Finally, the US economic policy uncertainty indices are sourced from the Federal Reserve Database.
perception of the market during the period. All series are stationary and not normally distributed.

4. Empirical findings

4.1. Dynamic connectedness effects

Table 1 lists average dynamic connectedness estimates between conventional and Islamic stocks across the nine different sectors examined. Conventional and Islamic stocks of all the sectors highly receive shocks almost as much as they transmit the same, although with some variations. No sector in both asset groups transmit shocks lower than 63.6% as recorded by the Islamic Utilities sector, whereas no sector receives volatility shocks lower than 93.1%, which can be attributed to the conventional Oil and Gas sector. This underlines the strong integration and competitiveness across the sectors and across conventional and Islamic asset categories. Furthermore, the Industrial sector is the highest transmitter of volatility shocks in both categories (i.e. 103% and 102% for conventional and Islamic stocks, respectively), and they are also among the highest receivers of shocks (93.7% and 93.5%, respectively) in the system.

Now, we examine the difference between the amount of volatility shocks given and received by each sector through net spillover estimates. For conventional stocks, three sectors, namely Oil and Gas, Technology, and Utilities, are the net receivers of shocks with a negative net spillover of \(-3.7\%\), \(-3.2\%\), and \(-7.7\%\), respectively, whereas the remaining six sectors are net transmitters with positive values of their net spillovers. This result suggests that the highlighted three sectors receive more shocks than they transmit. Two of these three sectors, namely Technology (\(-1.1\%\)) and Utilities (\(-30.6\%)\), exhibit similar behaviour under the Islamic stock group.

Two basic intuitions could be made from these results. First, the sectors with negative net spillovers can be considered to be less resilient compared with others, implying that they have the capability to take shocks from other sectors higher than they give. Second, for the remaining sectors with positive net spillovers, the values are lower for Islamic stocks than conventional stocks, except for the Healthcare sector. Although all these sectors are still poor hedgers, Islamic stocks have the tendency to mitigate risks more than their conventional stocks. In other words, investors in these conventional stocks might experience higher risks than investors in Islamic stocks. These results are analogous to the findings of Erdogan et al. (2020), Trichilli et al. (2020a), and Sherif (2020), which have indicated that Islamic stocks have greater immunity to speculative stuns to global financial markets. On average, Islamic stocks have higher diversification advantages than conventional stocks, and this could have been driven by some factors including size and leverage effects.

Finally, with the total connectedness index being as high as 93.7%, a strong integration, connectedness, and contagion movements are noted across the sectors and across the two asset groups (Hkiri et al., 2017). Fig. 1 presents the overall dynamic connectedness graph. Throughout the sampled period, the connectedness is very high, particularly higher around March and April, as also observed in the returns plots discussed earlier. Meanwhile, we attempt to provide robust results by conducting the spillover analysis by using a different methodology developed by Diebold and Yilmaz (2012). Although negligible differences are noted in results, especially in the net spillover status of some of the sectors (supplementary Table A3), the results largely corroborate those of the main model considered in this study. In fact, the same value for the total connectedness index (93.7%) is obtained.
4.2. Causality results

The factor responsible for the strong volatility connectedness between conventional and Islamic stocks remains unclear. To determine the factor, we perform the causality test on the net directional spillover measure for each sectoral stock of conventional and Islamic markets.

4.2.1. Effect of the COVID-19 growth rate on volatility spillovers

Although we perform the linear Granger-causality test first with the results showing evidence of causality in some cases (Table S3, available online), we rely on the results of the nonparametric causality-in-quantiles (nonlinear) test following the presence of nonlinearity in the series among other factors. Only the graphical results of the United States (Fig. 2a and b) and China (Fig. 3a and b) are presented, whereas the results for Saudi Arabia and Nigeria are presented in the supplementary material (Figs. S3a–S4b, available online) due to space constraint. For decision, if causality lines lie above the

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4 We test for nonlinearity by using the BDS test reported by Brock et al. (1996); however, the results are not presented due to space constraints.
significance line, the null hypothesis of no causality is rejected, but otherwise if they lie below it. The graphical plots show that the effects of the COVID-19 incidences of the considered countries on volatility interactions are heterogeneous across the sectors of both stock market types. In most cases, significance is found in either or both causality-in-mean and causality-in-variance, although it is stronger for the latter. Although a relatively high number of cases indicate that the causality-in-mean is not significant across the countries, the only two instances where the causality in variance is not significant relates to the causal effect of the COVID-19 incidences of Saudi Arabia and Nigeria on the net volatility spillovers of the Islamic Utilities sector. Moreover, the causal effects vary across different quantiles, implying that the effect of the incidence of each country on the volatility spillover of each sector varies across different market conditions.

4.2.2. Effect of speculative and sentiment factors on volatility spillovers

We hypothesise that the occurrence of the COVID-19 pandemic would not be the principal factor driving the volatility connectedness between conventional and Islamic stock markets but the speculations or sentiments it induces. Adekoya and Oliyide (2020b) empirically ascertained that the equity market volatility induced by infectious diseases has a stronger effect on dynamic connectedness between financial and commodity markets. A similar result is established by Fasanya et al. (2021). Here we expand the scope by additionally considering other speculative factors because they tend to significantly increase during the health pandemic compared with their historical trends. As shown by the linear causality results in Table A4, scanty evidence is obtained for the effect of speculative factors on the connectedness measures of the sectoral stocks of both conventional and Islamic markets. However, nonlinear results prove otherwise (Fig. 4a and b for the results of EMVID, and the supplementary material [Figs. S5a, S5b, S6a and S6b, available online, for the results of the economic sentiments and EPU]).

With the exception of the Islamic Consumer Services sector where significance is not found for the causality-in-mean, EMVID, economic sentiments, and US EPU significantly affect the net volatility spillovers of all the sectors in the two market groups. The significance is observed in either the lower, middle, or higher or virtually all the quantiles. The results of the speculative and sentiment factors tend to perform relatively better for both causality-in-mean and causality-in-

Fig. 2. (continued).
variance than the actual COVID-19 incidences. Consistent with the findings reported by Adekoya and Oliyide (2020b) and Fasanya et al. (2021a, 2021b), COVID-19 and related indices exert a strong effect on the connectedness among different international markets.

4.3. Dynamic portfolios and portfolio hedging effectiveness

We examine the performance of the assets by first constructing their dynamic investment portfolios and then evaluating their hedging effectiveness. We employ the minimum connectedness portfolio (MCoP) approach reported by Broadstock et al. (2021) on the pairwise connectedness series rather than the correlation or variance matrix of the series as used in previous methods. According to Broadstock et al. (2021), this approach provides a portfolio that is not significantly affected by network shocks. Therefore, to first concretely understand the composition of the portfolio of an individual asset, we graphically illustrate their distinct dynamic portfolio weights (Fig. S7, available online). A casual assessment of results first reveals some similarities across most of the sectoral stocks, although a few nuanced differences are still observable in some stocks. For instance, all the sectoral stocks, both conventional and Islamic, have significantly high and volatile weights from the start of 2020 until around May of the same year for some and June for others. These months correspond to the periods when the heat of the COVID-19 pandemic was at its peak with many countries under lockdown and stock markets/businesses closed down. During these periods, the highest connectedness between conventional and Islamic stocks occurred (Fig. 1). After the middle of the year, however, the weights are seen to either completely fall for some sectors or fairly decline and remain moderately constant until almost the end of the study period. The sectors that do show the latter trend include conventional consumer services and healthcare stocks and Islamic healthcare and utilities stocks.

Then, we proceed to unravel the portfolio and risk hedging implications of the results through the hedging effectiveness scores. Summarising the results in Table 2, we could observe that the scores are all significant mostly at 1%, except those of the conventional technology and utilities stocks. These results can be explained based on the phenomenon that investing an amount equivalent to the percentage value of the mean will reduce (increase) the volatility of the underlying asset by the percentage value of its positive (negative) hedging effectiveness.

![Fig. 3 a: China and the conventional stocks. b: China and Islamic stocks.](image-url)
For example, a 1%, 9%, 3%, and 2% investment in conventional basic materials, financials, industrial, and oil and gas stocks will reduce volatility by 21%, 68%, 42%, and 86% respectively. Similarly, average investments in Islamic financial services stocks by 8% and oil and gas stocks by 9% will respectively mitigate volatility by 5% and 74%, respectively. Stocks with negative hedging effectiveness ratios can also be accordingly interpreted. In summary, we find that the possibility of reducing portfolio volatility during the COVID-19 pandemic period is sensitive to the type of stock, whether conventional or Islamic, and the sector in each category. Investing in conventional stocks tend to strongly lower portfolio volatility than Islamic stocks because more sectors in conventional stocks have a positive hedging effectiveness ratio. In particular, investing in conventional basic materials, financial services, industrials, and oil and gas stocks as well as Islamic financial services and oil and gas stocks tend to reduce the overall portfolio volatility, whereas others increase it. The time-varying variance—covariance matrices obtained from the TVP-VAR model with one lag are used to derive the results.

5. Conclusion and policy inferences

The COVID-19 pandemic has been adjudged as a health crisis with the greatest devastating effect on financial markets in history. This has led to numerous studies examining its effect on the different components of financial markets either on country-specific, regional, or global basis despite its short time duration. However, although few studies have examined the response of Islamic markets to the pandemic, evidence regarding the volatility connectedness between conventional and Islamic stocks during the pandemic is scant. The evidence is even rarer for sectoral analysis. Recent studies have extended the knowledge by determining factors that actually cause volatility spillovers among financial markets. Accordingly, it is reasonable to propose that the COVID-19 pandemic might not only affect the performance of a financial market but also have serious implications in terms of cross-market risk relationships altering asset prices and the risk preferences of investors.

The contributions of this study are therefore in three folds, in addition to methodological advancements. First, this paper examines the dynamic connectedness between conventional and Islamic stocks at the sectoral level during the COVID-19 pandemic period. Second, we provide insights into factors that principally drive the volatility connectedness between COVID-19 incidence and speculative and sentiments factors. For robustness, the COVID-19 incidences in four countries (United States, China, Saudi Arabia, and Nigeria) and three other factors (equity market volatility due to infectious
that the risk transmission across markets is more driven by the heightened speculative and sentimental behaviour of policy makers and investors during the pandemic rather than its actual occurrence. Finally, the dynamic portfolio analysis shows that investing in conventional basic materials, financial services, industrials, and oil and gas stocks as well as Islamic financial services and oil and gas stocks tend to reduce overall portfolio volatility, whereas others increase it.

Like results reported by Albulescu et al. (2019) and Adekoya and Oliyide (2020b), this study provides the evidence of a global financial cycle channel during the COVID-19 pandemic period. This channel is largely driven by the occurrence of the pandemic and the speculative and sentimental attitude of policy makers and investors. Some crucial policy implications are then raised by these findings. Of great importance to investors is the understanding that during extreme market risks induced by health pandemics, investment in conventional and Islamic firms dealing in technology and utilities would provide greater hedging advantage than in other financial sectors. However, an increased share of the stocks of some sectors such as basic materials, financial services, industrials, and oil and gas stocks in the conventional market and financial services and oil and gas stocks in Islamic markets in their investment portfolios would mitigate risks more strongly than others. In addition, portfolio managers should closely monitor trends in the outbreak of health

or related crisis in understudied countries as well as global speculations and sentiments. The influence of these countries on global credit conditions and capital flows (such as the United States and China), global and regional Islamic finance (such as Saudi Arabia and Nigeria), and overall speculations make them strong inducers of risk transmissions among financial markets.

These findings also concern policy makers in these countries in different ways. For the United States and China, which are the front liners in the global scene, policymakers should ensure stability in economic policies and rapid policy intervention to the outbreak of any pandemic. These strategies can reduce the exposure of global financial markets to risks and speculative shocks. On the other hand, ensuring higher stability of the global Islamic financial market by Islamic countries including Saudi Arabia and Nigeria would increase its immunity to risks. Future studies should examine the connectedness between Islamic stocks and other assets that have been known to be fairly stable. Examples are the commonly known precious metals, especially gold, silver, palladium, and platinum.

### Conflict of interest

The authors declare that they have no conflict of interest in relation to this study.

### Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bir.2021.06.002.
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