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Dependence dynamics of Islamic and conventional equity sectors: What do we learn from the decoupling hypothesis and COVID-19 pandemic?

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ABSTRACT

The recent COVID-19 pandemic intensification generates a different set of challenges for global financial markets and portfolio management strategies. This paper uses network analysis to investigate the static and dynamic dependence within Islamic and conventional equity sectors. The study focuses on the decoupling hypothesis and how the dependence among sectors changes during COVID19. Empirical findings indicate a higher degree of spillover during the COVID19 sub-period. Islamic and conventional equities behave differently in terms of industry-level dependence during normal and crisis times, thus decoupling. Further, the dependence effect between conventional equity returns is stronger than Islamic equity returns during the COVID-19 pandemic. The finding of this paper has several significant implications for portfolio selection and risk management. Portfolios consisting of Islamic equity sectors including industrials, basic materials, consumer services, and technologies highlight low-diversification benefits across the entire sample period. Also, investment exposure to less connected Islamic and conventional equity sectors provides a good diversification strategy.

1. Introduction

The COVID-19 pandemic causes an unprecedented impact on global conventional and Islamic financial markets. The pandemic presents severe economic consequences for the real economy and increases the global financial markets’ comovements, and causes the spread of market disturbances. Therefore, the importance of portfolio diversification increases during crisis times, and the optimal risk-return trade-offs require a complete understanding of the different securities’ dynamic dependence in a portfolio. In such a context, recent empirical studies advocate the inclusion of new asset classes in the financial portfolio, such as clean energy indices (Asl et al., 2021; Nguyen et al., 2020; among others), precious metals (Rehman & Vo, 2021; Hernandez et al., 2018; among others), cryptocurrencies (Garcia-Jorcano & Benito, 2020; Mroua et al., 2020; among others), alternative investment (Platanakis et al., 2019; among others) and Islamic financial products (Alkhazali and Zoubi, 2020, Al-Yahyaee et al. 2020; among others).

Islamic financial assets have grown substantially during recent decades. At the end of 2019, the total value of Islamic finance assets

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was estimated at US $2.88 trillion and approximately US $3.69 trillion at the end of 2024 (The Islamic Finance Development Report, 2020). Islamic finance is attracting Muslims and conventional investors and has emerged as a vital tool for portfolio diversification. In principle, Islamic financial products are expected to be more resilient in a financial crisis because of the prohibition of interest and absence of risk transfer mechanisms since Islamic instruments are based on the principle of profit and loss sharing (Hassan et al., 2020).

In addition, Islamic financial instruments comply with Islamic law (Shariah). Therefore, they are based on profit-risk-sharing and the concept of screening, giving a set of ethical and financial constraints.

In this study, three facts have motivated us to examine the dependency network within Islamic and conventional equity sector indices. The first fact relates to the unprecedented volatility in the equity sector indices during the recent coronavirus period. March 2020 (which corresponds to the announcement of COVID-19 as a global pandemic by the World Health Organization) was one of the most volatile months in the equity indices' history (e.g., The Dow Jones Industrial Average recorded its worst single-day points drop ever, falling 2,997 points on March 16, 2020). The second fact relates to the existing studies' conflicting findings on the dynamic of Islamic and conventional stock markets during crisis times. Some recent empirical studies conclude that Islamic instruments can be used as a cushion during crisis periods and support the decoupling hypothesis (Al-Yahyaee et al., 2020; Ahmad et al., 2018; Hkiri et al., 2017; Abu-Alkheil et al., 2017; Mwamba et al., 2017; Kenourgios et al., 2016; Rizvi et al., 2015; among others). However, other empirical studies conclude that Islamic instruments do not provide a cushion during crisis times (Hassan et al., 2020; Shahzad et al., 2017; Sensoy, 2016; Nazlioglu et al., 2015; Ajmi et al., 2014; Hammoudeh et al., 2014; among others). The third fact admits that Islamic investors will diversify their portfolios among Islamic equity sectors. Similarly, conventional investors will diversify their investment among conventional equity sectors. Our results show that Islamic and conventional investments are different, at least in terms of whether dependence structures within Islamic and conventional sectors and their behaviors during the recent COVID19 crisis are significantly different.

This paper adds to the existing literature in three ways: First, we investigate the dynamic dependence among the Islamic and conventional equity sector indices during the recent COVID19 crisis. While testing decoupling among Islamic and conventional stocks, it is not sensible to see the correlation among Islamic-conventional sectors as the Islamic index is a filtered subset of the overall industry. According to Orzano and Welling (2019), Islamic and conventional indices have similar long-term performance characteristics and are typically highly correlated. Thus the correlation between the actual universe and a filtered sub-set is meaningless. A more genuine question is how Islamic sectors relate within the Islamic universe and compare them with conventional sectors’ comovement. Second, we construct a static and dynamic dependency network that describes the relationships between Islamic and conventional equity sector indices. We build a static dependency network by using partial correlations. We address time variations in both dependency and centrality networks. We construct a centrality network and operate to complement the dependency network. Third, the dynamic dependency network’s construction is based on correlation analysis, a generally applied method in portfolio management. Also, the dependency network methodology is not restricted by the number of return series and avoids dimensionality. To the best of our knowledge, this study is the first that investigates the static and dynamic dependence between Islamic and conventional Dow Jones equity indices of twenty sectors using network analysis before and during the COVID-19 pandemic.

The rest of this paper is organized as follows. Section 2 reviews the related literature. Section 3 presents the methodology. Section 4 describes the data. Section 5 presents and discusses the empirical results. Section 6 concludes the paper.

2. Literature review

Many empirical studies investigated conventional and Islamic equity indices’ contribution to portfolio diversification during the last decade. In the first part of this section, we discuss Islamic stock’s behavior in crisis times. In the second part, we emphasize the recent empirical literature on Islamic finance during the COVID-19 pandemic and then identify research gaps in the existing contemporary literature.

2.1. Financial crisis and Islamic investment

Recent empirical literature shows the importance of Islamic financial products in portfolio diversification during crisis times. Karim et al. (2010) study the effects of the global financial crisis (hereafter, GFC) on the integration of selected Islamic equity markets (Malaysia, US, UK, Japan, and Indonesia). Using daily data from February 15, 2006, to December 31, 2008, empirical results fail to prove the existence of co-integration among these Islamic equity markets before and during the GFC. Jawadi et al. (2014) studied Islamic and conventional indexes’ financial performance in three major regions (the USA, the Euro area, and the whole World) before and after the GFC. Using daily data from January 3, 2000, to June 27, 2011, and the CAPM-GARCH model, they find that Islamic investments outperform conventional financial performance during crisis times. The GFC’s impact on Islamic stock returns is less significant than conventional stock returns. Alkhaazali et al. (2014) studied the performance of selected Dow Jones Islamic indices and their conventional counterparts from 1996 to 2012. They find that Islamic indices perform better during the financial crisis. Ho et al. (2014) study the risk-adjusted performance (Sharpe ratio, Treynor Index, and Jensen alpha) of Islamic and conventional equity markets. They find that Islamic indices outperformed their conventional counterparts during crisis times.

Saiti et al. (2014) investigate whether

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1 IFDI2020, "ICD-REFINITIV Islamic Finance Development Report 2020", available at: https://icd-ps.org/uploads/files/ICD-Refinitiv%20IFDI%20Report%202020%2001607502893_2100.pdf
2 https://www.statista.com/
Islamic equity indices improve the portfolio diversification benefits for the US-based investor. They use the multivariate GARCH approach and daily return data for conventional MSCI Islamic equity indices (Malaysia, Indonesia, Turkey, China, Hong Kong, Taiwan, Japan, Korea). The authors find that Islamic countries (Malaysia, Indonesia, Turkey) provide better diversification benefits than other countries during crisis times. Ajmi et al. (2014) demonstrate a causality relationship between the Islamic equity market and risk factors, supporting the Islamic market’s recoupling hypothesis. Balcılar et al. (2015) investigate the risk exposures of ten major Islamic equity sector indices concerning shocks in conventional global markets. Using a dynamic three-regime and three-factor risk spillover model, they find that Islamic equity sectors are not isolated from developed equity markets. Also, they find the Oil & Gas, Consumer Services, and Technology equity sectors display negative risk exposures during high market volatility periods, implying that these Islamic equity sectors could serve as a safe haven for investors in developed markets during crisis periods. Nazlioglu et al. (2015) investigate the volatility spillover between global Islamic stocks and three conventional stock markets (the US, European and Asian markets) before, during, and after the GFC. They find risk spillover effects between Islamic and conventional equity indices, implying contagion effects. Kenourgios et al. (2016) investigate the contagion effects of the GFC and the European sovereign debt crisis (hereafter, ESDC) on Islamic equity and bond markets. Using daily MSCI Islamic stock market indices of the G7, Europe, the BRICS, and the Dow Jones Sukuk Index, empirical results support the conventional financial system’s decoupling hypothesis of the Islamic equities and bonds. They also find that the Islamic emerging stock indices of the BRICS are better than the Islamic developed Indices in portfolio diversification. Sensoy (2016) examines the systematic risks of Islamic equity indices and their conventional counterparts and finds that the systematic risk of Islamic equity is not lower than that of conventional equity during crisis periods and, hence does not support the decoupling hypothesis. Mwamba et al. (2017) study the tail-risks in Islamic and equity markets. They find that Islamic equities are less risky than conventional equities during the GFC. Ahmad et al. (2018) studied Islamic equity indices’ financial performance with their conventional counterparts during 2006–2015. They find that Islamic equity indices may act as an effective hedging financial instrument during the crisis. Hassan et al. (2020) investigate the contagion effect using MSCI Islamic and conventional indices during 2007–2017. Using the higher-order moment-based tests, empirical results show robust contagion effects of the financial crisis on Islamic stock indexes and then reject the decoupling hypothesis. Al-Yahyae et al. (2020) compare the performance of Islamic and conventional equity returns for twenty indices from ten sectors before, during, and after the GFC and the ESDC. They find that Islamic equity returns dominate their conventional counterparts across all the measurement ratios (the Sharpe, Roy, Treynor, Omega, and Jensen Alpha ratios). Using the wavelet approach, they find that Islamic equity sector returns’ comovements vary over time and across frequencies and depend on crisis periods.

2.2. COVID-19 pandemic and Islamic investment

The more recent literature has focused on the impact of the COVID-19 pandemic on equity markets (e.g., Guo et al., 2021; David et al., 2021; Al-Awadhi et al., 2020; among others); Energy and commodity markets (e.g., Lin & Su, 2021; Cui et al., 2021; among others); Precious metals (Dutta et al., 2020; Gharib et al., 2020; among others); Cryptocurrency markets (e.g., Iqbal et al., 2021; Umar and Gubareva, 2020; Mariana et al., 2020; Goodell and Goutte, 2020; Dutta et al., 2020; among others). However, empirical studies of the impact of the COVID-19 pandemic seems relatively understudied, and we find only a few papers related to the topic. Yarovaya 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. Achraf et al. (2020) investigate whether Islamic equity indices provide insurance and portfolio diversification benefits during the COVID-19 pandemic for global, US, and European markets. They find that Islamic equity indices provide hedging benefits and diversifying opportunities during crisis times, supporting the decoupling hypothesis. 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 et al. (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. Hasan et al. (2021) examine the impact of COVID-19 in the global Islamic and conventional stock markets. Using daily data from 21st January to 27th November 2020, and the wavelet approach, empirical findings show that the COVID-19 creates identical volatility in both conventional and Islamic stock markets. Also, they find that Islamic stock markets do not present any hedging or safe haven benefit for investors.

The previous literature shows the extensive empirical studies on the impact of the GFC on Islamic financial markets. However, the empirical literature on the recent coronavirus’s effect on Islamic equity markets is relatively understudied. This paper contributes to the existing literature in two important ways. First, it extends the current literature on Islamic equity markets by studying the dynamic connectedness of twenty major Islamic and conventional equity sectors using static and dynamic dependence networks. Second, it explores the time-varying dependency and compares the network dependency among Islamic and conventional equity sectors before and during the COVID-19 pandemic, which to our knowledge, has not been done before.

3. Methodology

In this paper, we use the dependency network presented by Junior et al. (2015) and developed by Wu et al. (2020) to measure dependency among Islamic and conventional equity sectoral indices. The dependence among the return series is calculated from the partial correlations.
3.1. Partial correlation and network dependence

Following Junior et al. (2015) and Wu et al. (2020), the first step is modeling partial correlation among variables. The partial correlation between variables i and j conditional on variable k is presented in Eq. (1):

\[
PC(i,j|k) = \frac{C(i,j) - C(i,k)C(j,k)}{\sqrt{(1 - C^2(i,k))(1 - C^2(j,k))}}
\]

(1)

where \(PC(i,j|k)\) represents the partial correlation between variables i and j conditional on variable k. \(C(i,j)\) represents the rank correlation measured by Kendall’s tau between variable i and j. The difference between \(C(i,j)\) and \(PC(i,j|k)\) represents the dependency of variable k on the correlation \(C(i,j)\), which is defined as \(dif(i,j|k) = C(i,j) - PC(i,j|k)\). In the case of \(dif(i,j|k) = 0\), the correlation between variables i and j does not depend on the variable k. The dependency effect of the variable k on the variable i increase if \(dif(i,j|k)\) increase. Wu et al. (2020) introduced the Kendall rank correlation instead of Pearson correlation to consider the nonlinear dependency among variables.

The total degree of dependency of variable k on the variable i can be calculated as the average of the degree of dependence of variable k on the correlations between variable i and all the other N-2 variables in the network, presented in Eq. (2):

\[
D(i,k) = \frac{1}{N-2} \sum_{j=1}^{N} dif(i,j|k), j \neq k, i
\]

(2)

The dependency \(D(i,k)\) is different than \(D(k,i)\), indicating that the dependency impact is asymmetric. Therefore, we can construct an asymmetric dependency network by using the dependency of all pairs of variables, which is calculated as the difference between the bidirectional dependency effects, or \(B_{ik} = D(k,i) - D(i,k)\).

3.2. The construction of centrality network

Following Wu et al. (2020), we construct a minimum spanning tree (MST), get a centrality network, and detect the return series playing the most critical linking roles in the network. The MST reflects the primary relationship among the return series in a network. The Kendall Tau rank correlations are converted into the metrics of distance defined as:

\[
md_{ij} = \sqrt{2(1 - C(i,j))}
\]

(3)

The greedy algorithm is applied to construct the centrality network in the MST form and link all nodes in a graph with minimum possible total edge weight and no loops. The normalized tree length is used to measure the degree of network integration. We use three centrality measures, which are (i) the normalized tree length to measure the degree of network integration, (ii) the degree of centrality, (iii) the percent of the number of edges between the two given nodes.

### Table 1
Descriptive statistics and unit root test results.

| Code   | Mean   | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | ADF   | KPSS  |
|--------|--------|-----------|----------|----------|-------------|-------|-------|
|        | Code   | Mean   | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | ADF   | KPSS  |
|        | Code   | Mean   | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | ADF   | KPSS  |
|        | Code   | Mean   | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | ADF   | KPSS  |
|        | Code   | Mean   | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | ADF   | KPSS  |

Note. The descriptive statistics are for the sample period August 1, 2015, until August 20, 2020, with 1580 daily observations. The industry returns are calculated as the natural logarithmic first difference of the consecutive prices multiplied by 100, mean and standard deviation values are in percentages (%). The ADF (the Augmented Dickey and Fuller (1979)), and KPSS (Kwiatkowski et al. (1992)) are the empirical statistics of unit root tests. *** indicate rejection of the null hypothesis of normality and unit root at 1% level of significance.
(iii) the closeness centrality, and (iv) the betweenness centrality to discover the most critical nodes in the network.

\[ \text{Normalized tree length: } NTL(t) = \frac{1}{N-1} \sum_{e_{ij} \in \text{MST}_t} e_{ij}, \]

where \( e_{ij} \) represent the edge length in the MST between node \( i \) and \( j \).

The degree of centrality: \( DC(i)_t = \sum_{j=1}^{n} a_{ij}, \)

where \( a_{ij} \) equal to 1 if and only if \( i \) and \( j \) have an edge in the MST, otherwise \( a_{ij} \) equal to 0.

The closeness centrality: \( CC(i)_t = \sum_{(lj)} R_{lj}, j = 1, 2, \ldots, N, j \neq i \)

where \( R_{lj} \) represents the shortest path from \( i \) to \( j \) in the MST.

4. Data specification and preliminary analysis

This paper’s sample consists of daily closing price data of twenty sectoral Islamic and conventional indices. The study period runs from August 1, 2015, to August 20, 2020, and all indices are sourced from Bloomberg. Islamic indices are subgroups of conventional benchmarks indices that include only companies compliant with Shariah. Table 1 provides the summary statistics and preliminary tests of Islamic and conventional equity return indices.

Table 1 shows that the technology equity sector has a higher average return for conventional and Islamic sectoral indices. The energy sector is riskier than other business sectors (as reflected by the higher standard deviation). All returns series are leptokurtic and have negative skewness. The kurtosis coefficients for all the return series exceed three, implying that the probability distributions of all sectoral indices’ returns are left-skewed. The Jarque-Bera test confirms the rejection of the normality distribution of all return series. The unit root tests, developed by Dickey and Fuller (1979) and Kwiatkowski et al. (1992), indicate that all the return series are stationary.

The conventional sectoral indices include the Dow Jones Global Basic Materials Index (BM), the Dow Jones Global Consumer Goods Index (CG), the Dow Jones Global Consumer Services Index (CS), the Dow Jones Global Energy Index (EN), the Dow Jones Global Financial Index (FIN), the Dow Jones Global Healthcare Index (HC), the Dow Jones Global Industrials Index (IND), the Dow Jones Global Technology Index (TECH), the Dow Jones Global Telecommunications Index (TEL), the Dow Jones Global Utilities Index (UTL).

The Islamic sectoral stock indices used in this paper include the Dow Jones Islamic Basic Materials Index (BM), the Dow Jones Islamic Consumer Goods Index (CG), the Dow Jones Islamic Consumer Services Index (CS), the Dow Jones Islamic Energy Index (EN), the Dow Jones Islamic Financial Index (FIN), the Dow Jones Islamic Healthcare Index (HC), the Dow Jones Islamic Industrials Index (IND), the Dow Jones Islamic Technology Index (TECH), the Dow Jones Islamic Telecommunications Index (TEL), the Dow Jones Islamic Utilities Index (UTL). The Dow Jones Islamic sectoral indices measure sectoral stocks’ performance that passes rules-based screens for adherence to Shariah investment rules. Dow Jones Islamic Market Indices exclude securities using two types of criteria:

\[ \text{(a). Conventional equity sectors} \]

\[ \text{(b). Islamic equity sectors} \]

\[ \text{Fig. 1. System dependency measures for the full sample. Note. The bars and charts with lines show the three summary measures of dependence network, To others, From others, and Net. The net positions are shown through a yellow dot on the red line. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)} \]
business activity and accounting ratio. Shariah screening prohibits companies’ investment directly from prohibited activities (e.g., Alcohol, gambling, pork-related products, tobacco, etc.). The Dow Jones Islamic Market Indices also exclude defense companies permitted in the S&P Islamic Indices. After eliminating Shariah’s non-compliant companies in business activities, the remaining companies are analyzed for compliance with financial ratios. The total income from non-permissible sources should not exceed 5%; the total debt should not exceed 33%.

5. Empirical findings and discussion

In the first step, we examine the entire static dependency network for the total sample. After that, we investigate the time-varying dependency network using a rolling window.

5.1. Dependency network analysis

5.1.1. Static analysis for the full sample

We estimate the pairwise dependency across the return series of conventional and Islamic equity sectors for the entire sample (August 1, 2015, to August 20, 2020). Following Diebold and Yilmaz (2014), we adopt three dependence network measures: To others, From others, and Net (difference between and to) measures. The Net measure indicates the most important variable that affects others. The equity sector return with the highest impact on the network is considered as the most important element. (Fig. 1) illustrates the full sample’s three dependence network measures (To, From, and Net). Fig. 1(a) plots the dependency measures for the conventional equity sectors, and Fig. 1(b) plots the dependency measures for the Islamic equity sectors.

From Fig. 1(a), we note that the financials sector (FIN), basic materials sector (BM), and consumer services sector (CS) are respectively the main contributors in affecting the other conventional equity sectors. In the case of Islamic equity sectors, Fig. 1(b) show that the industrial sector (IND) and the consumer goods sector (CG) play an essential role in affecting the other Islamic equity sectors. However, the energy (EN), telecommunications (TEL), technology (TECH), and utilities (UTL) sectors are less correlated to the other Islamic sectors. This finding is partly consistent with Balcılar et al. (2015), who find that Consumer Services, Oil & Gas, and Technology exhibit negative risk exposures during crisis periods, suggesting possible safe haven benefits for portfolio diversification.

Fig. 2 plots the pairwise dependency across all sectoral equity returns (conventional and Islamic) into a network chart. Since the dependency impact is asymmetric (Eq. (2)), equity return from sector i may depend on the equity return from sector j than from the reverse way. In that case, an arrow is drawing pointing from equity return from sector j to equity return from sector i, to demonstrate that variable equity return from sector j exerts net influence on equity return from industry i. The size of edges implies the magnitude of pairwise directional spillover. The pie (red color) on the node’s border shows the node’s net position; the higher red area shows the net transmission position relative to the reception.

Fig. 2a shows the directional network interconnections among ten conventional industries (business) sectors. We observe a mutual asymmetric dependency between financial (FIN) and basic material (BM) sectors (a bold arrow pointing from (FIN) to (BM) and a bold arrow from (BM) to (FIN)). Also, we observe that equity returns from telecommunications (TEL) and energy (EN) sectors are exerting

![Fig. 2. Complete dependency network. Note. Fig. 2(a) and 2(b) show the directional network interconnections among ten business sectors for the full sample. The size of the edges indicates the magnitude of pairwise directional spillover. The pie (red color) on the node’s border shows the node’s net position; the higher red area shows the net transmission position relative to the reception. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)](image-url)
net influence on equity return of the financial (FN) sector. We also observe that the basic material (BM) sector is net dependent on the telecommunications sector (TEL). Furthermore, Fig. 2(a) shows that (FIN), (BM), (CS), and (IND) nodes are larger than the other nodes (more red color on the border). This finding indicates that financial, basic material, consumer services, and industrial sectors reflect the more substantial influence in the dependency network (more outgoing arrows). However, (UTL), (TECH), (CG), and (HC) nodes are smaller than the other nodes (less red color on the border), demonstrating that utilities, technology, consumer goods, and healthcare sectors reflect the lesser influence in the dependency network (more ingoing arrows). Fig. 2(b) plots the pairwise dependency across ten Islamic sectoral equity returns.

Fig. 2(b) illustrates the directional network interconnections among ten Islamic equity sectors. We note that industrials (IND), consumer goods (CG), and basic materials (BM) nodes are larger than the other nodes, indicating that these sectors reflect the more decisive influence in the dependency network. This finding can be explained by Islamic finance being closely based on real economic activity. Islamic finance prohibits the charging of interest on a financial transaction. Shariah law is based on the principle of profit and loss, and risk-sharing and Islamic finance is presumed to be associated with real economic activity (e.g., industrials). The utilities (UTL), telecommunications (TEL), and technology (TECH) sectors reflect the lesser influence in the dependency network in Islamic equity sectors, implying possible safe haven benefits for global and faith-based investors.

5.1.2. Static analysis before and during COVID-19 pandemic

To investigate the impact of COVID-19 on the directional network interconnections among sectoral equity returns, we divide the whole sample into two sub-samples: The pre-COVID19 period (until the end of February 2020) and the COVID19 period (from March 2020). We select March 2020 as the starting date of the COVID-19 pandemic for two reasons. First, it corresponds to the announcement month of COVID-19 as a global pandemic by the World Health Organization. Second, it corresponds to the crash of global stock
markets. According to Mazur et al. (2020), March 2020 is considered one of the most dramatic stock markets crashes in history (e.g., Dow Jones Industrial Average plunged 6,400 points, equivalent to roughly 26%). (Fig. 3) plots the pairwise dependency across sectoral equity returns before and during COVID-19.

Fig. 3(a) shows the directional network interconnections among ten conventional equity sectors. We observe a strong dependence between sectoral equity returns during the COVID-19 period compared to the Pre-COVID19 period. All sectors play the role of receiver and transmitter of dependency. Fig. 3(b) shows the directional network interconnections among ten Islamic equity sectors. We note that sectoral conventional equity returns' dependence effect is more substantial during the COVID-19 pandemic period. The findings of the static dependency network show a higher degree of spillover during the COVID19 sub-period. So, the diversification across equity sectors is not a good strategy during the period of the COVID-19 pandemic for both conventional and Islamic equity indices.

5.1.3. Dynamic dependency analysis

We move from the static analysis to the dynamic dependency analysis to better investigate sectorial equity returns' dependence behavior during the COVID-19 period. (Fig. 4) plots the dynamic total dependency among conventional and Islamic equity sectors. Fig. 4 (a) illustrates the total dependency between conventional equity sectors. We notice variations of the overall dependence, and the time-varying spillover is intensified during the COVID-19 period. Three distinct periods are observed: (i) up to the end of 2018, a stable and lower dependency (ii) during 2019, the dependence increases quickly until September 2019 and then decreases until February 2020 (iii) from March 2020, the dependence rises sharply and reaches the higher level. The dependency increases during extreme stress because of the higher systemic risk level (Zhang and Broadstock, 2020; Wu et al., 2020). Fig. 4 (b) illustrates the total dependency between Islamic equity sectors. Four different periods are observed: (i) up to the end of 2017, a high and decreasing dependency level (ii) from 2018 until June 2019, the dependency level increases (iii) from July 2019 until February 2020, the dependency decreases (iv) from March 2020, the dependency increases sharply and reaches the higher level. The decreasing of dependency in the recent study period may be attributed to the dominating role of crude oil in the global economy (Wu et al., 2020) and the increasing level of dependency in the commodity market (Kilian and Zhou, 2018).

Fig. 4(a) and 4(b) show that Islamic and conventional equities behave differently during the normal period. These findings imply that conventional and Islamic sectoral equity indices can provide effective international portfolio diversification benefits during the normal period. Islamic instruments’ characteristics can explain this finding based on the prohibition of interest and the absence of a risk-shifting mechanism.

To give a clearer picture of sectorial equity returns’ dependence behavior, we proceed to the graphical presentation of plots’ three dependency measures discussed in the previous section (To others, From others, Net). (Fig. 5) plots the measures of the dependency network.

Fig. 5 confirm that Islamic and conventional equities behave differently during normal and crisis times (COVID-19) and thus are decoupled. The degree of spillover is intensified during the COVID19 sub-period for conventional and Islamic sectoral equity indices.

5.2. Centrality network analysis

To check the robustness of our empirical findings, we proceed to the centrality network analysis. Following the minimum spanning tree (MST) methodology presented in section 3.2, we get the following empirical results in static and dynamic analysis.
5.2.1. Static analysis for the full sample

Fig. 6 plots the MST for the full sample (from August 1, 2015, to August 20, 2020)

Fig. 6 (a) and 6 (b) plot the MST for the conventional and Islamic equity returns, respectively. Three attractive deductions from the network structure. First, we observe two clusters from the conventional network, and the financials (FIN) sector plays an essential position in connecting three sectors. Second, we note one central cluster from the Islamic network and the Industrials (IND) sector plays an indispensable role in connecting the sectors. Third, the finding of (Fig. 6) is consistent with the static dependency network ((Fig. 1)), indicating that the industrials sector and the financials sector play an essential role in affecting the other Islamic and conventional equity sectors respectively. Also, the finding of (Fig. 6) is partly consistent with Figures (2) and (3), where the industrials, consumer goods, and basic materials nodes are more significant than the other nodes in the case of Islamic sectors. Our findings are aligned with the study conducted by Balcilar et al. (2015), who found that basic Islamic materials and Industrials display the most significant risk exposures Financials and consumer services materials nodes are larger than the other nodes in the case of conventional sector.
sectors. This finding is partially aligned with the study of Al-Yahyaee et al. (2020), who find that Consumer services and Financials (among other sectors) present minor diversification benefits in terms of differences in portfolio diversification. Portfolios consisting of Islamic equity sectors including industrials, basic materials, consumer services, and technologies highlight low-diversification benefits across the entire sample period. The financials, consumer services, basic materials, and telecommunications sectors provide minor diversification benefits in conventional equity sectors across the whole sample period.

5.2.2. Dynamic analysis based on rolling windows

We use the rolling-window methodology to assess the time-varying behavior of the MST. First, we construct the system integration index, nearly the inverse of Normalized tree length: NTL(t) (Eq. (4)). (Fig. 7) plots the system integration index of the centrality network for the conventional and Islamic sectors.

Fig. 7 shows similar patterns of the level of connectedness, as presented in (Fig. 4). the total dependency degree and the time-varying spillover is intensified during the COVID-19 period for both the conventional and Islamic sectors.

Another measure we use in the centrality network analysis is closeness centralities of networks calculated by finding the shortest path between nodes. (Fig. 8) plots the degree of closeness between equity sectors before and during the COVID-19 pandemic.

Fig. 8 shows that conventional equity sector returns are more closed and connected during the COVID-19. We also notice that closeness is higher during the COVID-19 period than the pre-COVID period for all conventional industries. On the other hand, the Islamic equity sector’s returns are least close before and during the COVID-19 pandemic. Also, the closeness of Technology, Healthcare, and Utilities are lesser during the COVID-19 sub-period. The findings confirm that Islamic and conventional equities return behave differently during normal and crisis times, thus decoupling.

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Fig. 6. Static centrality network (minimum spanning tree - MST). Note. Fig. 6(a) indicates that the consumer services sector (CS) is connected to the utility sector (UTL). The financials (FIN) sector plays an essential role in connecting three sectors (basic materials (BM), energy (EN), and telecommunications (TEL)). Fig. 6(b) indicates that the industrials (IND) sector plays a central role in connecting three sectors (the consumer services sector (CS), basic materials (BM), and technologies (TECH)).

Fig. 7. System integration index of the centrality network over time.
6. Conclusion

This study intends to contribute to the ongoing debate concerning Islamic and conventional financial instruments’ behavior during crisis periods. We investigated the static and dynamic dependence between twenty Islamic and conventional equity sectors before and during the recent COVID-19 pandemic. We constructed a static dependency network using partial correlations and addressed time variations in dependency and centrality networks. We used the rolling-window methodology to test our findings’ robustness to assess the minimum spanning tree’s time-varying behavior before and during the coronavirus period.

This study’s findings show that (i) the financials sector mainly affects the other conventional equity sectors for the entire sample. However, the industrial sector plays the most critical linking role in the network of Islamic equity sectors. (ii) all sectors play the receiver and transmitter of dependency during the COVID-19 pandemic. (iii) the dependence effect between sectoral conventional equity returns is stronger than Islamic equity returns during the COVID-19 pandemic period. (iv) the utilities, telecommunications, and technology sectors reflect the lesser influence in the dependency network in Islamic equity sectors, implying possible diversification benefits for global and faith-based investors. Finally, (v) Islamic and conventional equities behave differently before and during the COVID-19 crisis. This finding supports the decoupling hypothesis, implying that Islamic equities can protect against crisis periods.

The finding of this paper has several significant implications for portfolio management. The constructed dependency network is based on the correlation analysis, which is at the core of the finance and investment theories. For international and faith-based investors, the importance of portfolio diversification rises during periods of market turbulence. However, optimal risk-return trade-offs through adequate diversification require a complete understanding of the portfolio’s different securities’ dynamic dependence. Investment exposure to less connected equity sectors provides a good diversification strategy. Islamic equity sectors may be an alternative for Muslims and conventional investors who want to diversify their portfolios and manage their risk during crisis times.

CRediT authorship contribution statement

Syed Jawad Hussain Shahzad: Data curation, Methodology, Software, Supervision, Writing – review & editing, Validation. Nader Naifar: Writing – original draft, Conceptualization, Formal analysis, Writing – review & editing, Validation.

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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