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Faith-based investments and the Covid-19 pandemic: Analyzing equity volatility and media coverage time-frequency relations

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ABSTRACT

We perform time-frequency wavelet-based analysis to explore how the media coverage of the Covid-19 pandemic influenced the volatility of the Islamic equity indices, covering various sectors of economic activity. Our results show that the coherence between the Media Coverage Index and the moves of the Islamic stocks varies from low and medium to high levels. We attribute the intervals of low coherence to the diversification potential of Islamic equity investments during a systemic pandemic such as Covid-19. We document differences in the patterns exhibited by various indices per sector, showing their potential role for designing hedging strategies across sectors, based on stocks of companies which comply with Shariah.

1. Introduction

The beginning of the 21-st century has witnessed an upsurge in investors' interest in Islamic finance. Nowadays, the \$2.4 trillion Islamic finance industry operates in accordance with the teachings of the Islamic faith and in alignment with the principles of the Shariah law. It consists of more than 1400 institutions spread across 80 countries. Its central principle is profit-and-loss sharing which requires that no return should be envisaged without proper risk sharing. Differently from the conventional financial systems, primarily based on interest rate and time value of money concepts, Islamic finance represents a rather asset-based system which prioritizes profit

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sharing over interest income and fosters the real “brick-and-mortar” economy. The main impetus for the growth of the Islamic finance industry was a relatively moderate impact of the 2008 Global Financial Crisis (GFC) on Islamic finance assets (Ahmed, 2010; Kaye and Hassan, 2011). Factors such as prohibition on speculation and use of risky asset classes in the industry resulted in better performance of Islamic financial assets during the GFC (Ho et al., 2014; Umar and Suleman, 2017; Shahzad et al., 2017).

Among the various Islamic financial assets, the Islamic equity market represents one of the most important domains of Islamic finance. Shariah law implies that Islamic equity investments must be scrutinized by Shariah compliant screening procedures. The first is qualitative compliance with Islamic investment guidelines that exclude stocks of all companies dealing with alcohol, tobacco, pork, gambling, weapons, interest-rate-based finance, and non-Shariah-compatible entertainment. The second screening is quantitative. It is based on a set of financial ratios allowing to remove from the investment targets those companies, which, although involved in Islamic law compliant businesses, obtain a large share of their revenues out of non-Shariah-compliant activities, such as borrowing and/or lending money on interest as well as holding a large proportion of assets in liquid form. Most of the research on the Islamic equity markets is based on a comparative analysis of the Islamic and conventional equities and it is motivated by the decoupling hypothesis (Dharani et al., 2019; Jawadi et al., 2020; Umar, 2017; Umar et al., 2020).

After the GFC, the Covid-19 pandemic is the biggest extreme risk event that has disrupted the world economy in an unprecedented manner. The Covid-19 crisis is profoundly challenging societies and economies. To withstand and mitigate the rapid penetration and economic consequences of the virulent disease, the vast majority of countries have implemented social distancing and severely restricted travel facilities. These contingency measures have adversely affected many industries and corporations, triggering a worldwide upsurge in unemployment. Because of the tremendous impact of the pandemic on the planetary scale, the literature on the Covid-19 fueled economic crisis has grown at a rapid pace (Akhtaruzzaman et al., 2020; Al-Awadi et al., 2020; Baker et al., 2020; Cheema-Fox et al., 2020; and Sharif et al., 2020). In particular, the global pandemic of Covid-19 has severely affected worldwide financial markets (Godel, 2020; Gubareva, 2020; Gubareva and Umar, 2020; Zaremba et al., 2020; and Zhang et al., 2020), including Islamic equity investments (Ashraf et al., 2020).

This study aims to contribute to this growing strand of literature on financial innovation related to Covid-19 pandemic by analyzing the performance of Islamic equity during this unique financial landscape. As mentioned above, Islamic and conventional investments have some fundamental differences that make Islamic financial paradigm as an alternative to the mainstream conventional setup. There has been a growing consensus among many investors that the mainstream investment paradigm must evolve, advancing from the sole focus on firm profit maximization to a more balanced vision based on the concepts of sustainability, social responsibility, and financial innovation. Moreover, the Covid-19 crisis has attracted a new wave of attention to the role of various assets as portfolio diversifying factors. Islamic equities, due to their underlying risk-sharing and non-speculative business model, are an important candidate for such diversification benefits for both faith-based (Muslim) and conventional investors.

Among different econometric techniques to deal with the relationship between public sentiment and financial market behavior, we point out a wavelet-based time-frequency analysis. It has been already applied in this domain, in general, and to study the relationship between emerging and developed market sentiment, in particular; see, e.g., Dash and Maitra (2020). In line with their research and inspired by many other studies based on wavelet analysis (Sun and Xu, 2018; Zaremba et al., 2019; and Goodell and Goutte, 2020), we employ the wavelet coherence and wavelet phase difference techniques to investigate the impact of Covid-19 media coverage on the volatility of the Dow Jones (DJ) Islamic equity indices covering the aggregate and sectoral indices. We employ the Ravenpack Media Coverage Index (MCI) and gauge its interdependence with the Islamic stocks indices, covering various sectors of economic activity in the first half of 2020. The Ravenpack MCI is an index that measures the relative proportion of Covid-19 related news in the overall news coverage.

The wavelet techniques allow us to obtain the results in the form of time-frequency heatmaps, containing information on both coherence and time difference of the studied pairs of indices. Specifically, the wavelet coherence analysis is capable of providing insights on the joint behavior of indices, not only along the sole dimension of time, but also over different investment horizons or so-called frequency periods, thus enabling to study various patterns of Islamic equity indices and their comovements with the MCI. In addition, we employ the phase difference technique to obtain further information on the direction of indices co-movements and investigate the causality relationships between the variations in Covid-19 media coverage and the Islamic equity indices.

The literature on spillover, safe-haven, cross-market interdependence, and hedging opportunities across assets and financial markets has attracted a lot of attention since the GFC (Gubareva and Borges, 2016; Umar et al., 2018; Riaz et al., 2019; Stereńczak et al., 2020; and Kenourgios et al., 2020). As mentioned earlier, the recent Covid-19 pandemic has presented a unique challenge and inspired a new stream of literature focused on the impact of this pandemic on financial markets. Our research contributes to this incipient and, hence, insufficient literature by documenting the Islamic equity investment reaction to the Covid-19 induced crisis. Our findings are important for faith-based investors and conventional investors, pursuing diversification in stocks that meet Islamic investment guidelines, as we discuss their unique dynamics during the Covid-19 crisis.

We summarize the contribution of our research to the contemporaneous state-of-the-art as follows. We add to the current literature on the Islamic equity investments' response to the Covid-19 economic impacts. In addition, we contribute to the knowledge regarding the impact of news sentiment on financial markets by documenting the dynamic interdependence of media coverage and Islamic equity. In particular, we analyze how international media data influence the performance of Shariah-compliant equity investments across various sectors of economic activity by employing various equity indices. The use of Islamic equity indices also allows us to add to the literature on ethical investments and their potential diversification and risk mitigating properties. Our findings can provide useful insights for institutional investors and policy makers, shedding light on the attractive hedging attributes of Islamic stocks. We document intervals of high, medium, and low coherence between the media coverage level and the price dynamics of the Dow Jones (DJ) Islamic equity indices, contributing also to the literature on nonlinear dynamics and regime switching (Dufrénot and Jawadi,

Table 1

Descriptive statistics for the MCI and the Dow Jones Islamic equity indices for the selected sectors.

	DJ Islamic All Sectors	DJ Islamic Basic Materials	DJ Islamic Cons. Goods	DJ Islamic Cons. Services	DJ Islamic Oil & Gas	DJ Islamic Finan-cials k	DJ Islamic Health Care	DJ Islamic Indust-rial k	DJ Islamic Tech-nology	DJ Islamic Telecom k	DJ Islamic Utilities k	MCI Media Coverage Index
Average	0.27	0.28	0.22	0.29	0.50	0.37	0.23	0.29	0.34	0.15	0.17	58.81
Standard deviation	0.23	0.20	0.18	0.26	0.36	0.31	0.18	0.22	0.26	0.08	0.10	25.90
Skewness	1.47	1.32	1.42	1.65	1.15	1.35	1.30	1.27	1.62	1.40	1.66	(1.06)
Kurtosis	1.42	1.05	1.23	2.15	0.73	0.97	0.76	0.90	1.95	1.24	2.28	(0.16)
Minimum	0.04	0.03	0.04	0.04	0.06	0.06	0.05	0.04	0.06	0.04	0.05	0.09
1st quartile	0.10	0.14	0.09	0.12	0.26	0.16	0.11	0.14	0.15	0.10	0.10	39.61
Median	0.19	0.23	0.16	0.22	0.45	0.27	0.16	0.24	0.24	0.12	0.14	73.21
3rd quartile	0.32	0.33	0.27	0.34	0.61	0.47	0.27	0.33	0.40	0.17	0.19	78.49
Maximum	1.00	1.00	1.00	1.11	1.49	1.25	1.00	1.00	1.10	1.00	1.00	82.95
Observed	130	130	130	130	130	130	130	130	130	130	130	130

Note. The table reports daily changes in the MCI and the DJ Islamic equity indices 1H, 2020.

2017; Gubareva and Keddad, 2020; and Umar and Gubareva, 2020). Finally, we spot our attention on the low coherence zones, which are valuable indications of the Islamic equity diversification potential.

The rest of the paper is organized as follows. Section 2 discusses the data and methodology and provides the econometric model specification. Section 3 presents the results and provides their interpretation. Section 4 concludes.

2. Data and methods

This study applies the squared wavelet coherence (SWC) and wavelet coherence phase difference (WCPD) techniques following Torrence and Compo (1998), Torrence and Webster (1999), and more recent works by Sun and Xu (2018) and Zaremba et al. (2019). Our approach is applied to the daily data of the Covid-19 media coverage and the prices of the DJ Islamic equity indices. The time span of our analysis covers the first half of the year 2020. We analyze the interdependencies between the pandemic media coverage, measured by the MCI, and various DJ Islamic equity indices encompassing various sectors of economic activity.

2.1. Data and descriptive statistics

The MCI historical time series are obtained from Ravenpack. The Ravenpack MCI measures the pandemic media coverage as the ratio of news sources covering the coronavirus to all news sources. Hence, it reflects the extension and impact of the pandemic on public mood influencing both the conventional and faith-based Islamic equity investments because of the level of coronavirus awareness of investors. The MCI value lies between 0 and 100%, with 100% indicating the highest level of news about coronavirus.

Apart from the MCI, our dataset includes the DJ Islamic equity indices for the eleven following aggregates: all-sectors, basic materials, consumer goods, consumer services, oil and gas, financials, health care, industrial, technology, telecommunications, and utilities.

Table 1 reports the summary statistics for the daily changes in the DJ Islamic equity indices for the selected sectors of economic activity from the beginning of January to the end of June 2020.

To disentangle the multiscale interdependency between the MCI and the DJ Islamic equity indices, we employ the SWC technique. We use the continuous wavelet transformation to obtain SWC measures following Torrence and Webster (1999) and Vacha and Barunik (2012). The SWC value for any day at any frequency, from high (daily) to low (32-day period), is bounded by 0 (depicting zero correlation) and 1 (depicting perfect correlation between the two time series). To supplement our coherence analysis and get a deeper insight into the lead-lag relations between the MCI and DJ Islamic equity indices, we employ the WCPD technique following Sun and Xu (2018) and Zaremba et al. (2019).

2.2. Econometric framework

Differently from standard time-series modelling, the SWC technique allows for the investigation of the comovements between two time-series in both the time and frequency domains. This technique is based on a bivariate framework established with a continuous wavelet transform, able of providing a variety of scaled localizations; see Rua and Nunes (2009). To perform the time-frequency wavelet-based analyses of the comovement between time-series, we use the wavelet coherence approach consisting of both the cross-wavelet transform (CWT) and coherence.

The CWT of two time series $x(t)$ and $y(t)$, in line with Torrence and Compo (1998), is expressed through their individual CWTs: $W_n^x(u, s)$ and $W_n^y(u, s)$ as:

$$W_n^{xy}(u, s) = W_n^x(u, s)^* W_n^y(u, s) \quad (1)$$

where u indicates the location, s represents the scale, and the asterisk * designates the complex conjugate. The CWT puts in evidence those areas in the time-frequency domain where the considered time-series co-move, even if they do not show a common high power. In other words, it captures the local covariance between the two time series $x(t)$ and $y(t)$ at each scale. For instance, a CWT value close to one signifies a high degree of synchronization between the time series. On the other hand, a CWT figure in proximity to zero signals an absence of relationship.

We follow the framework of Torrence and Webster (1999) and define the squared wavelet coherence (SWC), which captures the comovements between the two time series as:

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

where S is a smoothing operator over time as well as frequency scale. The SWC is but a correlation coefficient in the time-frequency domain, whose value belongs to the interval between zero and one.

It is worth mentioning that differently from the common Pearson correlation coefficient of the two time series, the SWC assumes only positive values. Hence, such an approach is unable to distinguish comovements of opposite signs, i.e., cannot differentiate between positive and negative correlations.

To get a deeper insight into the correlation analyses and lead-lag relations among the two time series, we employ the WCPD technique (Torrence and Compo, 1998), which allows for distinguishing between the two possible comovements: positive and

negative.

The WCPD is expressed as:

$$\phi_{xy}(u, s) = \tan^{-1} \left(\frac{\text{Im}\{S(s^{-1}W^{xy}(u, s))\}}{\text{Re}\{S(s^{-1}W^{xy}(u, s))\}} \right) \tag{3}$$

where *Im* and *Re* are, respectively, the imaginary and real parts of the smoothed CWT.

It is worth noting that the employed graphical presentation of the WSC provides us with the causal relationships between the two time series. For instance, we employ black arrows on the SWC panels to indicate phase differences. A phase difference equal to zero corresponds to perfect comovements of the two time series. Arrows pointing to the right (left) indicate time series which are in-phase (out of phase), i.e., are positively (negatively) correlated. An arrow pointing upward indicates that the first time series leads the second by $\pi/2$. By analogy, an arrow with downward direction signifies that, in this case, the second time series leads the first by $\pi/2$. Bearing these rules in mind, one could intuitively decipher the meaning of an arrow pointing in any other imaginable direction.

The next section is dedicated to the results and their discussion.

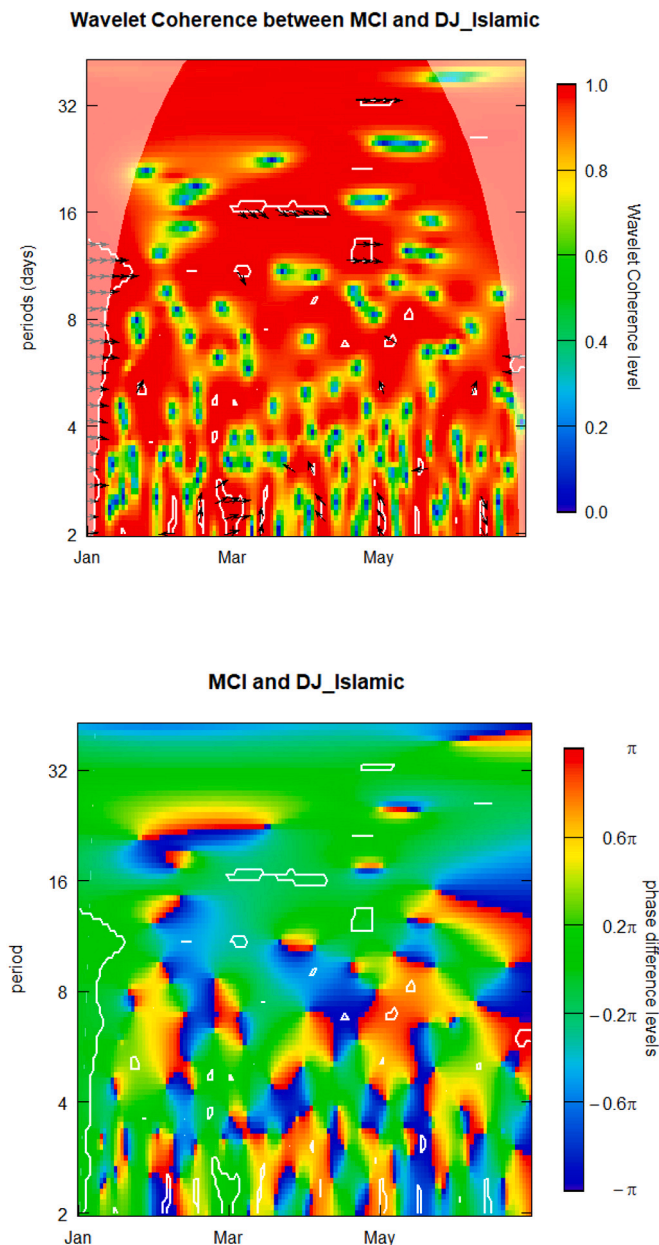


Fig. 1. Wavelet analysis: the Media Coverage Index (MCI) versus the DJ Islamic index.

3. Results

3.1. Media coverage index (MCI) and the aggregate all-sectors Dow Jones Islamic equity index

We begin our analysis by examining the SWC results between the MCI and the aggregate all-sectors DJ Islamic Equity index (DJ Islamic). The legends on the right-hand sides show the keys for reading the heatmaps. Time is displayed on the horizontal axis and the frequency, or the length of the period of analysis in days, is shown on the vertical axis. The interpretation of the left-hand graph is based on the color displayed for any day and frequency. In general, the warmer the color (yellow to red), the greater the coherence or interdependence between the indices. The cooler colors (blue to green) imply less coherence.

Fig. 1 displays the results for the SWC measure and WCPD based lead-lag relationship between the MCI and the all-sectors DJ Islamic.

For the MCI–DJ-Islamic pair, we document a varying level of coherence ranging from low to medium and to high coherence over the entire time scale. It is worth noting that for the 2-weeks-plus low-frequency band on the top of the left-hand-side panel, the heatmap appears to be predominantly red, signifying a high coherence during all analyzed period.

The initial period, corresponding to January, shows high overall coherence, although for the second half of January within the 1-week frequency band we observe a green shade with several blue spots implying lower levels of coherence during that time interval. We associate this pattern to the pre-Covid-19 period, when still all markets predominantly exhibited growth trends and a rather smooth functioning, preceding the provoked by the pandemic panic-leads-market phase in February 2020. Over the frequency scale, coherence is high across most frequencies, but more specifically, it changes from high to medium-low for higher frequencies, with the lowest coherence observed for the 3-day's frequency horizon. This result represents a certain interest from the point of view of the DJ Islamic performance, as the above phenomenon of diminishing coherence for a set of frequencies exhibits not constant but alternating patterns along the time scale. A further research of this phenomenon is desirable.

Although the predominantly red-colored intervals imply that the volatility of the DJ Islamic is highly correlated with the Covid-19 induced panic, leaving less room for diversification through Islamic stocks, the intervals of green regions imply that the DJ Islamic exhibited some diversification attributes despite the drastic effects of the pandemic contingency measures, implemented in February–March in a vast majority of countries worldwide.

We also identify causality and phase differences between the MCI and DJ Islamic moves. As already briefly mentioned in the section dedicated to the methodology, arrows on the SWC plot indicate the phase differences between the MCI and the ESG index moves. For example, \rightarrow and \leftarrow indicate that both the MCI and DJ Islamic are in phase and out of phase, respectively. \nearrow and \swarrow indicate that the MCI moves are leading those of the DJ Islamic, while \searrow and \nwarrow indicate that the MCI moves are lagging those of the DJ Islamic. In particular, the left-hand heatmap of Fig. 1 exhibits for the first half of January, the arrows \rightarrow , signifying an in-phase relationship in the 2-day to 2-weeks band, indicating the positive correlation between the MCI and the DJ Islamic. We ascribe this period to the ignition of the pandemic, when Covid-19 begins to spread on a global scale.

We also see a belt of arrows \searrow in March–April for the 16-days horizon, indicating that although being in phase with the DJ Islamic moves, the MCI index lags the DJ Islamic index, during the escalation of the Covid-19 fueled crisis. This is comprehensible, as the pace of economic and financial changes around the apogee of the pandemic was so rapid, the news sources were lagging to provide adequate coverage of the overwhelming disruption of normality due to the Covid-19 impact. We attribute this period to the effects of full-swing social distancing, and once again demonstrate that the wavelet analysis correctly reflects the underlying Covid-19 reality. In respect to the 16-days length of the investment horizon on a frequency scale, perhaps a clue to its understanding may reside in the number 8, which has a special meaning in Islamic culture. However, further investigation of this peculiarity stays beyond the scope of the present research.

To gain further insight into the interdependency relationship, the right-hand heatmap of Fig. 1 identifies the lead-lag relationship between the MCI and DJ Islamic. We notice two important features here. Firstly, we observe several regions of anti-phase in February and then since April onwards, where a lead by the DJ Islamic over the media coverage is especially evident by the blue color, signifying that Islamic law compliant companies as a whole behave as the locomotives of recovery. Second, interestingly enough, within the 1-week frequency band we observe alternating patterns suggesting an unsynchronized behavior of the two indices, although over the larger investment horizons in the 1-week-plus band, these asynchronies are self-cancelled. However, the overall average tonality of the phase heatmap could be characterized as cooler than green or greenish blue, bearing in mind that red/yellow spots on average are more than compensated by the predominating blue zones, showing the overall leadership of the DJ Islamic equity movements. Such results may be considered broadly consistent with the interpretation of businesses that meet Islamic investment guidelines as an advanced front in comparison to the overall mood of conventional investors, mostly dominated by naked animal spirits. This view is aligned with an inherent orientation of Islamic finance towards promoting the real economy sector. Our findings regarding the lead role of Islamic stocks could be of use for investors assessing the attractiveness of the Islamic equity investments as possessing some attractive hedging attributes, whose potential for portfolio diversification does not disappear, as evidenced herein, even within the periods of acute global crises.

3.2. DJ Islamic sub-index analysis per sector of economic activity

We extend our analysis and report the results for various sub-indices of the DJ Islamic for various sectors of economic activity.

3.2.1. The real physical “brick-and-mortar” sector

In this subsection, we discuss the results for the real sector comprising of Basic Materials, Consumer Goods, Oil and Gas, and Industrial sub-indices.

Fig. 2 displays the results for the SWC measure and WCPD between the coronavirus Media Coverage Index (MCI) and the DJ Islamic Basic Material index. The overall exhibited pattern is similar to the heatmaps of Figure1 and the respective findings regarding the impact of the MCI on the volatility of the aggregate all-sectors DJ Islamic equity index. However, in the phase-difference graph, we see that the blue and sky-blue regions are more visible in the center of the heatmap from February until May, being these intervals representative of the DJ Islamic Basic Material lead. This lead, reflected in the panel by the negative anti-phase blue pattern, spreads over the late-March apogee of the Covid-19 fueled crisis, certifying that DJ Islamic Basic Materials represent very attractive hedge attributes, as they do not vanish even during a free fall of the global economy accompanied by a severe disruption of financial markets. This pattern corresponds to the period prior around the pick of the Covid-19 economic crisis, when the DJ Islamic Basic Material companies were well ahead, performing better in comparison to the already staggered rest of the world.

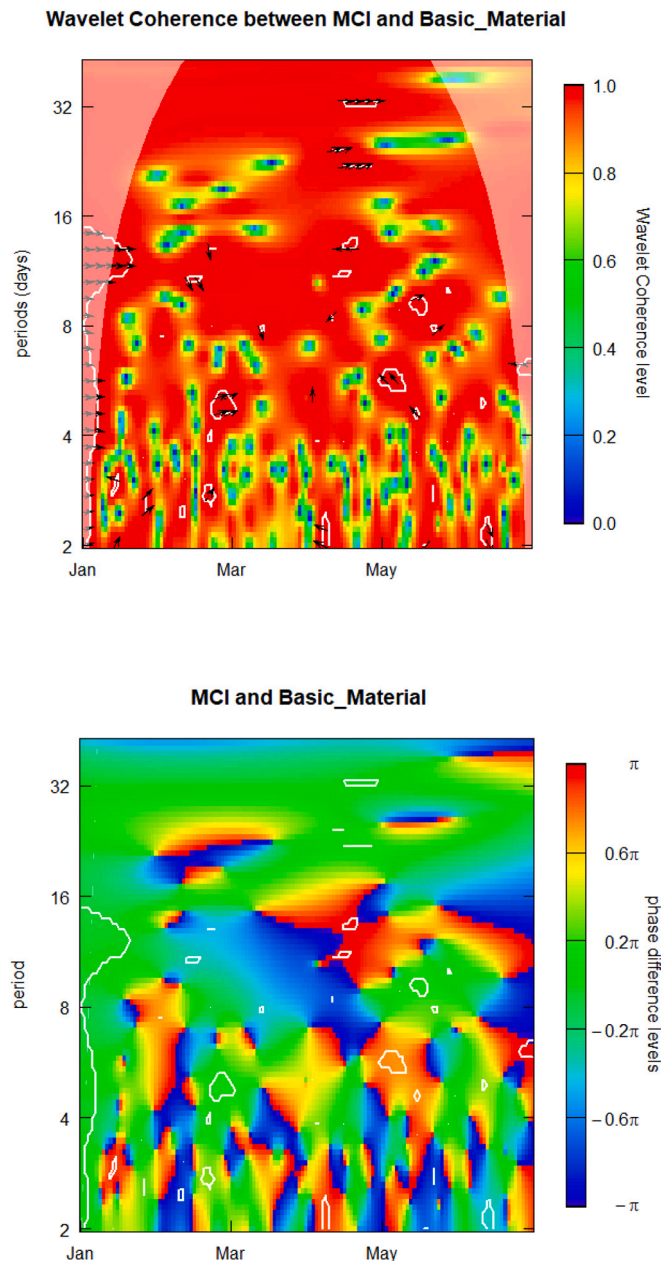


Fig. 2. Wavelet analysis: the MCI versus the DJ Islamic Basic Material index.

Fig. 3 displays the results for the SWC measure and WCPD between the MCI and the DJ Islamic Consumer Goods index. As with the other two indices, we observe alternating patterns of high and low coherence across time and frequency scales. Over the frequency scale, similarly to the previous cases, we also observe that coherence is high in the 5-days-plus band, diminishing for the panel's bottom within the 2-to-4-day's band. It is worth noting that the phase difference analysis produces patterns similar to those observed for the all-sectors DJ Islamic and the DJ Islamic Basic Material indices. For instance, we see several anti-phase periods since mid-February onwards. The greenish-turquoise and blue shaded anti-phase intervals signify that the coronavirus media coverage lags the moves of the stock prices of the DJ Islamic Basic Materials equities at the corresponding time and frequency. In addition, at the top of the phase difference heatmap, for the 1-month-plus frequency band, we see the sky-blue area becoming the blue lane, corroborating with the conclusion regarding the leadership of Islamic equities over the coronavirus media coverage, for the investments horizons superior to one month.

Fig. 4 displays the results for the SWC measure and WCPD based lead-lag relationship between the Media Coverage Index (MCI) and the DJ Islamic Oil and Gas index. Similarly to the previous cases, here again, the red predominant tonality corresponds to a high coherence. However, there are intervals of low coherence (green) across the time-frequency scale. In particular, for higher frequencies

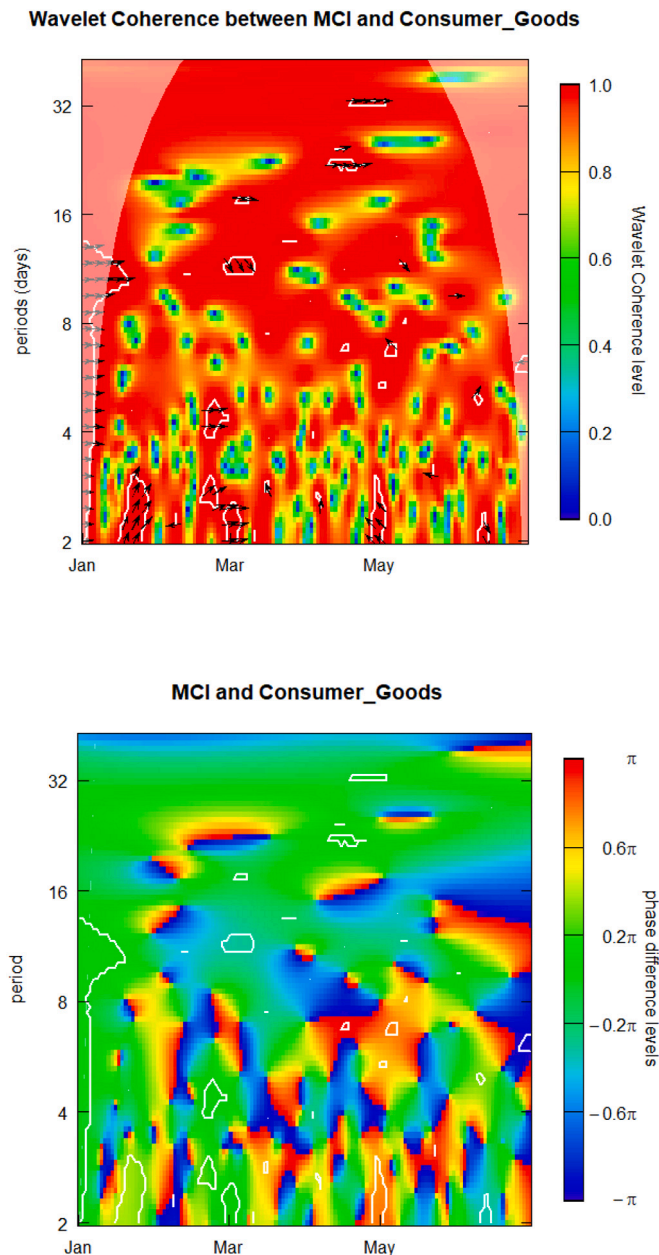


Fig. 3. Wavelet analysis: the MCI versus the DJ Islamic Consumer Goods index.

(1–8 days), we observe recurrent intervals of low coherence, especially for the 1-to-4-days band. A further research of this feature is needed, especially as in the case of the DJ Islamic Oil and Gas index, the short mini-cycles of average duration about 10 days are particularly well noticeable; see several small blue spots with greenish turquoise aureoles along the entire analyzed period.

To gain further insight into the interdependency relationship, we also identify the causality and phase differences between the MCI and the DJ Islamic Oil and Gas index. In the right-hand panel of Fig. 4, we observe that the predominant tonality is blue. It is the coolest panel in comparison to the other phase difference heatmaps. A pronounced well-defined blue cloud in the central part of the panel documents that the media coverage lags behind the Islamic Oil and Gas equity moves, certifying that Oil and Gas companies, which meet Islamic investment guidelines, perform the leadership role, especially evident in the most turbulent times around the apogee of the Covid-19 provoked economic crisis. This finding makes them the most attractive investment targets, capable of providing hedging attributes for those thinking to pursue a diversification of their assets by means of investing in Islamic stocks. From this analysis, we conclude that the DJ Islamic Oil and Gas companies play a role of the main driver of causality in the periods of global crises.

Fig. 5 displays the results for the SWC measure and WCPD-based lead-lag relationship between the Media Coverage Index (MCI) and the DJ Islamic Industrial index. Now once again we are analyzing companies involved in the real “brick-and-mortar” sector of

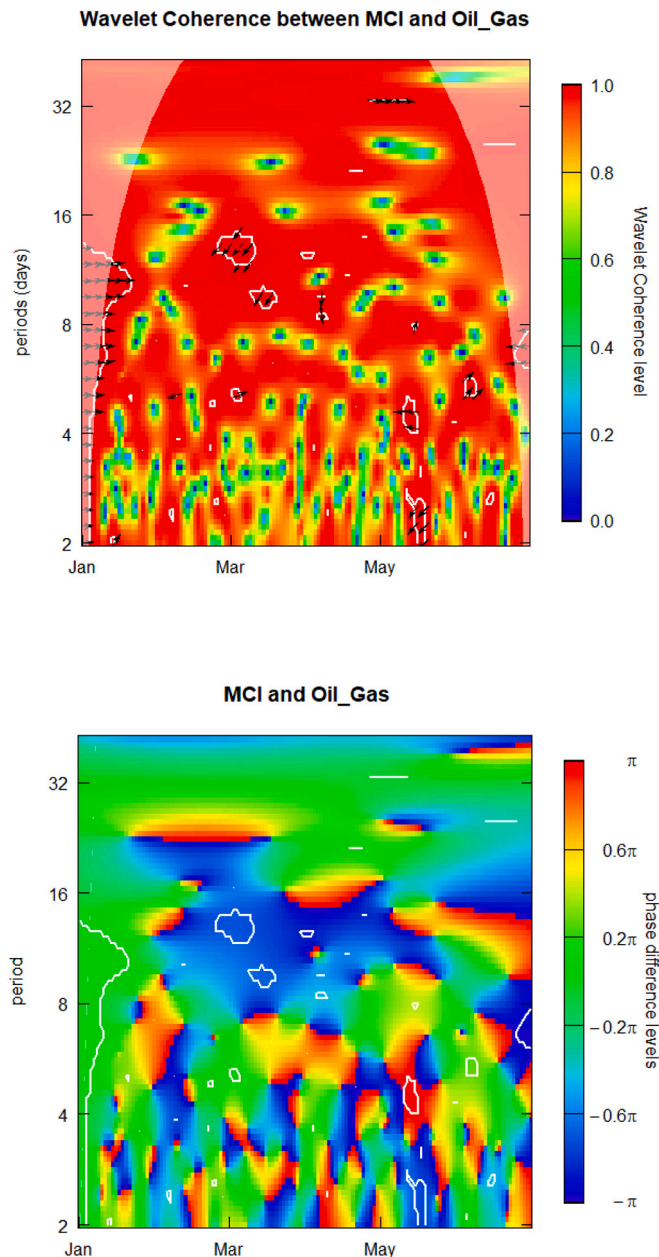


Fig. 4. Wavelet analysis: the MCI versus the DJ Islamic Oil and Gas index.

economic activity. As for the DJ Islamic Basic Material, the DJ Islamic Consumer Goods, and the DJ Islamic Oil and Gas indices, we observe an alternating pattern of high and low coherence across time and frequency scales. Over the frequency scale, similarly to the previous cases, we also observe that coherence is high in the 5-days-plus band, diminishing for the panel's bottom within the 2-to-4-day's band. It is worth noting that the phase difference analysis produces patterns similar to those observed for the three above-mentioned indices. For instance, we see several anti-phase periods since mid-February onwards. The greenish-turquoise and blue shaded anti-phase intervals signify that the coronavirus media coverage lags the moves of the stock prices of the DJ Islamic Industrial equities at the corresponding time and frequency. It is worth commenting that the green color dominates the area corresponding to January, i.e., the initial phase of Covid-19 pandemic, and also the 2-weeks-plus frequency band for the entire period of the analysis, reflecting a synchronicity in the movements of the MCI and the DJ Islamic Industrial. However, since February onwards, blue-colored zones dominate the panel for high frequencies below 2-weeks level. This evidence of the anti-phase behavior, when the DJ Islamic industrial leads the coronavirus media coverage, makes the stocks of the Shariah-compliant companies involved in industrial production a valuable investment opportunity, offering in addition attractive hedge attributes, especially under financial turmoil

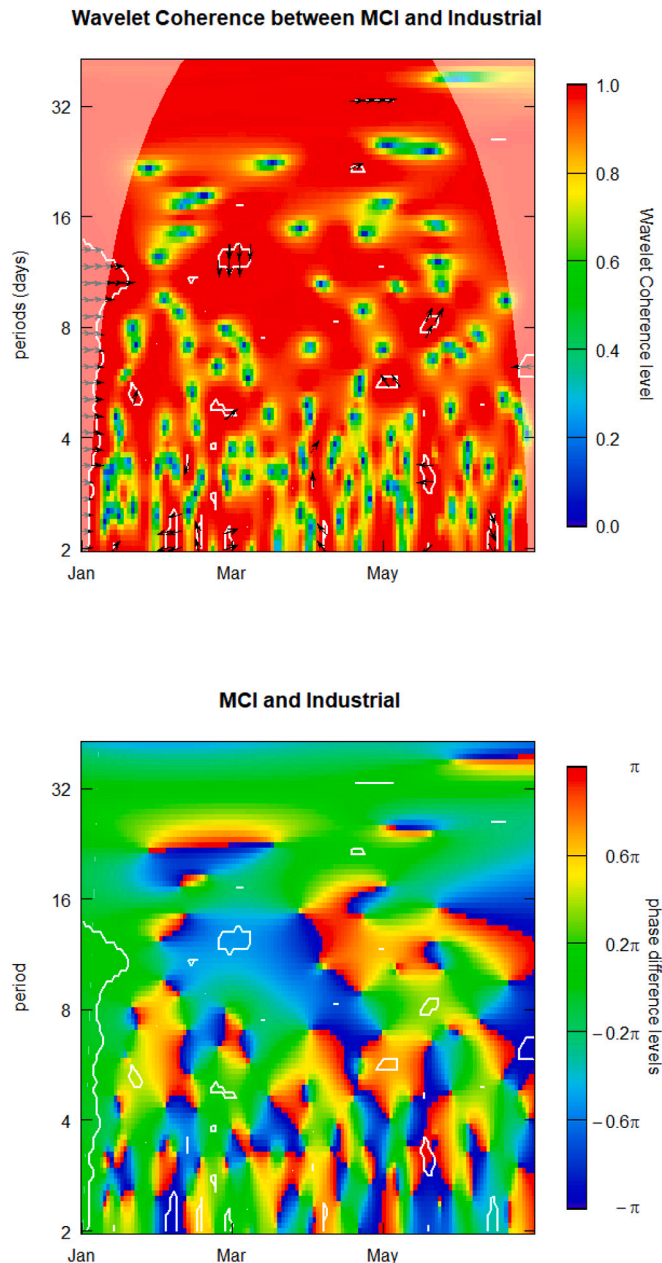


Fig. 5. Wavelet analysis: the MCI versus the DJ Islamic Industrial index.

conditions observed in the periods of global crises.

3.2.2. *The services-oriented and services-supporting sectors*

In this subsection, we discuss the results for Consumer Services, Financial Services, Healthcare, Technology, Telecom, and Utilities.

Fig. 6 displays the results for the SWC measure and WCPD based lead-lag relationship between the Media Coverage Index (MCI) and the DJ Islamic Consumer Services index. The SWC analysis results in an alternating pattern of high and low coherence across time and frequency scales, similarly to the previously considered indices. However, the outcomes of the phase difference analysis are slightly different. Although we see several anti-phase periods, since mid-February onwards, there is less of blue and sky blue regions, with the predominance of the green color in the center of the heatmap. This signify that the Islamic Consumer Services companies possess less leadership power and that their equity prices move in synchronicity with the coronavirus media coverage. In this manner, they are slightly less attractive for hedging purposes in comparison to the Islamic equity exposures to basic materials and consumer goods sectors of economy.

Fig. 7 displays the results for the SWC measure and WCPD-based lead-lag relationship between the Media Coverage Index (MCI)

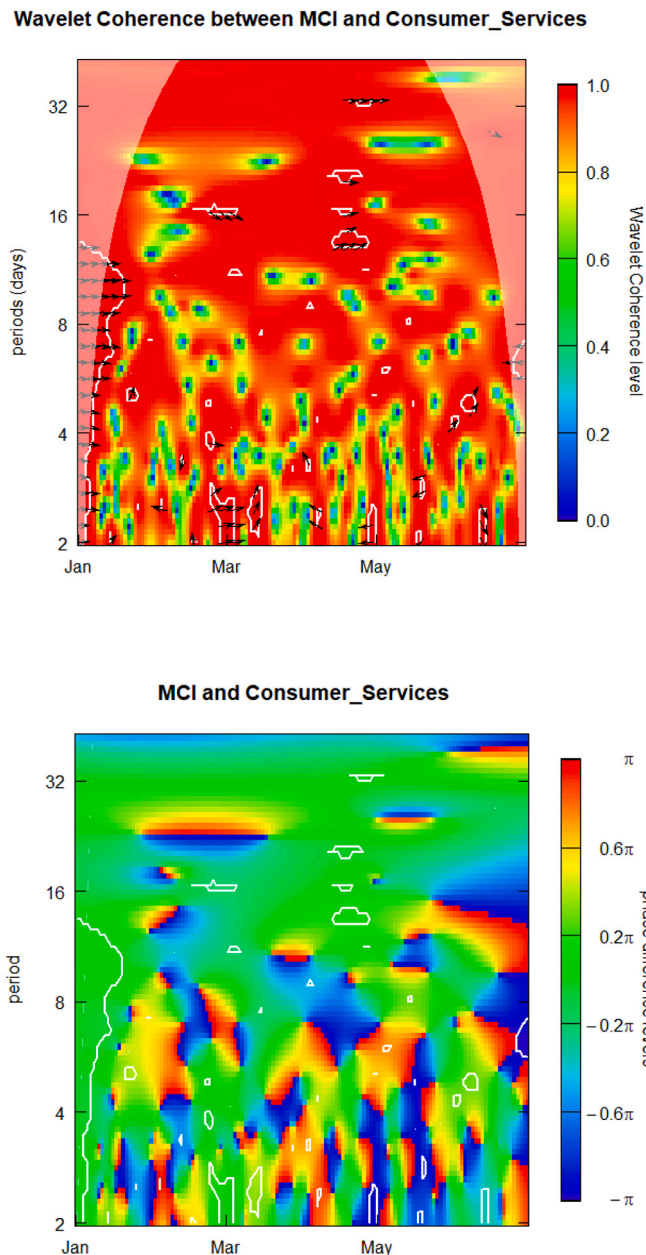


Fig. 6. Wavelet analysis: the MCI versus the DJ Islamic Consumer Services index.

and the DJ Islamic Financials index. Similarly to the previous cases, the time periods with higher coherence are seen in the 1-week-plus frequency band for the entire analyzed period. The right-hand heatmap of Fig. 6 identifies the lead-lag relationship between the MCI and the DJ Islamic Financials index. The observed patterns for DJ Islamic Financials are similar to those observed for the DJ Islamic Consumer Services. We believe that this makes sense as Islamic-law-compliant financial companies also provide services to their customers, in this case - financial services. Although we see several anti-phase periods, since mid-February onwards, there is somewhat less of blue and sky blue regions, with the predominance of the green color in the center of the heatmap. This signify that an equity exposure to stocks of Islamic Financials, which exhibit lower leadership power compared to other Islamic equities and whose equity prices move in synchronicity with the coronavirus media coverage, are slightly less attractive for hedging purposes in comparison to the Islamic equity exposures to basic materials, consumer goods, and oil and gas sectors of economy.

Fig. 8 displays the results for the SWC measure and WCPD-based lead-lag relationship between the Media Coverage Index (MCI) and the DJ Islamic Health Care index. Similarly to the previous cases, the time periods with higher coherence are seen along the entire analyzed period; see the predominantly red color for the 1-week-plus frequency band. We also see a cloud of arrows \searrow in March for 1-to-2-weeks band, indicating that although being in-phase with the DJ Islamic Health Care moves, the MCI index lags the DJ Islamic

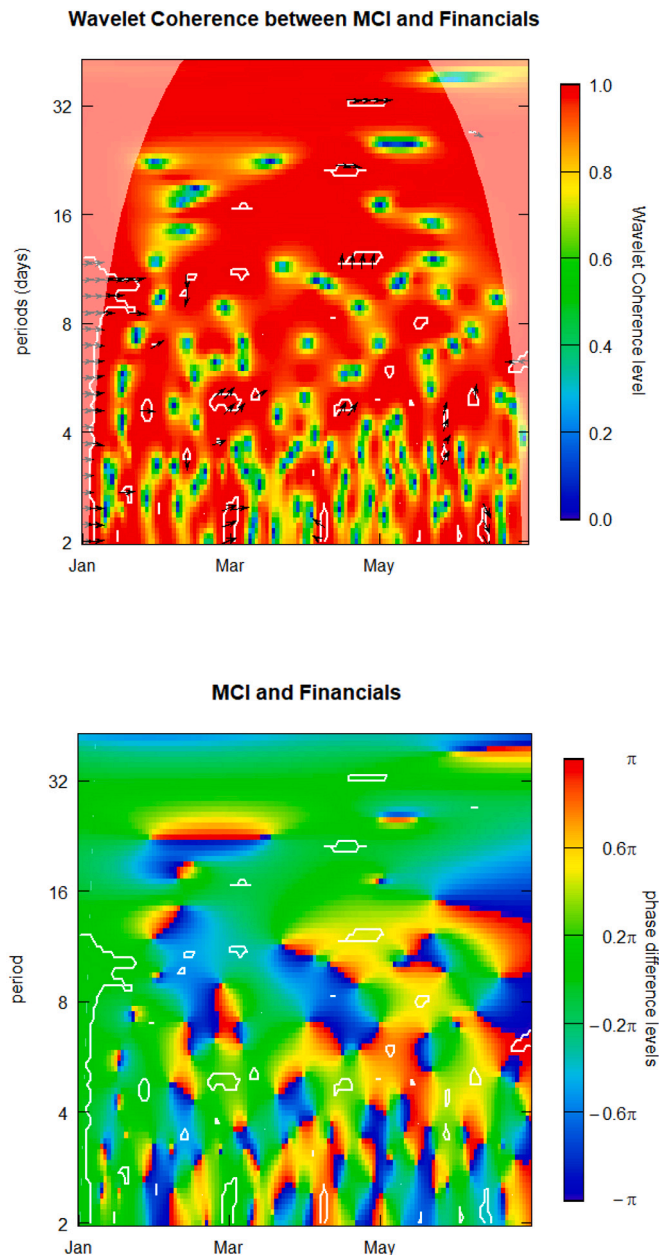


Fig. 7. Wavelet analysis: the MCI versus the DJ Islamic Financials index.

Health Care index, during the escalation of the Covid-19 fueled crisis. This is comprehensible, as the health care companies, both conventional and Shariah-compliant, were at the very edge of the battle against Covid-19 virulent disease, being ahead of the coronavirus media coverage by news sources.

The right-hand heatmap of Fig. 7 identifies the lead-lag relationship between the MCI and the DJ Islamic Health Care index. As once again we deal with services, now with health care services, similarly to the DJ Islamic Consumer Services and DJ Islamic Financials, we see that the average tonality of the phase heatmap is green. This signify that the equity prices of the Shariah-compliant health care companies move in synchronicity with the coronavirus media coverage, and hence are slightly less attractive for hedging purposes in comparison to the Islamic equity exposures to basic materials, consumer goods, and oil and gas sectors of economy. Therefore, equity exposures to the Islamic health care stocks, which exhibit lower leadership power compared to other Islamic equities, offers limited diversification possibilities and are relatively less attractive for investors in the search for hedging attributes that work in periods of economic crisis.

Fig. 9 presents the results for the SWC measure and WCPD-based lead-lag relationship between the Media Coverage Index (MCI)

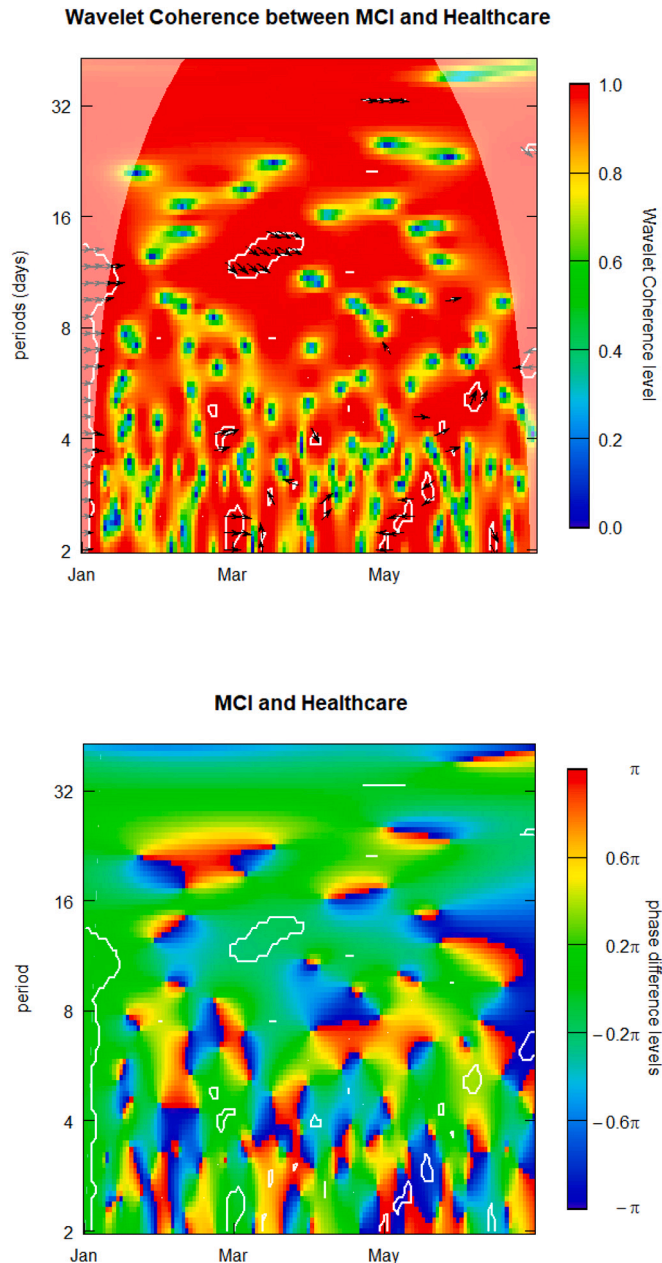


Fig. 8. Wavelet analysis: the MCI versus the DJ Islamic Health Care index.

and the DJ Islamic Technology index. Once again, the time periods with higher coherence are seen along the entire analyzed period, see the predominantly red color for the 1-week-plus frequency band. Interestingly enough, here we have a kind of so-called services-supporting industry, as the vast majority of technology outcomes are currently predestined to be used in services-oriented industries such as consumer services, financial services (fintech), and health care (biotech) sectors of economic activity. Hence, it comes with no surprise that the phase difference heatmap of the Islamic technology is very similar to the heatmaps for the above-mentioned services-oriented sectors. For instance, we observe a vast green region in the center of the phase difference heatmap, telling us that DJ Islamic Technology index and the MCI movements are in phase around the apogee of the Covid-19 fueled crisis, thus making the investments in the Shariah-compliant technology companies less attractive due to their relatively low diversification capacity in times of economic crises and financial turmoil.

Fig. 10 displays the results for the SWC measure and WCPD between the coronavirus, MCI and the DJ Islamic Telecom index. As once again we analyze herein a services-supporting industry, namely, of telecommunications, the overall exhibited pattern, as expected, is similar to the heatmaps of Figs. 4, 6–8 for the other already discussed services-oriented and services-supporting industries. A

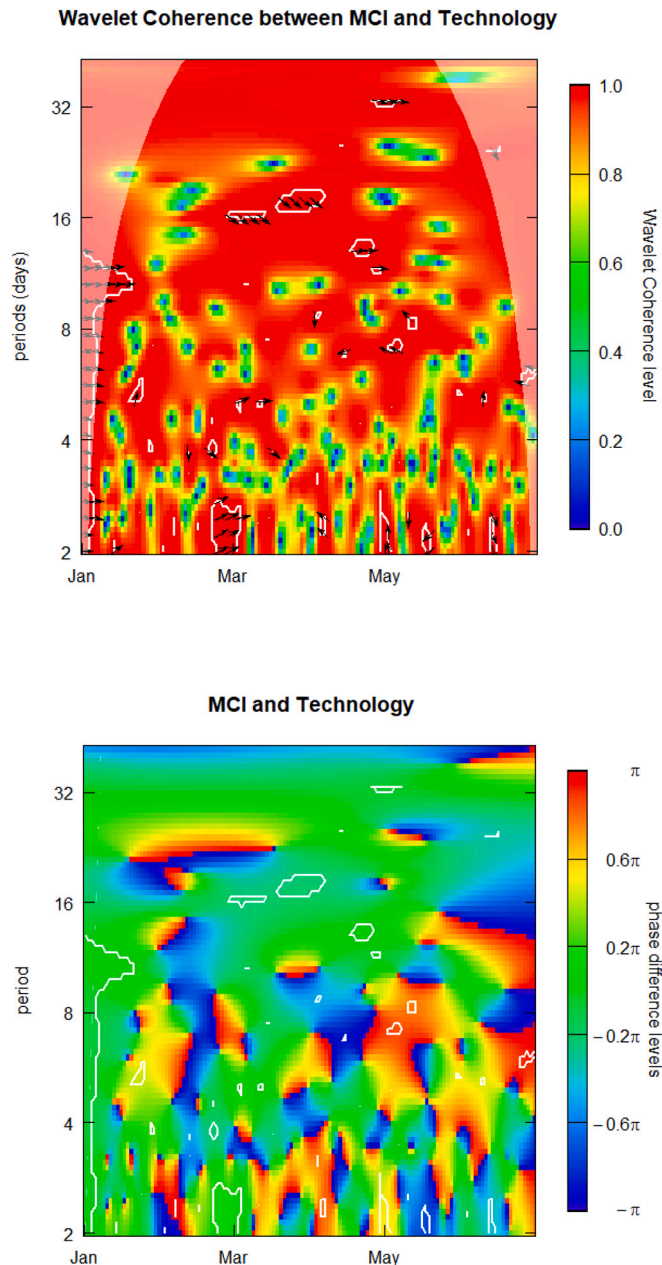


Fig. 9. Wavelet analysis: the MCI versus the DJ Islamic Technology index.

green region is observed for the low 10-days-plus frequencies in the middle of the phase difference panel corresponding to the period from late February until June, which covers the extreme impacts on economic activity, being a consequence of social distancing contingency measures to withstand the propagation of the Covid-19. Green color tells us that DJ Islamic Telecom index and the MCI movements are synchronized around the apogee of the pandemic-fueled crisis. We, hence, conclude that, similarly to other services-oriented industries, investments in the Shariah-compliant telecom companies are relatively less attractive in comparison to the real economy sector due to their rather limited diversification capacity under stressed conditions when hedging attributes are highly demanded by investors.

Finally, we extend our analysis and report the results for the DJ Islamic Utilities index. Fig. 11 displays the results for the SWC measure and WCPD between the MCI and the prices of Islamic utilities. As with other indices, in the wavelet coherence panel, we observe an alternating pattern of high and low coherence across time and frequency scales. Over the frequency scale, similarly to the previous cases, we also detect that coherence is high in the 5-days-plus frequency band, diminishing for the panel's bottom within the 2-to-4-days' band. The phase difference heatmap is similar to panel observed for the other services-oriented and services-supporting sectors. Although it shows several anti-phase periods along the whole analyzed Covid-19 history, mostly for 1-day-to-2-weeks

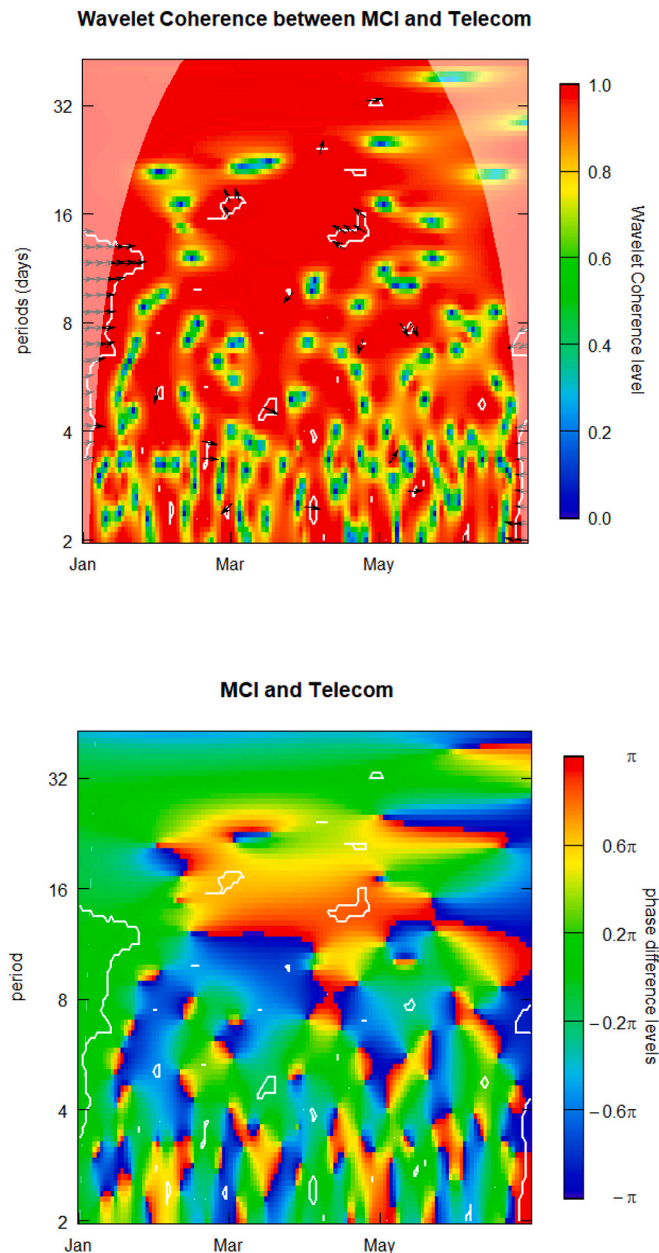


Fig. 10. Wavelet analysis: the MCI versus the DJ Islamic Telecom index.

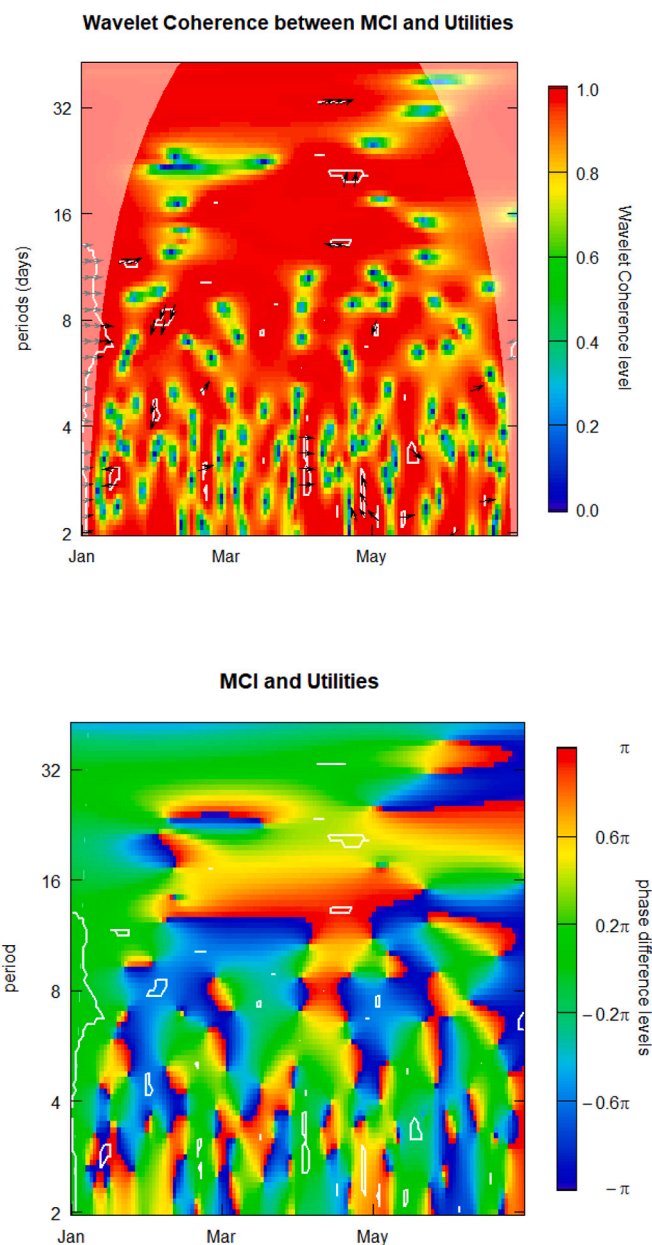


Fig. 11. Wavelet analysis: the MCI versus the DJ Islamic Utilities index.

frequency band, for the lower frequencies in the 2-weeks-plus band we observe a well-defined red and yellow cloud since mid-February until mid-May, signifying that the moves of the DJ Islamic Utilities index lag behind the movements of the MCI. It is the warmest heatmap among all considered herein DJ Islamic sub-indices. The phase difference panel for the DJ Islamic Utilities exhibits the most pronounced lead of the coronavirus media coverage extended over the crucially critical period of the current pandemic. Therefore, we conclude that equity exposure to utilities, which meet Islamic investment guidelines, is the least attractive from the downside risk diversification perspective among other Islamic equities.

3.3. Additional comments and implications

By means of the application of the time-frequency wavelet-based econometric technique, we are able to correctly capture the different nature of the Islamic-law-compliant stocks in diverse sectors of economic activity. As per our analysis, certain patterns arise. An important finding is that the diversification capacities of the real “brick-and-mortar” industries are superior to that of the services-oriented and services-supporting sectors. Within the former cluster, we place the four following sectors: basic materials, consumer

goods, oils and gas, and industrial. On the other hand, we classify consumer services, financial services and health care as services-oriented businesses. And finally, among the services-supporting sectors we consider technology-oriented corporations from fintech, biotech, and other advanced domains, telecommunication companies, and public utilities.

This knowledge could be of use for accurate assessing the attractiveness of investments in Islamic equities as possessing appealing hedging attributes, which are more present in real “brick-and-mortar” stocks and are less pronounced in services-oriented and services-supporting equity exposures. This finding is largely compatible with the basic concept underlying Islamic finance, which is an asset-based system promoting the real physical economy. It is especially so in comparison to conventional financial systems, based on the interest rate concept rather than on profit sharing. However, within the proper Islamic-low-compliant companies, there are more asset-based “brick-and-mortar” stocks, and less asset-based equities of services-oriented and services-supporting businesses. And we have empirically evidenced the hedge-related consequences of relative size differences in the asset-based inclinations of companies’ economic activities by means of the wavelet time-frequency analysis.

4. Conclusion

This study examines the interdependence between the Media Coverage Index (MCI) and the volatility of eleven DJ Islamic equity indices covering diverse sectors of economy. We employ wavelet coherence and wavelet phase difference methodologies. Our results show predominantly medium to high coherence between various DJ Islamic equity indices and the MCI. The predominant high coherence implies the high correlation between a systemic event such as the Covid-19 pandemic and the financial market volatility, underscoring the importance of alternative assets for hedging. However, there are intervals of low coherence across various time and frequency scales for these indices. The low coherence intervals show that DJ Islamic equity indices allow for diversification benefits and can serve as a potential safe haven even during a global catastrophe such as the Covid-19. We also observe several differences in the patterns of coherence exhibited by various indices encompassing various sectors of economic activity. We report that appealing hedging attributes, which are more present in real “brick-and-mortar” stocks and are less pronounced in services-oriented and services-supporting equity exposures.

Thus, our findings corroborate the usage of Islamic equity investments by investors pursuing diversification and downside risk hedge strategies, based on market segmentation across various sectors of economic activity, and most importantly, differentiating between conventional equities and those meeting the Islamic investment guidelines. The results of this study have important implications for portfolio managers, private and institutional investors, policy makers, and future research. The results can be useful for portfolio managers and investors for designing hedging strategies across sectors, which could work in the periods of global crisis, as evidenced by the Covid-19 pandemic. Thus, banks and hedge funds could use our findings for better delineating accurate risk profiles of Islamic equities. A recent upsurge of attention towards Shariah-compliant investments certifies that Islamic equities are becoming a basilar pillar of global contemporaneous finance. On the other hand, policymakers can use the results of this research for designing policies to reduce market volatility during such highly uncertain times. Lastly yet importantly, future research can focus on extending our results by using alternative techniques and measuring the portfolio implications of including such investments in a portfolio choice framework.

Data availability statement

The data that support the findings of this paper are available on request.

Acknowledgments

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