ECONSTOR Make Your Publications Visible.

A Service of

ZBW

Leibniz-Informationszentrum Wirtschaft Leibniz Information Centre for Economics

Sahabuddin, Mohammad et al.

Article

Co-movement and causality dynamics linkages between conventional and Islamic stock indexes in Bangladesh: A wavelet analysis

Cogent Business & Management

Provided in Cooperation with:

Taylor & Francis Group

Suggested Citation: Sahabuddin, Mohammad et al. (2022) : Co-movement and causality dynamics linkages between conventional and Islamic stock indexes in Bangladesh: A wavelet analysis, Cogent Business & Management, ISSN 2331-1975, Taylor & Francis, Abingdon, Vol. 9, Iss. 1, pp. 1-16, https://doi.org/10.1080/23311975.2022.2034233

This Version is available at: https://hdl.handle.net/10419/288349

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.



WWW.ECONSTOR.EU

https://creativecommons.org/licenses/by/4.0/

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.







Cogent Business & Management

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/oabm20

Co-movement and causality dynamics linkages between conventional and Islamic stock indexes in Bangladesh: A wavelet analysis

Mohammad Sahabuddin, Md. Farjin Hassan, Mosab I. Tabash, Mohammad Ahmad Al-Omari, Md. Kausar Alam & Fakir Tajul Islam

To cite this article: Mohammad Sahabuddin, Md. Farjin Hassan, Mosab I. Tabash, Mohammad Ahmad Al-Omari, Md. Kausar Alam & Fakir Tajul Islam (2022) Co-movement and causality dynamics linkages between conventional and Islamic stock indexes in Bangladesh: A wavelet analysis, Cogent Business & Management, 9:1, 2034233, DOI: <u>10.1080/23311975.2022.2034233</u>

To link to this article: https://doi.org/10.1080/23311975.2022.2034233

© 2022 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.

d	n.	(1
Е			
E			
E			
_			_

Published online: 12 Feb 2022.

|--|

Submit your article to this journal 🗹



View related articles 🗹



View Crossmark data 🗹



Citing articles: 8 View citing articles 🗹





Received: 05 February 2021 Accepted: 24 December 2021;

*Corresponding author: Mohammad Sahabuddin, University of Science and Technology Chittagong, Bangladesh E-mail: dr.sahabuddin@ustc.ac.bd

Reviewing editor: David McMillan, University of Stirling, Stirling, United Kingdom

Additional information is available at the end of the article

BANKING & FINANCE | RESEARCH ARTICLE

Co-movement and causality dynamics linkages between conventional and Islamic stock indexes in Bangladesh: A wavelet analysis

Mohammad Sahabuddin¹*, Md. Farjin Hassan², Mosab I. Tabash³, Mohammad Ahmad Al-Omari³, Md. Kausar Alam⁴ and Fakir Tajul Islam⁵

Abstract: The study examines the co-movement and dynamic causality between conventional and Islamic stock indexes in Bangladesh from 20 January 2014 to 31 August 2019. This study employs multi-scales and wavelet-based techniques in examining the co-movement and causality between variables. The results reveal that the co-movement between Islamic and conventional stock indexes is very high in the long run. Furthermore, the results of this study indicate that there is a leadlag relationship between Islamic and conventional index using wavelet-based decomposed Granger Causality methods. The results point out that the causality varies in time and scales domain properties. However, the Dhaka Stock Exchange Shariah Index (DSES) shows significant influences on DSEX and creates a bidirectional causality for the selected brand scales over the study period. The

ABOUT THE AUTHOR

Mohammad Sahabuddin is working at the University of Science and Technology Chittagong, Bangladesh. He is also a postdoctoral researcher in Universiti Malaysia Perlis. His area of interests is Islamic finance and Shariah compliant stock market.

Md. Farjin Hassan is doing research in Finance at Universiti Putra Malaysia, Malaysia. His research interests include financial performance and Islamic finance.

Mosab I. Tabash is currently working as MBA Director at the College of Business, Al Ain University, UAE. His research interests include Islamic banking, financial performance, and investments.

Mohammad Ahmad Al-Omari works as Assistant Professor at College of Business, Al Ain University, UAE. He published many papers in his area of research.

Md. Kausar Alam, works as Assistant Professor at BRAC Business School, BRAC University, Bangladesh. His research interests are Shariah governance, institutional theory, and Islamic banking.

Fakir Tajul Islam is currently working at University of South Asia, Bangladesh. He is an enthusiastic learner of various fields of Business including Investment & Finance, Banking, and Risk Management.

PUBLIC INTEREST STATEMENT

Assets allocation and risk mitigation are the prime investment strategy for all investors. A robust comovement among the assets leads to achieve the expected gain and affects the risk pattern in a particular portfolio. Moreover, stock markets have become interconnected and maintained complex linkages throughout the globe. This indicates that investors can enjoy the movement of funds and shift their investment decisions in different regions and holding periods. However, technology has a powerful two-edged sword that drives the world financial markets toward a convergent and divergent movement. Due to the scarcity and thrive of information, they are worried and concerned about their decision in future investments. Therefore, co-integration relationship is not enough for predicting the appropriate market trend across the counties. Along with the time domain properties, investors should consider the time-frequency domain properties for facing the challenges and predicting the appropriate level of co-movement in different stock markets.





 ${}^{\odot}$ 2022 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.

findings contribute to the existing literature by adding new evidence on the comovement and causality linkages between Islamic and conventional stock indexes and provide one more index for gaining portfolio diversification benefits among national and international investors.

Subjects: Economics; Finance; Business, Management and Accounting

Keywords: Co-movement; causality; Islamic and conventional stock indexes; Bangladesh

1. Introduction

Stock market co-movement is a crucial specific concept in finance literature (Mensi et al., 2018, 2017). It has increased the growing interest among investors, fund managers, academicians, and policymakers in financial markets across the countries. To attain the portfolio diversification benefits, co-movement is highly applicable in both national and international investment avenues (Dewandaru et al., 2014). Assets allocation and risk mitigation are the prime investment strategy for all investors. A robust co-movement among the assets leads to achieving the expected gain, and it affects the risk pattern in a particular portfolio. Moreover, stock markets have become interconnected and maintained complex linkages throughout the globe. This indicates that investors can enjoy the movement of funds and shift their investment decision in different regions and holding periods (Khan, 2011). Moreover, technology has a powerful two-edged sword that drives the world financial markets toward a convergent and divergent movement (Buriev et al., 2018). Due to the scarcity of information, investors are worried and concerned about their decisions in future investments (Zhang et al., 2018). Particularly, the long-run co-integration relationship is not an adequate approach in predicting the perspective of the market trend across the countries. Moreover, along with the time-domain properties, there are many determinants such as macroeconomics, world uncertainty, ethics, investors' behavior that influence stock returns. Thus, investors face challenges in predicting the appropriate level of co-movement in different stock markets.

In addition, the modern financial world has witnessed drastic changes in financial markets. They have seen an optimistic trend of Islamic finance during the Global Financial Crisis (GFC) period of 2007–2008. After GFC, Islamic Capital Market (ICM) has exerted considerable influence on the mainstream market (Jawadi et al., 2020). ICM is fundamentally different from the conventional capital market. Riba (interest), Gharar (uncertainty), and Maysir (gambling) are strongly prohibited in Islamic capital markets, whereas these are common practices in conventional capital markets (Shamsuddin, 2014). Distinct from conventional banking, the Islamic banking structure has several additional mechanisms in its corporate governance system for attaining trust, confidence and ethics (Mollah & Zaman, 2015). Among these, the Audit and Shariah committee, internal control, Shariah Department, Shariah auditor make differentiate Islamic corporate governance system. Particularly, the Audit and Shariah committee accomplish their role in a different way compared to conventional corporate governance. The audit committees of conventional banks drive bank risk lower via incentives to maintain higher capital ratios as well as through the reallocation effect for profit, but the Shariah committees drive bank risk lower via incentives to increase efficiency and reduce the volatility of profits in Islamic banks (Nguyen, 2021, p. 2).

However, to quantify the Islamic stock, an Islamic business concern or firm comply the two-tires (qualitative and quantitative) screening method in their stock index for drawing the intention of customers. Qualitative screening criteria deal with the basic principles of Shariah within the business which are mandatory to follow and quantitative screening criteria deals with the monitory functions which are limit the corporate debt by a certain percentage for confirming the lower level of debt as well as a lower level of bankruptcy (Jaballah et al., 2018; Qoyum et al., 2021).

In order to give effect to the modern portfolio theory (MPT), also known as mean-variance analysis Harry Markowitz wrote an essay titled "Portfolio Selection" in 1952, MPT can be likened

to the investment-based theory. This theory aims to ensure the maximization of the returns from a portfolio, through a proportionate alteration and selection from the bundles of assets in a specific portfolio. In addition, this theory is more suitable to express how the best possible diversifications can be ascertained. For example, when investors have the option of choosing from two or more portfolios with equal values, and a similar rate of returns, the MPT is a guide to the investors on how to make a choice based on the one that produces the lesser risk. The Islamic Finance framework consists of an ethically-oriented trade system and boasts the presence of social and responsible investments as well as sustainable finance and banking, on a highly regulated financial system. These ethical and moral assumptions and high caution of Islamic investments make this alternative financial system a "Safe Haven" to improve performance, especially in stormy times with high conventional financial risk (Delle Foglie & Panetta, 2020; Jawadi et al., 2014).

However, due to the rapid growth of the world financial system sector, ICM has shown positive momentum and a rapid development rate. According to the Islamic Fiancé Development Report-IFDI (2018), the size of the Islamic finance industry has grown up to \$2.438 trillion in 2017. Besides, the phenomenal growth and consistent development of Islamic finance have not only attracted Muslim investors but have become a viable alternative investment instrument to non-Muslim investors. Therefore, the Islamic stock market works in parallel in many developed and developing countries (Lahsasna et al., 2018).

GFC (2007–2008) is the turning point for the Islamic finance industry. After GF, Islamic stock markets become more visible and highlighted. Interestingly, during the GFC period, both conventional and Islamic stock markets have been affected (Arshad & Rizvi, 2013). However, due to the unique features of Shariah law, Islamic stock markets have shown resilience as demonstrated in more conclusive evidence in the previous empirical literature. However, there are inclusive results found by the researchers between conventional and Islamic stock markets (Delle Foglie & Panetta, 2020); interestingly, most of the empirical studies have reported that the Islamic stock index shows relatively better performance, and also provide better diversification benefits in crisis and non-crisis period (Abbes & Trichilli, 2015).

Previous studies focused on stock market co-movement in developed countries showing cointegration relationships using parametric time domain-based approaches. Rua and Nunes (2009) introduce time and frequency domain approaches in their first study, finding out a lower and higher level of co-movement in different times and scales dynamics. The evidence suggests that a lower level of co-movement encourages portfolio diversification opportunities. On the other hand, a higher level of co-movement diminishes the portfolio diversifications opportunities.

This study aims to examine the co-movement and causality dynamics between Islamic and conventional stock indexes in Dhaka Stock Exchange (DSE), Bangladesh. The findings would assist the national and international investors to diversify their capital and attain maximum gain with minimum risk. Several studies examined the co-movement of developed countries' stock markets (Chowdhury Diebold & Yilmaz, 2009; Harris & Pisedtasalasai, 2006; Kogid et al., 2022; Wagner & Szimayer, 2004; Xiao & Dhesi, 2010). Nonetheless, there are very few studies exploring the co-movement and causality dynamics between Islamic and conventional stock market indexes in developing countries (Arshad & Rizvi, 2013; Majdoub & Mansour, 2014; Saadaoui & Boujelbene, 2015).

This study would increase the standing literature in numerous ways. First, this is the first study to examine the co-movement and causality dynamics between conventional and Islamic stock indexes in Bangladesh using a nascent continuous and multi-scales wavelet-based analysis. Second, this study would increase potential knowledge of the standing literature regarding rising economy countries such as Bangladesh. Third, by applying various econometric models to express the interdependence between conventional and Islamic stock indexes, the study offers robust results. It is noteworthy that the present study applies a sophisticated model that could control

time-frequency domain properties in time series data better. Particularly, a set of wavelet techniques would allow an estimation of frequency brand properties without losing the merit of timedomain properties. Besides, this model could assist to uncover the stock markets' co-movement and dynamic causality linkages without bothering the stationarity and non-stationarity testing which are hard to estimate when using other econometric models. Therefore, this approach may provide several insights into changing the pattern of co-movement and causality dynamic linkages which could provide a good assessment of long term, short term, and mid-term stock markets comovement simultaneously and detect the changes of causality dynamic over time.

The paper is structured as follows. Section one narrates the introduction. Section two illustrates the literature review. While section three describes the methodology, whereas section four provides the findings of the discussions. Section five concludes the manuscript with some policy implications, recommendations and limitations.

2. Literature review

International finance consists of two important concepts; one is financial markets' integration and the other one is stock markets' co-movement. The financial markets' integration is the mechanism that enables the markets of a country to get reliably associated with other nations or regions. It is a general concept representing the complex inter-relationship among several financial markets. On the other hand, the concept of co-movement is more specific and closely associated with international finance. It is understood in relation to the nature and extent of interdependency among the asset returns (Panda & Nanda, 2017). Moreover, financial markets' inter-dependency and linkages throughout the globe have also important implications in the modern world. For instance, if stock markets, in particular, those in the US experience the occurrence of certain events, their reactions may affect other financial markets in other parts of the globe immediately (Sheikh et al., 2020).

Stock market co-movement is significant and theoretically growing in international finance literature for taking advantage of cross-countries investment horizons. Markowitz (1952) identified a low correlation between the different assets classes in the domestic market which led to motivating the portfolio diversifications benefits. Nevertheless, compared to domestic market portfolios, international market diversification produces higher returns and lesser risks (Annaert & Verdickt, 2021; Grauer & Hakansson, 1987; Grubel, 1968). Moreover, investors do not need to focus on the domestic investment market but may look forward to carrying out business in the international stock market. Therefore, the current study principally takes into account the portfolio diversification, Capital Asset Pricing Model (CAPM) theories as to the theoretical underpinning items.

Moreover, portfolio diversifications benefits and stock market co-movement show opposite directions in theoretical perspectives. When a particular stock market shows a low level of co-movement, it leads to better portfolio benefits. On the other hand, the portfolio diversification benefits diminish when a high level of co-movement exists across the countries' stock markets (Rua & Nunes, 2009). According to Markowitz (1952), portfolio diversifications benefit is possible at a low level of correlation in domestic markets. From the seminal work and empirical evidence of Tobin (1958) and Grubel (1968), it has been acknowledged that international portfolio diversifications mitigate the total risk of portfolios.

Therefore, it is important to assess the significance level of co-movement for investment decisions and portfolio diversifications in international financial markets avenues. When two or more markets are moving together and have increased the co-movement between two asset prices, the returns can moderate the benefit of investment portfolios diversifications. Interestingly, this trend can be used to change the pattern of co-movement, which is known as the adjustment of the portfolio (Bacchetta & Van Wincoop, 2021; Ling & Dhesi, 2010). Potential gains can be earned from international portfolio diversifications when returns are not perfectly correlated with

investments in different domestic stock markets. The evidence has suggested domestic and foreign investors look forward at low levels of co-movement of stock prices for attaining portfolio diversification benefits. Investors are continually ready to take the opportunity to adverse the risk and increase their expected returns by allocating their assets in different countries and different assets' lines. Therefore, many investors like segregating their investment strategies and investing some of their capital in foreign markets as well as purchasing the shares of foreign firms (Panda & Nanda, 2017).

Arshad and Rizvi (2013) point out the crisis period movements have affected the Islamic and conventional markets. Similarly, Hasan et al. (2021) examine the impact of the COVID-19 pandemic on Islamic and conventional stock markets. They suggest that both markets show a similar trend of volatility and higher co-movement during the pandemic period. On the other hand, Majdoub and Mansour (2014) suggest that Islamic stock markets are weakly correlated to US stock markets. Therefore, investors may minimize risk and diversify their funds.

Saiti et al. (2014) provided insights on the topic of Islamic stock market performance. They pointed out some unique criteria of the Islamic stock index like ethical and ratio screening, the limit of interest-based leveraged, exclusion of interest-based financial sector and assets. Therefore, they have concluded that the risk-return trade of chemistry should be different from conventional and Islamic stock indexes. In addition, Khamlichi et al. (2021) analyze the performance between developed and emerging countries from Islamic and conventional stock markets perspectives. They reveal that the conventional stock market performs better in emerging countries' perspectives. On the other hand, Islamic stock markets perform better in the developed counties' stock markets perspectives.

Nazlioglu et al. (2015) point out that the Islamic stock markets movement and stocks transmission mechanism are not much different from conventional stock markets during the crisis period. Besides, they have suggested that due to the contagion effect, both markets show a similar type of response in the crisis period. In their view, there is a drought to gain from a diversified portfolio.

Sahabuddin et al. (2018) examine the co-movement between FTSE Bursa Malaysia EMAS (FBMEMAS) and sectoral indexes in Bursa Malaysia. The results show that the sectoral stock index moves together with the Shariah-based stock index in the long run. However, the speed of adjustment varies in the short run amongst variables.

Hasan and Abu (2019) studied the conventional and Islamic stock index co-movement and volatility transmission using ARDL bound testing co-integration model and EGARCH and GARCHBEEK estimations respectively. The evidence reveals that there are short-run and long-run linkages between the two indexes, and he found a remarkable volatility transmission mechanism in Islamic as compared to conventional stock indexes. Therefore, portfolio diversification benefits are not applicable between the two series. However, policymakers, investors, and fund managers should add and find other faith-based categories of assets in their risk-return portfolios. Finally, Sahabuddin et al. (2020) examined the long-term and short-term movement between conventional and Islamic stock markets in Bangladesh and Malaysia. The results show that there is a significant relationship between the variables. Likewise, Jawadi et al. (2020) examined the relationship between two stock markets during the study period from 1996–2018.

Moreover, Delle Foglie and Panetta (2020) systematically reviewed a set of sample studies that were published in different journals from 2009 to 2019. They report that there is no comprehensive overview regarding the safe haven issue between conventional and Islamic stock markets. Consequently, Qoyum et al. (2021) investigate Islamic firms' level performance on social, environmental and governance perspectives. They find out that firms level performances vary on social,

environmental and governance perspectives. Islamic firms' level performance is better on social and environmental perspectives but not in governance perspectives.

Therefore, there is a research gap concerning the empirical and theoretical context. Previous studies focused only on time domain properties, particularly long-run and short-run relationships among the variables in Bangladesh. To the best of our knowledge, there is no study about Shariah and conventional indexes using time and frequency domain properties in the Bangladesh stock market. Thus, this research is an attempt to fill this research gap by exploring the decomposed-based long-term, mid-term, and short-term relationship between conventional and Islamic stock indexes.

3. Methodology

3.1. Data

In this study, daily data were used. All data were collected from the DataStream and the Dhaka Stock Exchange website (www.dsebd.org). The study period extends from 20 March 2014 to 31 August 2019. Due to the growing markets demand for Islamic products and services, many non-Muslim countries are in the line to introduce the Islamic stock indexes. For example, Dow Jones first introduced the Islamic stock indexes in 1999, while Dow Jones Islamic Market Titans 100 Index was introduced in 2009. Interestingly, until August 2011, the Dow Jones family has included 68 indexes all over the world (Farooq & Reza, 2014). Consequently, The Dhaka Stock Exchange Shariah (DSES) index is based on Shariah-compliant principles that are considered as a proxy of the Islamic index. This index strictly maintains Shariah standards in selecting the companies under the DSES index. The first Islamic stock index in Bangladesh has been introduced by the Dhaka Stock Exchange (DSE) in 2014. The introduction has been made in view to enable investors' participation in equity investments that are attuned with Shariah principles. It is expected to oblige as Shariah-compliant broad market benchmark in evaluating the Banaladesh equity market performance. There is no eventual event or date to take the data. It is a continuous process to develop and introduce Islamic indexes in response to the demand and supply economic theory. Therefore, due to the availability of data, the researchers specified the span of the study and collected the data accordingly. The data sets were not divided into different periods due to the use of relatively new wavelet-based econometric analysis.

3.2. Model specification

The data of the study is computed; the stock returns of conventional and Islamic markets by the first differences of the natural logarithm form of daily price indexes and expressed as percentages by multiplying 100 times. In other words, the formula for deriving stock returns can be written as follows:

$$R_{t} = \log(P_{t}/p_{t-1}) \times 100 = (\log P_{t} - \log P_{t-1}) \times 100$$
(1)

where Rt indicates the returns and P represents index levels at the time t and t – 1. Due to the national holidays, bank holidays, or any other reasons and time differences, data were missing of the respective stock markets; stock prices were assumed to stay the same as those of the previous day. All stock returns are calculated by the first difference of the natural logarithms form of each stock-price index and expressed as percentages (multiplied by 100 times).

3.3. Wavelet approach

Wavelet is a popular and powerful method that has been developed recently. It is not only used in signal processing in engineering sectors but also econometric predictors in finance literature. Because of signal processing methodology, the wavelet critically analyses time-frequency causality between time-series economic data. The focus of this technique is to develop a fruitful interrelationship at multi-dimensional-based frequency brand properties. Since this method decomposes data at multi-scales solutions, it can provide a robust outcome besides standard time series estimators (Ferrer

et al., 2016). Moreover, frequency and scales show an interesting movement like higher frequency (lower scale). This movement permits the user to distinguish the different scales and frequency ranges (Aguiar-Conraria et al., 2008). Apart from the frequency and time domain properties, this nascent method discusses the econometric synergy, which covers the shortcoming of error terms and structural breaks (Antonakakis et al., 2017; Yang et al., 2017). This methodology is run by a small wave packet that grows and decays over time. The role of this method is based on the calculation of location and estimation of scale parameters. The wavelet function is defined as:

$$\Psi\tau, \mathbf{s}(\mathbf{t}) = \frac{1}{\sqrt{|\mathbf{S}|}} \Psi\left(\frac{t-\tau}{s}\right) \mathbf{s}, \tau \in \mathbf{R}, s \neq$$
(2)

Here, S defines the length of the parameter, where τ indicates the position of the parameter. In addition, s denotes the normalization dynamic that causes one-unit wavelet variance and $\Psi \tau$, s = 1 shows the relationship between frequency and scales. Moreover, the study makes use of Morlet wavelet that describes the smoothest (father) and detailed (mother) functions of the wavelet family. This function is widely used in economics and fiancé literature due to its strong practical implications (Reboredo et al., 2017). The equation of this function is as follows:

$$\Psi^{m}(t) = \frac{1}{4\pi^{1/4}} e^{i\varpi ot} e^{-t^{2}/2}$$
(3)

Where, $4\pi^{1/4}$ conserves the wavelet energy as a band and it maintains central frequency. On the other hand, ϖ o refers to the localizations that maintain the balance between time and frequency. However, $e^{-t2/2}$ indicates the Gaussian envelope, and $e^{i\varpi ot}$ denotes a complex analytic wavelet.

3.4. The continuous wavelet transformation (CWT)

The wavelet approach mainly contains two parts, namely CWT and Discrete Wavelet Transformation (DWT). However, due to the colorful graphical presentation and simple interpretation, CWT is more friendly and popular than DWT (Aguiar-Conraria & Soares, 2011). Where CWT is a multiresolution-based analysis for dilatation and contraction of wavelet functions, DWT is a multiresolution filters-based analysis for decomposition and re-composition of data.

$$w_{x}(\mathcal{S}) = \int_{-\infty}^{\infty} \mathcal{X}(t) \frac{1}{\sqrt{\mathcal{S}}} \Psi^{*}\left(\frac{t}{\mathcal{S}}\right)$$
(4)

Here, Ψ denotes the function of the mother wavelet and * depicts the complex conjugate function. In addition, τ denotes the translation of the parameter as well as S is representing for the scales of a parameter.

3.5. Wavelet coherence

Wavelet is a set of analysis techniques that maintain a big family. These are WPS, CWT, and wavelet coherence transform (WCT) that are commonly used to examine the dependency between two-time series. These techniques are superior to any other approaches due to time and frequency domain characteristics (Reboredo et al., 2017).

Aguiar-Conraria et al. (2008) state that WCT as the ratio of the cross-spectrum to the spectrum element of each series can be regarded as the spatial similarity (both in frequency and time) between two series. This is represented as the coefficient of time-frequency space correlation. Coherence for wavelets is defined as follows:

$$Rn^{2}(S) = \frac{|S(s^{-1}W^{x/y}n(s)|^{2}}{S(s^{-1}|Wn^{x}(s)| \bullet S(s^{-1}|Wn(s)^{y}|^{2}}$$
(5)

where R² represents the coherence of wavelets and S is a smoothing operator. The value range of WCT is 0 to 1. WCT is an appropriate technique for analyzing co-movement between two markets or indexes. No other techniques could show a latitudinal relationship between the two-time series co-

efficient in frequency and time domain properties previously. WCT can be expressed in the same way as the coefficient of correlation. When the value of WCT is near 1, it indicates that there is a strong dependency that exists between the two markets or indexes. On the other hand, a lower dependency is shown when the value of CWT is close to 0. Meaning that higher variation indicates a large wavelet power spectrum. Though the coefficient of correlation is statistically significant, WCT is estimated using simulation from Monte Carlo wavelet analysis (Torrence & Compo, 1998).

3.6. Phase differences

Phase differences are covered by the whole-time span for frequency brand functions that provide a clear idea about lead-lag between two series. However, the phase differences are expressed by an arrow which indicates a positive and negative correlation between the two series in frequency and time domain aspects. The phase differences of WCT are defined as follows:

$$\Phi xy(\mathcal{S}) = \arctan \frac{\mathcal{I}\left((\mathbf{s}^{-1}\mathcal{W}^{xy}(\mathbf{s})\right)}{\mathcal{R}((\mathbf{s}^{-1}\mathcal{W}^{xy}(\mathbf{s}))}$$
(6)

Here, R and I indicate the real and imaginary components respectively for the sections of the smooth power spectrum. The phase differences are represented by arrows that show the relationship between the two series. When the arrow points stay in the right (left) and the trend is up (down), it indicates the series is in phase (out of phase) and the correlation of coefficient is positive (negative). In this case, the second (first) variables lead to the first variable. On the other hand, when the arrow points stay on the right side but the trend is down (up), it indicates that the first (second) leads the second variable. In addition, when the arrow points stay on the left (right) side of the graphical plot, it indicates the series is in phase (out of phase) and the correlation of coefficient is negative (positive). In this context, when the arrow points stay in the left (right) and the trend shows up (down) movement, it indicates the second variable leads the first variable. Consequently, when the arrow point stays in the left (right) and the trend shows down (up) when the first (second) variable leads the first variable.

4. Empirical findings and discussion

4.1. Stock price performance and return

Figure 1 displays the stock price and return performance in Islamic and conventional stock indexes in Bangladesh. The graphical presentation shows that all Islamic and conventional stock prices move together, but the volatility clustering varies in the period. Precisely, the indexes track the same upward and downward trends and specify co-movement among the series.

4.2. Summary of descriptive statistics

Table 1 represents the summary of statistics among the conventional and Islamic stock indexes' returns. The output indicates that the conventional stock index (DS30) in Dhaka Stock Exchange, the maximum mean returns (-0.0021), are bigger compared to their Islamic counterparts. A higher standard deviation of the non-Shariah compliant index in the Dhaka Stock Exchange compared to the Shariah index signifies higher volatility in the former than in the latter. However, the kurtosis statistics are positive and higher than 3 for both indexes, reflecting a leptokurtic distribution. The results also show that the data sets of the three indexes are negatively skewed indicating left-skewed index distribution.

4.3. Wavelet power spectrum (WPS)

The wavelet power spectrum is an absolute value of the wavelet square which transforms and indicates a different type of variance pattern (high and small) by image plotting. It provides time and scale-based measurement for the time series variables. The verticals and horizontal axis show the scale and time domain properties. The thick black outlines indicate the region of a 5% significance level.

Table 1. Summary of descriptive statistics						
	DSES	DSEX	D\$30			
Mean	0.0028	-0.0054	-0.0021			
Std. Dev.	0.4239	0.3815	0.4389			
Skewness	4.4603	-0.6805	0.6462			
Kurtosis	111.0966	57.0248	58.7953			
Jarque-Bera	656848.7	163062.9	173908.7			
Observations	1340	1340	1340			

Source: Developed by the authors



Figure 2 depicts the results of the CTW power spectrum for DSES, DSEX and DS30 indexes. Both Islamic and conventional indexes show a similar type of variance movement. In the short run and mid-run, both indexes show relatively higher variance than the long run. Interestingly, from 2016 to 2019, both indexes show higher variance in all time and scale domain properties. However, the wavelet power spectrum does not show any significant differences between conventional and Islamic stock indexes.

4.4. Cross wavelet transform (CWT)

Figure 3 identifies the phase differences between conventional and Islamic stock indexes' returns. The results observe the most significant period of co-movement occurs in 2018 and 2019. During these periods the high level of co-movement at 16–256 brand scales can be seen. Furthermore, the led-lag relationship is clear from these findings. Majority of the arrows display (\nearrow) and (\rightarrow), signifying a positive correlation between conventional and Islamic stock indexes in the Dhaka Stock Exchange, Bangladesh. Moreover, these results also indicate that the conventional stock index led to Islamic stock return in medium and long run holding periods (16–256 frequency brands).

Figure 1. Plot daily stock price index and return movement. Source: Developed by the authors Figure 2. Wavelet-based cross power spectrum of DSEX, DS30 and DSE. Source: Developed by the authors







4.5. Wavelet coherence

Figures 2–4 exhibit the results of wavelet coherence that show the co-movement of the two series. The horizontal axis indicates the time component which covers the study period from 2014–2019. The period numbers 200, 400, 600, 800, 1000 and 1200 indicate the number of working days starting in

20 January 2014 (Bhuiyan et al., 2019), and corresponding to 200 and 1200 (i.e., 2014/200, 2015/400, 2016/600, 2017/800, 2018/1000 and 2019/1200). On the other hand, the vertical axis represents the frequency elements, which are based on a daily unit ranging from 4–256 days' scales.

Further, these scales can be divided into three holding periods, for example, short term (2to 64), mid-term (64–128) and long-term (128–256) day's scale. In-between, the colored part investigates the extent of co-movement between the pair of indexes. The warner (red color) regions identify how highly dependent are the two series and color (blue color) regions indicate how less dependent are the two series. However, in the plots, the thick black contour estimates a Monte Carlo simulation, suggesting that the area is statistically significant at a 5% level. If the vector arrows point to the right, it shows that the indexes are in phases (positive correlation), but if the pointing is to the left, it means that the indexes are not within the phase (negative correlation). Subsequently, if the vector arrows point to the right and down, it means that the first series is leading, whereas if they point to the right and up, it means that the second series is leading, and vice versa (Madaleno & Pinho, 2010). In this study, DSEX is considered as the first series in all cases of wavelet coherence diagrams in examining the co-movement of conventional and Islamic stock indexes in the Dhaka Stock Exchange, Bangladesh (Sakti et al., 2018).

The results of wavelet coherence on the plots (pair-wise indexes) express that the red color regions are dominant over the blue color regions. Thus, conventional and Islamic stock indexes return show a stronger co-movement over time and frequency domain properties. Particularly, in the long-run, there is a high and significance co-movement between the two variables. The higher level of co-movement exhibits the two series in the long-run. This indicates that international investors should not consider investing their funds for portfolio diversifications within this holding period at 64–256 brand scales. However, during the short-run and mid-run holding periods (brand scale-4 to 16 and 64), there is a lower level of co-movement existence between the two variables for a specific holding period (2014–2017).



Figure 4. Wavelet coherence dynamic of DSEX vs DSES, DSEX vs DS30 and DSES vs DS30. Source: Developed by the authors

Table 2. Wavelet-based granger causality test							
DEPENDENT VARIABLE		IND	INDEPENDENT VARIABLE				
D1		DES	DEX	DS30			
	DES		0.8042	0.5178			
	DEX	0.3207	_	0.4079			
	DS30	0.1172	0.4405	_			
D2		DES	DEX	DS30			
	DES	—	1.E-05	0.0178			
	DEX	3.E-06		0.0040			
	DS30	0.0001	0.0077				
D3		DES	DEX	DS30			
	DES	_	0.0046	0.4847			
	DEX	5.E-08	_	4.E-08			
	DS30	0.1430	0.0074	—			
D4		DES	DEX	DS30			
	DES	_	0.0460	0.1641			
	DEX	0.0558	—	0.0029			
	DS30	0.0010	8.E-07	—			
D5		DES	DEX	DS30			
	DES	_	1.E-05	0.0019			
	DEX	5.E-06	—	0.0473			
	DS30	0.0001	0.0080	_			
D6		DES	DEX	DS30			
	DES	—	1.E-40	5.E-31			
	DEX	0.0883		3.E-06			
	DS30	0.0041	0.0002	_			
D7		DES	DEX	DS30			
	DES	_	0.0017	6.E-15			
	DEX	6.E-06	—	7.E-07			
	DS30	0.1359	0.6784	_			
D8		DES	DEX	DS30			
	DES	_	4E-146	3E-242			
	DEX	2E-115	_	3E-147			
	DS30	1E-233	2E-109	_			

Source: Developed by the authors

This result indicates that there are portfolio diversification opportunities in the short-term and mid-term holding periods between conventional and Islamic stock markets.

4.6. Wavelet-based decomposition granger causality analysis

To investigate the robustness of the CWT and WC analysis results, this study employs the wavelet-based decomposed Granger Causality tests. These examinations are determined for eight frequency brands (D1 to D8), and the outputs are included in Table 2. From these outputs, the results show that DSEX naturally does cause DSES for D3-D7 scale brands. Additionally, DSES does not cause DSEX for D1-D8 scale brands. Interestingly, DS30 moderately influences the DSES and strongly influences DSEX. This index can cause DSES for D2and D5 frequency brands and DSEX for D2-D7 frequency brands. However, DSES show a significant influence on DSEX, and a bidirectional causality at selected brand scales over the study period is discovered.

5. Conclusion

The study aimed at examining the co-movement and causality between conventional and Islamic stock indexes in Bangladesh focusing on the Dhaka Stock Exchange. Prior literature indicated that no study has discussed co-movement and causality between Islamic stock and conventional indexes in the Bangladesh context using a continuous and multi-scales-based wavelet approach. Therefore, this study provides valuable results for national and international investors. Wavelet analysis is a very powerful technique in distinguishing the co-movement between the markets in terms of short, medium, and long-term movement. Moreover, it offers more insights on interdependencies, dynamic causality linkages from more than one or two brand scales. In addition, it provides more rigorous findings than standard time series techniques without compromising stationarity and non-stationarity of data.

The analysis of data clearly shows a significant and high-level co-movement between Islamic stock and conventional indexes in the long-run. The high co-movement between the two series in the long-run holding period indicates that investors should not consider investing their funds for portfolio diversifications in the long-run. Furthermore, this study finds a lead-lag relationship between conventional and Islamic stock indexes using wavelet-based decomposed Granger Causality methods. The results point out that causality linkages vary in time scales properties. However, DSES show a significant influence on DSEX, and a bidirectional causality at selected brand scales over the study period is discovered.

However, based on the findings, this study has implications for policymakers, fund managers, and investors by adding new evidence to the co-movement and causality dynamics between conventional and Islamic stock indexes that provide one more index for gaining portfolio diversification benefits for national and international investors. The findings of the study offer valuable insight for domestic and international investors who intend to increase portfolio diversification. Specifically, DSES has a significant influence and opens a window for investment. Therefore, investors can take benefit from this alternative investment horizon in short-term and mid-term holding periods. Regulators and policymakers may take further actions to develop the Islamic stock index for a long-term holding period.

The study is limited to the context of Bangladesh, and further comparative and empirical studies can be conducted in other countries. Subject to the availability of data, future research should be designed to capture more sample countries and include sectoral and uncertainty indexes.

Funding

The authors received no direct funding for this research.

Author details

Mohammad Sahabuddin¹ E-mail: dr.sahabuddin@ustc.ac.bd Md. Farjin Hassan² E-mail: farjinhassan@gmail.com Mosab I. Tabash³ E-mail: mosab.tabash@aau.ac.ae ORCID ID: http://orcid.org/0000-0003-3688-7224 Mohammad Ahmad Al-Omari³ F-mail: mohammad.alomari@aau.ac.ae Md. Kausar Alam⁴ E-mail: kausarflorence@gmail.com Fakir Taiul Islam⁵ E-mail: ftajul2019@gmail.com ¹ University of Science and Technology Chittagong, Bangladesh. ² Putra Business School, Malaysia. ³ College of Business, Al Ain University, Al Ain, United Arab Emirates ⁴ Brac Business School, Brac University, Dhaka,

- Bangladesh.
- ⁵ South Asia School of Business, University of South Asia, Dhaka, Bangladesh.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Citation information

Cite this article as: Co-movement and causality dynamics linkages between conventional and Islamic stock indexes in Bangladesh: A wavelet analysis, Mohammad Sahabuddin, Md. Farjin Hassan, Mosab I. Tabash, Mohammad Ahmad Al-Omari, Md. Kausar Alam & Fakir Tajul Islam, *Cogent Business & Management* (2022), 9: 2034233.

References

- Abbes, M. B., & Trichilli, Y. (2015). Islamic stock market sand potential diversification benefits. *Borsa Istanbul Review*, 15(2), 93–105. https://doi.org/10.1016/j.bir. 2015.03.001
- Aguiar-Conraria, L., Azevedo, N., & Soares, M. J. (2008). Using wavelets to decompose the time– Frequency effects of monetary policy. *Physica A: Statistical Mechanics and Its Applications*, 387(12), 2863–2878. https://doi.org/10.1016/j.physa.2008. 01.063
- Aguiar-Conraria, L., & Soares, M. J. (2011). Oil and the macroeconomy: Using wavelets to analyze old issues. *Empirical Economics*, 40(3), 645–655. https:// doi.org/10.1007/s00181-010-0371-x

Annaert, J., & Verdickt, G. (2021). Go active or stay passive: Investment trust, financial innovation and diversification in Belgium's early days. *Explorations in Economic History*, 79(1), 101378. https://doi.org/10.1016/j.eeh. 2020.101378

- Antonakakis, N., Chang, T., Cunado, J., & Gupta, R. (2017). The relationship between commodity markets and commodity mutual funds: A wavelet-based analysis. *Finance Research Letters*, 24(1), 1–9. https://doi.org/ 10.1016/j.frl.2017.03.005
- Arshad, S., & Rizvi, S. A. R. (2013). The impact of global financial shocks to Islamic indices: Speculative influence or fundamental changes? *Journal of Islamic Finance*, 2(2), 1–11. https://doi.org/10.12816/ 0001112
- Bacchetta, P., & Van Wincoop, E. (2021). Puzzling exchange rate dynamics and delayed portfolio adjustment. Journal of International Economics, 131 (1), 103460. https://doi.org/10.1016/j.jinteco.2021. 103460
- Bhuiyan, R. A., Rahman, M. P., Saiti, B., & Ghani, G. M. (2019). Co-movement dynamics between global sukuk and bond markets. *International Journal of Emerging Markets*, 14(4), 550–581. https://doi.org/10. 1108/IJOEM-12-2017-0521
- Buriev, A. A., Dewandaru, G., Zainal, M. P., & Masih, M. (2018). Portfolio diversification benefits at different investment horizons during the Arab uprisings: Turkish perspectives based on MGARCH–DCC and wavelet approaches. *Emerging Markets Finance and Trade*, 54(14), 3272–3293. https://doi.org/10.1080/ 1540496X.2017.1362555
- Chowdhury Diebold, F. X., & Yilmaz, K. (2009). Measuring financial asset return and volatility spillovers, with application to global equity markets. *The Economic Journal*, 119(534), 158–171. https://doi.org/10.1111/j. 1468-0297.2008.02208.x
- Delle Foglie, A., & Panetta, I. C. (2020). Islamic stock market versus conventional: Are islamic investing a 'Safe Haven'for investors? A systematic literature review. *Pacific-Basin Finance Journal*, 64(1), 101435. https://doi.org/10.1016/j.pacfin.2020.101435
- Dewandaru, G., Rizvi, S. A. R., Masih, R., Masih, M., & Alhabshi, S. O. (2014). Stock market co-movements: Islamic versus conventional equity indices with multi-timescales analysis. *Economic Systems*, *38*(4), 553–571. https://doi.org/10.1016/j.ecosys.2014.05.003
- Ferrer, R., Bolós, V. J., & Benítez, R. (2016). Interest rate changes and stock returns: A European multi-country study with wavelets. *International Review of Economics & Finance*, 44(1), 1–12. https://doi.org/10. 1016/j.iref.2016.03.001
- Grauer, R. R., & Hakansson, N. H. (1987). Gains from international diversification: 1968–85 returns on portfolios of stocks and bonds. *The Journal of Finance*, 42(3), 721–739. https://doi.org/10.1111/j. 1540-6261.1987.tb04581.x
- Grubel, H. G. (1968). Internationally diversified portfolios: Welfare gains and capital flows. *The American Economic Review*, 58(5), 1299–1314.
- Harris, R. D., & Pisedtasalasai, A. (2006). Return and volatility spillovers between large and small stocks in the UK. Journal of Business Finance & Accounting, 33 (9-10), 1556–1571. https://doi.org/10.1111/j.1468-5957.2006.00635.x
- Hasan, D., & Abu, M. (2019). Co-Movement and volatility transmission between Islamic and conventional equity index in Bangladesh. *Islamic Economic Studies*, 26(2), 43–71. https://doi.org/10.12816/ 0052877
- Hasan, M. B., Mahi, M., Hassan, M. K., & Bhuiyan, A. B. (2021). Impact of COVID-19 pandemic on stock markets: Conventional vs. Islamic indices using wavelet-based multi- timescales analysis. The North American Journal of Economics and Finance, 58(1), 101504. https://doi.org/10.1016/j.najef.2021.101504

- Islamic Finance Development Report. (2018). retrieved from https://ceif.iba.edu.pk/pdf/Reuters-Islamicfinance-development-report2018.pdf, accessed in July 2021.
- Jaballah, J., Peillex, J., & Weill, L. (2018). Is being Sharia compliant worth it? *Economic Modelling*, 72(1), 353–362. https://doi.org/10.1016/j.econmod.2018.02. 011
- Jawadi, F., Jawadi, N., & Idi Cheffou, A. (2020). Wavelet analysis of the conventional and Islamic stock market relationship ten years after the global financial crisis. Applied Economics Letters, 27(6), 466–472. https://doi.org/10.1080/13504851.2019.1631438
- Jawadi, F., Jawadi, N., & Louhichi, W. (2014). Conventional and Islamic stock price performance: An empirical investigation. *International Economics*, 137(1), 73–87. https://doi.org/10.1016/j.inteco.2013.11.002
- Khamlichi, A. E., Yildiz, S. B., Sarkar, K., & Hoque, H. (2021). Do Islamic stock indices perform better than their conventional counterparts? *International Journal of Business Performance Management*, 22(2–3), 236–256. https://doi.org/10.1504/IJBPM.2021.116417
- Khan, T. A. (2011). Cointegration of international stock markets: An investigation of diversification opportunities. *Undergraduate Economic Review*, 8(1), 7
- Kogid, M., Lily, J., Asid, R., Alin, J. M., & Mulok, D. (2022). Volatility spillover and dynamic co-movement of foreign direct investment between Malaysia and China and developed countries. *Quality & Quantity*, 56(1), 131–148. https://doi.org/10.1007/s11135-021-01123-9
- Lahsasna, A., Hassan, M. K., & Ahmad, R. (2018). An overview of Islamic capital market (ICM) and Sukuk industry. In Forward lease Sukuk in Islamic capital markets (pp. 11–35). Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-94262-9 2
- Ling, X., & Dhesi, G. (2010). Volatility spillover and timevarying conditional correlation between the European and US stock markets. *Global Economy and Finance Journal*, 3(2), 148–164.
- Madaleno, M., & Pinho, C. (2010). Relationship of the multiscale variability on world indices. *Revista De Economia Financiera*, 20(2), 69–92.
- Majdoub, J., & Mansour, W. (2014). Islamic equity market integration and volatility spillover between emerging and US stock markets. The North American Journal of Economics and Finance, 29(1), 452–470. https://doi. org/10.1016/j.najef.2014.06.011
- Markowitz, H. (1952). Portfolio selection. The Journal of Finance, 7(1), 77–91.
- Markowitz, H. (1952). The utility of wealth. Journal of Political Economy, 60(2), 151–158. https://doi.org/10. 1086/257177
- Mensi, W., Hkiri, B., Al-Yahyaee, K. H., & Kang, S. H. (2018). Analyzing time-frequency co- movements across gold and oil prices with BRICS stock markets: A VaR based on wavelet approach. *International Review of Economics & Finance*, 54(1), 74–102. https://doi.org/ 10.1016/j.iref.2017.07.032
- Mensi, W., Shahzad, S. J. H., Hammoudeh, S., Zeitun, R., & Rehman, M. U. (2017). Diversification potential of Asian frontier, BRIC emerging and major developed stock markets: A wavelet-based value at risk approach. Emerging Markets Review, 32(1), 130–147. https://doi.org/10.1016/j.ememar.2017.06.002
- Mollah, S., & Zaman, M. (2015). Shari'ah supervision, corporate governance and performance: Conventional vs. Islamic banks. *Journal of Banking & Finance*, 58(1), 418–435. https://doi.org/10.1016/j.jbankfin.2015.04. 030

- Nazlioglu, S., Hammoudeh, S., & Gupta, R. (2015). Volatility transmission between Islamic and conventional equity markets: Evidence from causality-invariance test. *Applied Economics*, 47(46), 4996–5011. https://doi.org/10.1080/00036846.2015.1039705
- Nguyen, Q. K. (2021). Oversight of bank risk-taking by audit committees and Sharia committees: Conventional vs Islamic banks. *Heliyon*, 7(8), e07798. https://doi.org/10.1016/j.heliyon.2021.e07798
- Omar Farooq, M., and Hasib Reza, M. (2014). Dow Jones Islamic Market US Index: Applying technical analysis from a comparative perspective, International Journal of Islamic and Middle Eastern Finance and Management, 7(4), 395–420. https://doi.org/10.1108/ IMEFM-12-2013-0134
- Panda, A. K., & Nanda, S. (2017). Market linkages and conditional correlation between the stock markets of South and Central America. *Journal of Financial Economic Policy*, 9(2), 174–197. https://doi.org/10. 1108/JFEP-08-2016-0063
- Qoyum, A., Sakti, M. R. P., Thaker, H. M. T., & AlHashfi, R. U. (2021). Does the Islamic label indicate good environmental, social, and governance (ESG) performance? Evidence from Sharia-Compliant firms in Indonesia and Malaysia. *Borsa Istanbul Review*. https://doi.org/10.1016/j.bir.2021.06.001
- Reboredo, J. C., Rivera-Castro, M. A., & Ugolini, A. (2017). Wavelet-based test of comovement and causality between oil and renewable energy stock prices. *Energy Economics*, 61(1), 241–252. https://doi.org/10. 1016/j.eneco.2016.10.015
- Rua, A., & Nunes, L. C. (2009). International comovement of stock market returns: A wavelet analysis. *Journal* of Empirical Finance, 16(4), 632–639. https://doi.org/ 10.1016/j.jempfin.2009.02.002
- Saadaoui, A., & Boujelbene, Y. (2015). Volatility transmission between Dow Jones stock index and emerging Islamic stock index: Case of subprime financial crises. *Emerging Markets Journal*, 5(1), 41–49. https://doi. org/10.5195/EMAJ.2015.68
- Sahabuddin, M., Muhammad, J., HjYahya, M. H. D., Shah, S. M., & Rahman, M. M. (2018). The co-movement between Shariah compliant and sectorial stock indexes performance in Bursa Malaysia. *Asian Economic and Financial Review*, 8(4), 515. https://doi.org/10.18488/journal.aefr.2018.84.515. 524
- Sahabuddin, M., Muhammad, J., Yahya, M. H., & Shah, S. M. (2020). Co-movements between Islamic and conventional stock markets: An empirical

evidence. Jurnal Ekonomi Malaysia, 54(3), 27–40. http://dx.doi.org/10.17576/JEM-2020-5403-03

- Saiti, B., Bacha, O. I., & Masih, M. (2014). The diversification benefits from Islamic investment during the financial turmoil: The case for the US-based equity investors. Borsa Istanbul Review, 14(4), 196–211. https://doi.org/10.1016/j.bir.2014.08.002
- Sakti, M. R. P., Masih, M., Saiti, B., & Tareq, M. A. (2018). Unveiling the diversification benefits of Islamic equities and commodities. *Managerial Finance*, 44(6), 830–850. https://doi.org/10.1108/MF-08-2017-0278
- Shamsuddin, A. (2014). Are Dow Jones Islamic equity indices exposed to interest rate risk? *Economic Modelling*, 39(1), 273–281. https://doi.org/10.1016/j. econmod.2014.03.007
- Sheikh, U. A., Tabash, M. I., Asad, M., & McMillan, D. (2020). Global financial crisis in effecting asymmetrical co-integration between exchange rate and stock indexes of South Asian region: Application of panel data NARDL and ARDL modelling approach with asymmetrical granger causility. *Cogent Business & Management*, 7(1), 1843309. https://doi.org/10. 1080/23311975.2020.1843309
- Tobin, J. (1958). Liquidity preference as behaviour towards risk. *Review of Economic Studies*, 26(2), 65–86. https://doi.org/10.2307/2296205
- Torrence, C., & Compo, G. P. (1998). A practical guide to wavelet analysis. Bulletin of the American Meteorological Society, 79(1), 61–78. https://doi.org/ 10.1175/1520-0477(1998)079<0061:APGTWA>2.0. CO;2
- Wagner, N., & Szimayer, A. (2004). Local and spillover shocks in implied market volatility: Evidence for the US and Germany. *Research in International Business and Finance*, 18(3), 237–251. https://doi.org/10.1016/j.ribaf. 2004.04.008
- Xiao, L., & Dhesi, G. (2010). Volatility spillover and time-varying conditional correlation between the European and US stock markets. *Global Economy and Finance Journal*, 3(2), 148–164.
- Yang, Z., Ce, L., & Lian, L. (2017). Electricity price forecasting by a hybrid model, combining wavelet transform, ARMA and kernel-based extreme learning machine methods. *Applied Energy*, 190(15), 291–305. https://doi.org/10.1016/j.apenergy.2016.12.130
- Zhang, X., Zhang, Y., Wang, S., Yao, Y., Fang, B., & Philip, S. Y. (2018). Improving stock market prediction via heterogeneous information fusion. *Knowledge-Based Systems*, 143(1), 236–247. https://doi.org/10. 1016/j.knosys.2017.12.025



© 2022 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.

You are free to:

Share — copy and redistribute the material in any medium or format. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Under the following terms: Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. No additional restrictions You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

Cogent Business & Management (ISSN: 2331-1975) is published by Cogent OA, part of Taylor & Francis Group. Publishing with Cogent OA ensures:

- Immediate, universal access to your article on publication
- High visibility and discoverability via the Cogent OA website as well as Taylor & Francis Online
- Download and citation statistics for your article
- Rapid online publication
- Input from, and dialog with, expert editors and editorial boards
- Retention of full copyright of your article
- Guaranteed legacy preservation of your article
- Discounts and waivers for authors in developing regions

Submit your manuscript to a Cogent OA journal at www.CogentOA.com