Available online at www.sciencedirect.com

Borsa İstanbul Review

Borsa İstanbul Review xxx (xxxx) xxx

http://www.elsevier.com/journals/borsa-istanbul-review/2214-8450

Full Length Article

Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries

Seyfettin Erdoğan [a,*], Ayfer Gedikli [a], Emrah İsmail Çevik [b]

[a] Istanbul Medeniyet University, Faculty of Political Sciences, Department of Economics, Turkey
[b] Tekirdag Namik Kemal University, Faculty of Economics and Administrative Sciences, Department of Economics, Turkey

Received 13 November 2019; revised 14 April 2020; accepted 14 April 2020
Available online ■ ■ ■

Abstract

Empirical findings focusing on the relationship between capital markets and macroeconomic variables are used as data sources in determining policies for the development of the conventional and Islamic financial system. The aim of this study is to investigate the existence of volatility spillover effects between foreign exchange markets and Islamic stock markets in three major emerging countries, namely India, Malaysia, and Turkey using daily data for the period 2013−2019. Volatility spillover effects are investigated using the causality-in-variance test developed by Hafner and Herwartz (2006). In order to examine the nature of the relationship between the variables, and whether it changes over time, the time-varying test statistic is estimated using rolling samples. We find evidence in favor of volatility spillovers from the Islamic stock market to the foreign exchange market only in Turkey. The time-varying test results show that the presence of volatility spillover is at least one direction between exchange rates and the Islamic stock market at specific periods.

JEL classification: G2; G23; F31; C12

Keywords: Islamic stock market; Exchange rates; Volatility spillover effect

1. Introduction

Islamic finance stands out as an important component of the global financial system and an alternative model of intermediation with its remarkable performance. With its more than $2 trillion annual value, the share of Islamic finance in the global financial system is increasing steadily (Paltrinieri, Floreani, Kappen, Mitchell, & Chawla, 2019, p. 719). Besides banking and insurance activities, the Islamic stock market (Shariah compliant stocks) is one of the main branches of the Islamic financial system. Through the development of the Islamic financial system, and increasing interest in Islamic finance, the Islamic stock market is improving and deepening. This provides a new area of investment for investors. It should be underlined that the increasing interest of investors in Islamic finance cannot be explained by Islamic sensitivities alone. The reliability of the Islamic financial system is one of the main factors that increases the attractiveness of this system.

Because of its reliability, Islamic stocks continue to be a growing investment area on a global scale. The flexible structure of Islamic stock indexes against financial crises is one of its important features. In addition, its structure, designed to have limitation on derivative instruments, provides reliability for them. This feature is another important advantage of Islamic finance over traditional finance. Furthermore, clear prerequisites for filtering criteria of Islamic stock indexes have been determined. The aim is that the debt to equity ratio should not be more than 33% and there are restrictions on the sectors that carry out prohibited activities with Islamic jurisprudence.

* Corresponding author.
E-mail addresses: erserdagm@hotmail.com (S. Erdoğan), ayfergedikli@yahoo.com (A. Gedikli), eicevik@nku.edu.tr (E.İ. Çevik).
Peer review under responsibility of Borsa İstanbul Anonim Şirketi.

https://doi.org/10.1016/j.bir.2020.04.003

However, technology, consumption and industrial sectors are encouraged by applying Islamic banking and Islamic financial instruments. Supporting productive sectors producing real goods and services contributes to Islamic stocks being less risky and reliable (Raza, Ibrahimy, & Ali, 2015).

The less riskiness of Islamic stock markets and instruments increases the strength of the system, especially in times of financial crisis. The supportive performance of the Islamic stock market indexes to the soundness of economies during a period of financial crisis was confirmed by the research of Kenourgios, Naifar, and Dimitriou (2016). The authors examined the effects of the global financial crisis and the Eurozone sovereign debt crisis for the 2007−2015 period. Based on the empirical results, it was found that Islamic equities and bonds act as a barrier against possible instability tendencies in a financial crisis. Hkiri, Hammoudeh, Aloui, and Yarovaya (2017) also state that Islamic indexes provide a safe haven for investors in times of crisis. Hkiri et al. (2017) arrived at this result by researching the relationship between conventional indices and Islamic indices. Using data for the 1999−2014 period, the authors examined volatility spillovers between nine regional Islamic stock indexes and their conventional counterparts. According to empirical results, there is no barrier for Islamic equities against financial shocks affecting conventional markets. In addition, there is no difference between the Islamic financial system and the conventional financial system against volatility spillovers. However, during a global crisis, a decoupling of the Islamic indexes from conventional indexes has been identified.[1] According to this result, Islamic stock indexes can be used as a safe haven for conventional indexes.

Not only because of its reliable and less risky structure, but also its positive effects on macroeconomic stability, the attractiveness of Islamic stock markets has been growing steadily. These stock markets are based on five basic principles. The first principle is the prohibition of usury, the second is risk-sharing, and the third is the prohibition of speculative attempts. According to the third principle, any kind of speculation that increases individual earnings is forbidden by ignoring the increase in asymmetric information and information disequilibrium problems in the financial system and the real sector. While investing, Muslims must verify all the information they receive, and they cannot take unrealistic expectations (overly optimistic or overly pessimistic) into account. In other words, 'Muslims should neither be misled nor mislead'. It may be possible to be misled once. However, there should be no systematic stumbling. In addition, misleading others is never compatible with Islam. The fourth principle is to be in compliance with the stated contract. The fifth principle is that the practices should comply with Sharia law. In addition to the Qur'an and Sunnah, jurisprudence should also be used (Mustapha, Bacha, & Mansur, 2017, p. 5; Rashid, Hassan, & Yein, 2014, p. 222). As a requirement of these principles, companies that produce prohibited goods or services, such as alcohol, tobacco, pork, guns, gambling, or interest-driven financial institutions/companies should be excluded. In addition, financial preconditions, such as low debt ratio, low cash holdings and low indirect income from interest should be applied (Paltrinieri et al., 2019, p. 719).

Islamic indices were first introduced in the late 1990s. The first index was DMI 150 (Dar al Mal al Islami), which was initiated in April 1998 with the participation of Faisal Finance and Bank Vontobel. The purpose of this index was to monitor the performance of 150 publicly traded global companies. In the same year, SAMI (Socially Aware Muslim Index) was introduced to track the performance of 500 Sharia-compliant companies. After these initial attempts, a large number of Islamic indices emerged offering alternative opportunities to market participants. The Dow Jones introduced the Dow Jones Islamic Market Index (DJIMI), FTSE Group, Global Islamic Index Series (GIIS), Morgan Stanley, MSCI Global Islamic Indices, Standard and Poor's, S&P Shariah Index Series and Stoxx, Stoxx Europe Islamic Indices (El Khamlichi, Sarkar, Arouri, & Teulon, 2014, p. 1138 and 1149). There is no consensus on which activities should be included in these indices. Each index is based on criteria determined by its own Shariah Board in company selection. These criteria are not standardized on a global scale. Occasionally, it can be seen that the criteria determined by different indexes contradict each other. For example, a company that is not accepted by another index due to a higher debt ratio may be selected by the Dow Jones Islamic Market (DJIMI), since the DJIMI confirms that the company's indicators are in accordance with its own criteria (Haider, Shah, Ashraf, Ghauri, & Ibne, 2015, p. 241).

Parallel to global improvements in Islamic finance, Islamic indexes have been created in many Islamic countries. Although there are several national-based Islamic stock market indexes, such as the Participation 30 and 50 Index for Turkey,[2] FTSE Bursa Malaysia Hijrah Shariah Index, FTSE Bursa Malaysia

[1] There are a number of studies determining that there is no difference between the Islamic and traditional stock markets during periods of financial crisis. Ajmi, Hammoudehb, Nguyenc, and Sarafrazi (2014) studied the relationship between Islamic and global conventional equity markets, and the Islamic stock market and economic and financial variables, in the period 1999−2010. According to the empirical results, there is no differentiation between the Islamic equity market and the conventional equity market in terms of being affected by financial shocks. Cevik and Bugan (2018) also found similar results.

[2] The Participation 30 Index is a stock market index traded at BIST and initiated on 31.12.2008. The main purpose of the Participation 30 Index is to measure the price and return performance of securities. The index is compliant with Islamic banking principles. Companies within the scope of the index cannot engage in interest-based finance, trade, service, brokerage, alcoholic beverage, gambling, lottery, pork, tourism, entertainment, media, broadcasting, advertising, tobacco products, and weapons sectors. In addition, companies that have gold, silver and foreign currency trading activities are also excluded from the index. Financial prerequisites are determined for companies wishing to enter the index. In order for a company to enter the index, total conventional loans (interest based)/market value and interest-yield cash and securities/market value must be less than 30%. Furthermore, Income from activities not convenient to be included in the index/Total income should not exceed 5% (Participation 30 Index Rules Booklet, 2019; Participation 30 Index, 2019).

Please cite this article as: Erdoğan, S et al., Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2020.04.003

EMAS Shariah Index and the Tasis Shariah 50 Index for India), international Islamic stock market indexes are also calculated. For instance, the Dow Jones has started calculating the Islamic stock market index since 2007 in India. The Dow Jones Islamic Market India Index represents the performance of stocks traded on the Bombay Stock Exchange that pass screens for Shariah compliance. On the other hand, the Dow Jones Islamic Market Malaysia Index was launched in 2008. The Dow Jones Islamic Market Malaysia Titans 25 Index is designed to track the top 25 stocks in the Dow Jones Islamic Market Malaysia Index, which is comprised of Malaysia-domiciled companies that pass rules-based screens for adherence to Shariah investment guidelines. As of January 2020, the mean value of market capitalization of the index is 5110.57 Million USD. The Dow Jones Islamic Market Turkey Index was launched in 2004. The index is designed to measure the performance of stocks traded in Turkey that pass rules-based screens for adherence to Shariah investment guidelines. The index covers sixteen stocks that pass the Shariah screen. As of January 2020, the mean value of market capitalization of the index is 1522.45 Million USD. It should be noted that in order for a company to be included in the Dow Jones Islamic stock index, stocks must pass industry and financial ratio screens for Shariah compliance. Companies that sell/produce alcohol, defense/weapons, entertainment, financial services, pork-related products, and tobacco are excluded.[3]

The Islamic stock market index is an important indicator for monitoring the development of Islamic finance. In addition, it is an essential index for Islamic stock market investments. Therefore, it should be clarified whether changes in macroeconomic indicators have an impact on the Islamic stock market index. Identifying the relationship between macroeconomic indicators and the index is essential to determine the source of economic instability trends and to prepare coherent policy measures.

Exchange rates are one of the most important macroeconomic variables that are affected by or which affect stock markets. Due to this feature, exchange rates are one of the main variables included in research in this field. An increase in exchange rates and exchange rate volatility increases input costs, raises borrowing costs, triggers financial crisis expectations, and negatively affects consumption and investment expenditure. Exchange rate volatility also has negative effects on the financial system and the stock market. On the other hand, changes in the stock market are also likely to have an impact on exchange rates.

There are two fundamental models that explain the relationship between exchange rates and the stock market (stock prices) in the literature. The first model is the Balance of Trade Model suggested by Dornbusch and Fischer (1980). In this model, it is accepted that changes in exchange rates have an effect on stock price. Changes in exchange rates can affect the direction of changes in stock prices due to their impact on exports and imports. For exporting companies, depreciation of the national currency leads to an increase in export demand. The increase in exports may cause an increase in the stock prices of these firms and consequently an improvement in their stock returns. A devaluation of domestic currency results in an increase in import input costs, meaning that imports become more expensive. A decline in the sales volume of the importing companies naturally leads to a decline in profits and a decrease in stock prices (Dahir, Mahat, Ab Razak, & Bany-Ariffin, 2018, p. 101−102). The second model is the Portfolio Balance Model. According to this model, changes in stock prices have an effect on exchange rates (Frankel, 1983). The direction of the relationship between stock price and exchange rates is potentially extremely important for the investor. The relationship between the two variables is a natural result of the close integration between the capital markets. The causal relationship from stock prices to exchange rates can be explained. A decrease in stock prices leads to a decrease in the wealth of domestic investors. A decrease in wealth causes a decline in money demand and then a decline in interest rates. Increased capital outflow, due to low-interest rates, leads to higher exchange rates, which means a depreciation of national currency (Granger, Huang, & Yang, 2000, p. 338).

Although there is a wide range of literature investigating the relationship between exchange rates and conventional stock prices, there is no consensus among the studies. The literature can be divided into three groups based on the findings of the research studies involved that determine the relationship between the variables. Firstly, there are studies showing that there is a one-way causal relationship from stock prices to the exchange rates. Secondly, there are studies that determine a one-way causal relationship from stock exchange to stock prices. Thirdly, there are studies that determine the bidirectional relationship between variables. With the development of the Islamic financial system, increasing interest in Islamic investment instruments and the establishment of Islamic stock indices, the relationship between these indices and the exchange rates have begun to be investigated. Findings obtained from the investigation of the relationship between conventional and Islamic indices and exchange rates are used as data sources in determining policies to improve the financial system, as well as macroeconomic performance.

The aim of this study is to investigate the existence of a volatility spillover effect between exchange rates and the Islamic stock market in India, Malaysia, and Turkey, using daily data for the 2013−2019 period. Volatility spillover effects are investigated using the causality-in-variance test developed by Hafner and Herwartz (2006). The Dow Jones Islamic stock market indexes were preferred. In order to examine whether the relationship between the variables varies over time, we also calculated time-varying causality-in-variance test statistics.

Although the relationship between the conventional stock market and foreign exchange markets has been widely-examined in the literature, there have been only a limited number of studies that focus on the relationship between Islamic stock markets and foreign exchange markets. The basic contribution of this study is to investigate the relationship

[3] For more detailed information on the Dow Jones Islamic stock market indices, www.us.spindices.com should be visited.

Please cite this article as: Erdoğan, S et al., Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2020.04.003

between the aforementioned variables in the sample period. To the best of our knowledge, this study is the first attempt to investigate the effect of time-varying volatility spillover effects between Islamic stock markets and exchange rates by means of the Hafner and Herwartz (2006) causality-in-variance test.

The study consists of three parts. In the first part, we present a literature review, in the second part an econometric framework, and in the third part data and empirical results are presented.

2. Literature review

There is a great deal of literature on the relationship between conventional indices and macroeconomic variables. Research studies have included macroeconomic variables that are likely to interact with the stock market. Industrial production, inflation rate, money supply, treasury bill rate, interest rate, Islamic interbank overnight rate, and federal fund rate are some of the variables that have been investigated.

Aggarwal (1981) investigated the effects of exchange rate changes on stock prices using US data for the period between 1974 and 1978. According to the results, there was a positive relationship between the variables. A decrease in the value of the US Dollar was found to be related to a decrease in stock prices. Abdalla and Murinde (1997) used data from India, Korea, Pakistan, and the Philippines for the period between 1985 and 1994. The authors concluded that there was a unidirectional causality relationship from exchange rates to stock prices in all countries included in the analysis. Ibrahim (1999) investigated the relationship between the seven macroeconomic variables (real industrial production index, consumer price index, M1, M2, domestic credit aggregates, reserves, and exchange rates) and stock prices using Malaysia's data for the period between 1977 and 1996. According to the empirical results, there was a causality relationship between exchange rates changes and stock prices in the short term. Liu and Wan (2012) investigated the relationship between the Shanghai stock market and exchange rates using data between 2005 and 2011. The authors could not find causality between stock prices and exchange rates prior to the global financial crisis. As for the post-crisis period, the researchers found unidirectional causality from exchange rates to the stock index. Tsai (2012) analyzed data from Singapore, Thailand, Malaysia, the Philippines, South Korea, and Taiwan for the period between 1992 and 2009. They concluded that the negative relationship between the stock market and the foreign exchange market was more apparent when exchange rates were extremely high or extremely low. Tsagkanos and Siriopoulos (2013) analyzed data from the EU and the USA for the period between 2008 and 2012, and determined a causal relationship from stock prices to exchange rates. This result is valid for the EU in the long term and for the USA in the short term.

Chkili and Nguyen (2014) investigated the relationship between exchange rates and stock market returns using data of BRICS countries for the period between 1997 and 2013. According to the results, stock markets significantly affected exchange rates. However, changes in exchange rates did not affect stock market returns. Sui and Sun (2016) investigated the spillover effects between exchange rates and stock prices using data from different periods for BRICS countries. They concluded that there were significant spillover effects from exchange rates to stock returns in the short run. In addition, a strong relationship was found between these variables during the 2007−2009 financial crisis. Using data from South Africa for the period between 1996 and 2016, Sikhosana and Aye (2018) investigated asymmetric volatility transmission between real exchange rates and stock returns. According to the results, there was a bi-directional volatility spillover effect among the variables in the short run. In addition, negative shocks in exchange rates had a great effect on stock market volatility, and positive shocks in the stock market had a great effect on exchange rate volatility.

Bahmani-Oskooee and Saha (2016) investigated the effects of exchange rates changes on stock prices for Brazil, Canada, Chile, Indonesia, Japan, Korea, Malaysia, Mexico, and the UK. The selected starting year of the analysis period varied by country due to data availability. They found that exchange rates changes had asymmetrical effects on stock prices. Jebran and Iqbal (2016) investigated the volatility spillover effects between the stock market and foreign exchange market in Pakistan, India, Sri Lanka, China, Hong Kong, and Japan for the period between 1999 and 2014. The results obtained show that Bi-directional asymmetric volatility spillover was identified among variables in Pakistan, China, Hong Kong, and Sri Lanka. There was a one-way volatility effect from stock market to foreign exchange market in India. Volatility effect was not available between the variables in Japan. Luqman and Kouser (2018) analyzed data from fourteen countries for the period between 2000 and 2016 and determined that an asymmetric relationship between the stock price and exchange rate was valid.

There have also been studies investigating the relationship between stock prices and exchange rates in Turkey. Bahmani-Oskooee and Domac (1997) identified the existence of a relationship between Turkish stock prices and exchange rates using data the period between 1986 and 1994. Buberkoku (1997) utilized data from Canada, England, Switzerland, Germany, Australia, Singapore, S. Korea, and Turkey for the period between 1998 and 2008. The author found a unidirectional causality relationship from stock prices to exchange rates in Turkey. Gunduz and Hatemi-J (2002) utilized data from Egypt, Israel, Jordan, Morocco and Turkey for the period between 1996 and 2000. In the period after the Asian financial crisis, a causal relationship from stock prices to exchange rates was found for Turkey. Zeren and Koç (2016) investigated the relationship between exchange rates and the stock market

Please cite this article as: Erdoğan, S et al., Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2020.04.003

using data from Turkey, Japan and England for the period between 1990 and 2013. Bi-directional causality was found between the variables during periods of crises. Using data for the period between 2001 and 2016, Turgut (2017) investigated the relationship between stock prices and real exchange rates. According to the test results, there was a bi-directional causality among the variables in the long run. In the short run, unidirectional causality was detected from real exchange rates to stock prices.

After the introduction of Islamic indices, the number of studies analyzing the relationship between macroeconomic variables and Islamic stock markets has started to increase. There have been many studies investigating the relationship between Islamic indices and selected macroeconomic variables for Malaysia. Abd. Majid and Yusof (2009) investigated the relationship between macroeconomic variables and Islamic stock returns in the post-1997 financial crisis in Malaysia. In the study, real exchange rates, money supply (M3), treasury bill rate and federal fund rate were identified as important variables for the stability of the Islamic stock market. Hussin, Muhammad, Hussin, and Abdul Razak (2012a) used data for the period between 2007 and 2011. According to the empirical results, the Islamic stock price was negatively but not significantly related to the exchange rate. Furthermore, the Islamic stock return was not affected by the exchange rate. Similarly using data of the period between 1999 and 2007, Hussin, Muhammad, Abu, and Awang (2012b) found that Islamic stock prices were negatively related to exchange rates. Isa, Abdullah, and Hassan (2012) investigated the relationship between macroeconomic variables and Malaysian Shariah Indices. According to the test results, the effects of all of the macroeconomic variables on the Kuala Lumpur Shariah index were positive in the long run for the period between 1990 and 2006. Abd. Majid (2016) investigated the relationship between Islamic stock prices and selected macroeconomic variables using data from 1999 to 2013. The empirical results showed a significant relationship between the variables in the long run.

Sakti and Harun (2013) examined the relationship between the Jakarta Stock Exchange Islamic Index and macroeconomic variables using data from the period between 2000 and 2010. The results indicated that there was a long-running relationship between the Islamic stock market and macroeconomic variables in Indonesia. In this context, long-term currency depreciation was associated with an increase in Islamic stock prices. However, the response of exchange rates to changes in the Jakarta Stock Exchange Islamic Index was negative, both in the long and short-term. Rana and Akhter (2015) examined the relationship between interest rate and exchange rates, and the Shariah compliant stock index (KMI-30) and the conventional stock index (KSE-100) using Pakistan's data for the period between 2008 and 2013. The exchange rate was found to be important for both conventional and Islamic stock indices. Kumar and Sahu (2017) investigated the relationship between macroeconomic variables and stock returns using data from India for the period between 2006 and 2015. According to the results, there was a long-term relationship between selected macroeconomic variables and the Dow Jones Islamic India market index. Moreover, a unidirectional causality was found from the exchange rates to the Dow Jones Islamic India market index. Mohsina and Islam (2017) investigated the impact of selected macroeconomic variables on the Islamic stock market using data from India for the period between 2007 and 2016. Only exchange rates had negative and statistically significant effect on the Islamic stock market. Erdoğan, Gedikli, and Cevik (2019) examined the effects of industrial production index, inflation rate, real money supply and current account deficit on the participation 30 index for the period between 2011 and 2019. The effects of the selected variables on the Islamic stock market index are different in the short and long term. The results show that the Islamic stock market index is negatively affected by the inflation rate in the long-term.

3. Econometric framework

There have been two common methods to examine the presence of volatility spillovers (the so-called 'causality-in-variance') in the literature. The first method is based on a prediction of multivariate GARCH models, which investigate the causality relationship between variables by restricting certain parameters. Although MGARCH models have been extensively used in the literature, Hafner and Herwartz (2006) emphasize that the power advantages of MGARCH models outweigh the curse of the large size.

The second approach relies on an estimation of flexible univariate GARCH models allowing for modeling idiosyncratic time-series properties of the data. Cheung and Ng (1996) suggested a testing procedure to examine causal links between the variances of series. Here, the Causality-in-Variance Test suggested by Cheung and Ng (1996) is based on cross-correlation functions (CCF) of standardized residuals obtained from a GARCH model. Hafner and Herwartz (2006) show that, in the case of small to medium sample sizes, the causality-in-variance test of Cheung and Ng (1996) suffers from significant oversizing if the innovations underlying a conditionally heteroskedastic process are leptokurtic. Moreover, studies in the literature show that the causality-in-variance test, based on the CCF, is extremely sensitive to the number of lags and leads.

In this context, Hafner and Herwartz (2006) suggest a test procedure that depends on a Lagrange Multiplier (LM) to investigate causality relationships between variances of the series and found that the LM test outperforms the causality-in-variance test of Cheung and Ng (1996). The null hypothesis of the LM test can be defined as:

$$H_0 = Var\left(\varepsilon_{it} \middle| \mathrm{I}_{t-1}^{(j)}\right) = Var\left(\varepsilon_{it} \middle| I_{t-1}\right) \tag{1}$$

where $i, j = 1, 2, \ldots, N$, $i \neq j$ and $I_t^{(j)} = I_t \middle| \sigma(\varepsilon_{j\tau}, \tau \leq t)$. The null hypothesis in Equation (1) is that there is no causality-in-variance. However, the testing procedure proposed by Hafner and Herwartz (2006) relies on the estimation of the GARCH model. Here, we use the following GARCH model suggested

Please cite this article as: Erdoğan, S et al., Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2020.04.003

by Bollerslev (1986) for returns series of the Islamic stock market index (s_t) and exchange rates (exc_t):

$$\begin{aligned} &s_{it} = \mu_{it} + \varepsilon_{it}, \\ &\varepsilon_{it} \setminus (\varepsilon_{it-1},\ \varepsilon_{it-2}, ...,\ s_{it-1},\ s_{it-2}, ...) \sim\ GED\left(0,\ \sigma_{it}^2\right) \\ &\sigma_{it}^2 = \omega + \alpha_i \varepsilon_{it-1}^2 + \beta_i \sigma_{it-1}^2 \end{aligned} \tag{2}$$

$$\begin{aligned} &exc_{jt} = \mu_{jt} + \varepsilon_{jt}, \\ &\varepsilon_{jt} \setminus \left(\varepsilon_{jt-1},\ \varepsilon_{jt-2}, ...,\ exc_{jt-1},\ exc_{jt-2}, ...\right) \sim\ GED\left(0,\ \sigma_{jt}^2\right) \\ &\sigma_{jt}^2 = \omega + \alpha_j \varepsilon_{jt-1}^2 + \beta_j \sigma_{jt-1}^2 \end{aligned} \tag{3}$$

where μ_{it} and μ_{jt} are the means and ε_{it} and ε_{jt} are the innovation processes of returns of the stock market index and exchange rates, respectively. The LM test statistic can be formulated as follows:

$$\lambda_{LM} = \frac{1}{4T}\left(\sum_{t=1}^{T}\left(\xi_{it}^2 - 1\right)z_{jt}'\right) V(\theta_i)^{-1} \left(\sum_{t=1}^{T}\left(\xi_{it}^2 - 1\right)z_{jt}\right) \xrightarrow{d} \chi^2(2) \tag{4}$$

where $\xi_{it}$is standardized residuals obtained from a GARCH model, $V(\theta_i) = \frac{\kappa}{4T}\left[\sum_{t=1}^{T} z_{jt}z_{jt}' - \sum_{t=1}^{T} z_{jt}x_{it}'\left(\sum_{t=1}^{T} x_{it}x_{it}'\right)^{-1}\sum_{t=1}^{T} x_{jt}z_{jt}'\right]$ and $\kappa = \frac{1}{T}\sum_{t=1}^{T}\left(\xi_{it}^2 - 1\right)^2$. Also$z_{jt} = \left(\varepsilon_{jt-1}^2, \sigma_{jt-1}^2\right)'$, $x_{it} = \sigma_{it}^{-2}\left(\partial\sigma_{it}^2/\partial\theta_i\right)$and $\theta_i = (\omega_i, \alpha_i, \beta_i)'$.

The Hafner and Herwartz (2006) procedure can be summarized by the following steps:

1. Estimate a GARCH (1,1) model for ε_{it} and ε_{jt} and obtain standardized residuals ξ_{it}, partial derivatives x_{it}, and the volatility process σ_{jt}^2entering z_{jt}.
2. Regress $\xi_{it}^2 - 1$on x_{it}' and the misspecification indicators in z_{jt}'.
3. λ_{LM} is equal to T times the coefficient of explanation (R^2) of the latter regression.

The asymptotic distribution of λ_{LM} will depend on the number of misspecification indicators in z_{jt}. In our case, λ_{LM} test statistic follows a χ^2 (2) distribution.

Empirical studies on this subject emphasize that financial markets generally have time-varying properties. In addition, the dynamic relation between financial markets tends to change over bull and bear markets (Cevik, Atukeren, & Korkmaz, 2018; Cevik & Bugan, 2018; Cevik, Korkmaz, & Atukeren, 2012). In addition, it is well-known that the structural breaks in the variance of a series cause significant size distortions in the causality-in-variance test. To that end, we calculate time-varying LM statistics using rolling samples in the GARCH model. The first step in accounting for a time-varying causality-in-variance test is to determine the appropriate rolling sample size. Since the GARCH model estimation requires a large sample size, too small a rolling sample size leads to convergence problems in the GARCH model. However, a large size rolling sample may cause a long delay in detecting changes in causality. As a compromise, we consider a rolling sample size of 500 days (corresponding to approximately two years) in estimating a rolling sample for the GARCH model. The time-varying LM test is then calculated for each rolling sample using the Hafner and Herwartz (2006) procedure described in steps 1 to 3.

4. Data and empirical results

In this study, we consider daily data for the Islamic stock market and exchange rates in India, Malaysia, and Turkey.[4] The sample period of the study is based on data availability and it covers 2013 through to 2019 with 1651 observations. The Dow Jones Islamic market indexes are considered as Islamic stock markets. We also consider the local currencies against the US Dollar as exchange rates. Data for the stock exchange market and currency exchange market are collected from the DataStream. We use the logarithmic return series (first differences of logarithm of price series) as a measure of returns.

We present the descriptive statistics for all the returns series in Table 1. According to the results in Table 1, all of the returns series are positive for all of the sample periods. The Indian Islamic stock market provides the highest mean return for the sample. On the other hand, the lowest mean return is obtained from the Malaysian Islamic stock market. The Turkish Islamic stock market is more volatile than the Indian and Malaysian Islamic stock markets according to standard deviation. When the descriptive statistics of the foreign exchange market are examined, it can be seen that the highest mean return is obtained from Turkey. However, the foreign exchange market in Turkey is more volatile than the foreign exchange market in India and Malaysia. These findings are consistent with a priori expectations because the volatility of the exchange rates in Turkey has significantly increased between 2018 and 2019 due to speculative attacks in August 2018, and hence extreme movements in exchange rates in Turkey. While the stock market returns series exhibits negative skewness, the exchange rates return series has positive skewness for all of the countries, except for Malaysia. The null of normality is strongly rejected for all returns series according to the Jarque-Bera normality test. The Box-Pierce Q statistics for the squared returns series imply the presence of autocorrelation in the variance of the series, and these findings are confirmed by the ARCH LM test results. Finally, all returns series are stationary in levels according to Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests.

We start our analysis by first testing causality-in-mean between the variables. Therefore, we estimate the bivariate Vector Autoregression (VAR) model using the return series for the Islamic stock market and exchange rates, and an optimal

[4] We use the Dow Jones Islamic Stock Market Indexes. The Islamic stock market index for India, Kuwait, Malaysia, and Turkey is calculated by S&P Dow Jones. On the other hand, since the Kuwait Central Bank has pursued the pegged exchange rate policy, we exclude Kuwait from the sample.

Please cite this article as: Erdoğan, S et al., Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2020.04.003

Table 1
Descriptive statistics.

	India		Malaysia		Turkey	
	s_t	exc_t	s_t	exc_t	s_t	exc_t
Mean	0.049	0.016	0.000	0.018	0.027	0.073
Median	0.062	0.000	0.013	0.000	0.018	0.000
Max	3.564	4.020	2.695	2.639	5.250	14.707
Min	−5.971	−2.679	−3.350	−2.562	−8.228	−6.475
Std. Dev.	0.761	0.416	0.587	0.455	1.167	0.952
Skewness	−0.590	0.743	−0.243	−0.149	−0.600	2.865
Kurtosis	6.675	13.936	6.328	8.080	6.482	47.150
J-B	1024.734 [0.000]	8379.106 [0.000]	778.381 [0.000]	1781.583 [0.000]	933.195 [0.000]	136347.0 [0.000]
ARCH (5)	4.813 [0.000]	49.990 [0.000]	26.530 [0.000]	45.772 [0.000]	16.195 [0.000]	85.142 [0.000]
Q (20)	37.912 [0.009]	78.193 [0.000]	23.478 [0.266]	21.939 [0.000]	19.985 [0.458]	79.363 [0.000]
Q_s (20)	54.525 [0.000]	1022.08 [0.000]	365.501 [0.000]	822.468 [0.000]	198.438 [0.000]	518.028 [0.000]
ADF	−23.454[a]	−8.581[a]	−38.452[a]	−39.367[a]	−40.692[a]	−20.362[a]
PP	−37.122[a]	−41.217[a]	−38.402[a]	−39.443[a]	−40.692[a]	−35.716[a]
KPSS	0.055[a]	0.060[a]	0.032[a]	0.065[a]	0.037[a]	0.035[a]

Notes: The figures in square brackets show the probability (p-values) of rejecting the null hypothesis. ARCH (5) is the LM conditional variance test statistic. Q (20) and Q_s (20) are the Box-Pierce serial correlation test statistics for the return and squared return series respectively.
[a] Indicates that the series in question is stationary at a 1% significance level.

Table 2
Causality-in-mean test results.

	Causality Direction	Test Statistic	p-value
India	$s_t \rightarrow exc_t$	21.918***	[0.000]
	$exc_t \rightarrow s_t$	0.841	[0.974]
Malaysia	$s_t \rightarrow exc_t$	27.373**	[0.011]
	$exc_t \rightarrow s_t$	17.207	[0.190]
Turkey	$s_t \rightarrow exc_t$	60.576***	[0.000]
	$exc_t \rightarrow s_t$	6.341	[0.175]

Notes: → indicates the direction of causality. *** and ** show a statistically significant causality relation at 1% and 5% levels, respectively.

lag length is selected by the Akaike information criteria. We present the Granger causality test results in Table 2. The test results in Table 2 show a unidirectional causality relationship from the Islamic stock market to the foreign exchange market in all of the countries. On the other hand, the null hypothesis of no causality from the foreign exchange market to the Islamic stock market cannot be rejected at conventional levels, and these findings are consistent with the Portfolio Balance Model. It should be noted that currencies, as well as bonds and gold, are considered assets in the Portfolio Balance Model, and hence an increase in the stock price leads to an appreciation of the domestic currency. Because an increase in stock prices attracts international investment, it increases the demand for domestic currency. Therefore, it can be stated that developments in stock markets cause changes in the foreign exchange rate market for the countries in the sample.

The results in Table 1 indicate that the conditional variance of all returns series is time-varying and hence, the justification for using a GARCH model for modeling volatility. In addition, there is well-documented literature that focuses on the effect of structural breaks in variance on the GARCH model. These studies show that the presence of structural breaks in variance leads to overestimating GARCH parameters (Aggarwal, Inclan, & Leal, 1999; Hillebrand, 2005; Lamoureux & Lastrapes, 1990). Therefore, we first used structural breaks in the variance test proposed by Sanso, Arago, and Carrion (2004) and found evidence in favor of structural breaks in the return series. For example, we found three sudden change points in the Turkish Islamic stock market and that the Indian Islamic market had one sudden change point. We determined four sudden change points in the variance of exchange rates in Malaysia and five structural breaks points in the variance of the Indian exchange rate. However, we could not find evidence in favor of structural breaks in the variance of exchange rates in Turkey. We generated dummy variables to account for structural breaks in the variance equation.

We use the Akaike information criterion to determine the optimal lag length in the mean equation and a GARCH (1,1) model seems to be adequate for modeling volatility. According to the results shown in Table 3, the GARCH parameters (α and β) are statistically significant at the 1% level. Note that α estimates exhibit persistence of shocks, and β parameter estimates point to a persistence in volatility clustering. In this context, the persistence of shocks in the volatility of exchange rates seems to be higher than the stock market indexes in India and Turkey. Similarly, the volatility clustering effect is higher in the stock market than in the foreign exchange market in all of the countries.

The LM test results for causality-in-variance are presented in Table 4. The results in Table 4 show a lack of causality between Islamic stock markets and exchange rates in India and Malaysia, because the null hypothesis of no causality-in-variance cannot be rejected at conventional levels. This finding shows that there is no correlation between Islamic exchanges and foreign exchange markets in terms of volatility spread.

On the other hand, the results in Table 4 suggest that there is a unidirectional causality between the Islamic stock market and foreign exchange market in Turkey, and the causal link runs from the Islamic stock market to the foreign exchange

Please cite this article as: Erdoğan, S et al., Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2020.04.003

Table 3
GARCH model results.

		ω	α	β	ν	$\alpha + \beta$	Ln(L)	Q (50)	Q_s (50)
India	s_t	0.053 [0.014]	0.070 [0.001]	0.814 [0.000]	1.310 [0.000]	0.884	−1776.749	48.140 [0.548]	20.661 [1.000]
	exc_t	0.304 [0.051]	0.112 [0.011]	0.582 [0.002]	0.952 [0.000]	0.694	−503.451	51.375 [0.420]	26.222 [0.998]
Malaysia	s_t	0.012 [0.000]	0.135 [0.000]	0.836 [0.000]	1.296 [0.000]	0.971	−1260.678	27.442 [0.996]	34.478 [0.954]
	exc_t	0.020 [0.001]	0.093 [0.000]	0.820 [0.000]	1.226 [0.000]	0.913	−559.739	63.567 [0.094]	28.372 [0.994]
Turkey	s_t	0.156 [0.013]	0.053 [0.002]	0.873 [0.000]	1.270 [0.000]	0.926	−2464.148	40.148 [0.864]	32.101 [0.977]
	exc_t	0.034 [0.002]	0.137 [0.000]	0.831 [0.000]	0.871 [0.000]	0.968	−1772.336	34.039 [0.959]	30.168 [0.988]

Notes: The figures in square brackets show the p-values. v is the GED parameter. $Q(50)$ and $Q_s(50)$ indicate Ljung-Box serial correlation test values for the return and the squared return series, respectively.

Table 4
Causality-in-variance test results.

	Causality Direction	Test Statistic	p-value
India	$s_t \rightarrow exc_t$	2.540	[0.280]
	$exc_t \rightarrow s_t$	2.487	[0.288]
Malaysia	$s_t \rightarrow exc_t$	2.519	[0.283]
	$exc_t \rightarrow s_t$	3.889	[0.143]
Turkey	$s_t \rightarrow exc_t$	24.411***	[0.000]
	$exc_t \rightarrow s_t$	4.453	[0.107]

Notes: → indicates the direction of causality. *** and ** show a statistically significant causality relation at 1% and 5% levels, respectively.

market. In other words, the null hypothesis of no volatility spillover going from the Islamic stock market to the exchange rates can be rejected at a 1% significant level. These results suggest that the Islamic stock market is the Granger cause-in-variance of the exchange rates. On the other hand, the null hypothesis of no volatility spillover from exchange rates to the Islamic stock market cannot be rejected. The presence of a causal link from the stock market to the foreign exchange market in Turkey is consistent with the Portfolio Balance Model.

To examine whether the volatility spillover effect between the Islamic stock market and foreign exchange market is time-varying, we calculate the LM test for each subsample by estimating the rolling GARCH model. The probability (p-values) of rejecting the null hypothesis is presented in Fig. 1, panels (a) - (c).

It should be noted that the time-varying causality-in-variance test results offer different pictures, because we cannot ascertain any causal link between the Islamic stock market and the foreign exchange market in either India or Malaysia according to the results in Table 3. On the other hand, the time-varying test results in Fig. 1 show the presence of volatility spillover in at least one direction between exchange rates and the Islamic stock market at specific periods. For instance, the results in Fig. 1 Panel (a) indicate the existence of volatility spillover from the Islamic stock market to the exchange rates at the beginning of the sample. On the other hand, the null hypothesis of no volatility spillover from the exchange rates to the Islamic stock market is strongly rejected for the period between 2016 and 2017. These findings are consistent with the a priori expectations, because exports declined considerably due to weak external demand and the real effective exchange rate appreciating in 2014 and 2015 in India, and negative growth in exports observed in 2015. It should be noted that in the last 20 years, negative export growth in the Indian economy was realized for the first time in 2015, except for periods of global financial crisis. At the beginning of 2015, real effective exchange rates started to depreciate and hence, exports bounced back early in 2016. While positive growth rate was observed in exports in 2016, import growth was negative. The increasing amount of foreign currency depending on external trade performance may have affected the volatility in capital markets for the period 2016 to 2017. However, we cannot determine significant and persistent causality between the Islamic stock market and exchange rates for the second half of 2018 and the beginning of 2019, because the null hypothesis can be seldom rejected and causality is generally borderline for cases in this period. Nevertheless, we find evidence in favor of unidirectional volatility spillover from the exchange rates to the Islamic stock market at the end of 2019. The time-varying test results show evidence of spillover effects from the foreign exchange market to the Islamic stock market then a spillover effect in the opposite direction. This finding is consistent with the Trade Balance Model that indicates that changes in the exchange rates affect the stock market. These results are similar to the empirical results found in Mishra (2004), Abdalla and Murinde (1997) and Singh (2015).

We present the time-varying causality-in-variance test results for Malaysia in Fig. 1 (b). It should be expressed that we cannot determine any persistent causality relationship between the Islamic stock market and foreign exchange market until the beginning of 2017, because we can rarely reject the null hypothesis in this period. On the other hand, we find evidence in favor of volatility spillover running from the Islamic stock market to the foreign exchange market after 2017. It is worth noting that the Islamic market index gave a strong bullish recovery for the periods of 2017 and 2018 and the growth rate of the index was almost 20% for the period. Then the index started to drop sharply after election results in May 2018. These events led to increased volatility in the stock market, and hence the foreign exchange rate market may also have been affected by these developments. Moreover, we can detect bidirectional volatility spillover between the Islamic stock market and the foreign exchange market after 2018. This result shows that the degree of interconnectedness between the Islamic stock market and the

Please cite this article as: Erdoğan, S et al., Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2020.04.003

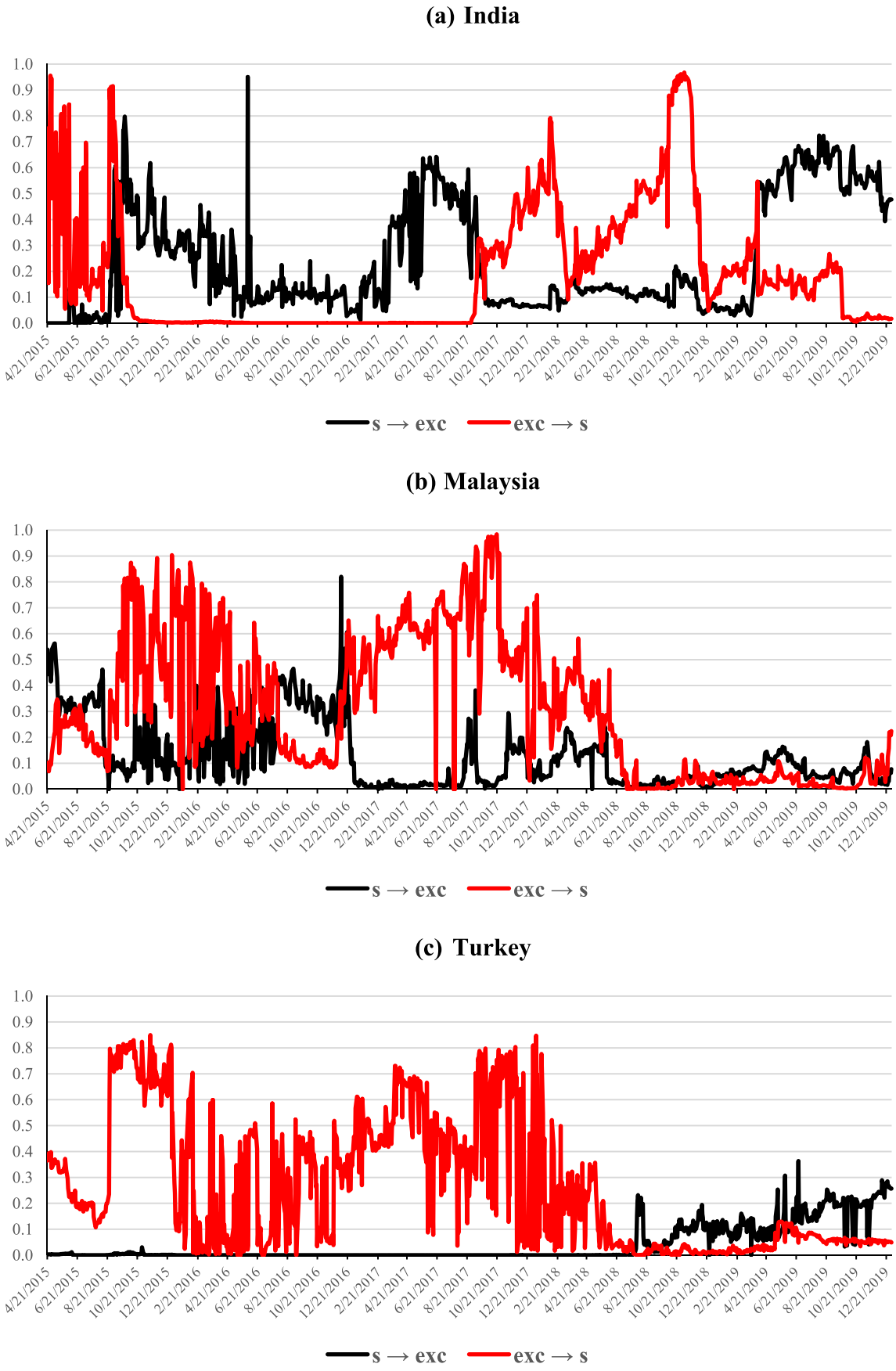

Fig. 1. Time-varying causality-in-variance test results.

Please cite this article as: Erdoğan, S et al., Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2020.04.003

exchange rate market has increased, especially since 2018. The results in favor of a unidirectional causality relationship from the stock market to the exchange rates are consistent with the empirical results found in Lee, Doong, and Chou Lee, Doong, and Chou (2011). On the other hand, Andreou, Matsi, and Savvides (2013) found a bidirectional causality relationship between the stock market and the foreign exchange market in India.

The results in Fig. 1 Panel (c) indicate the existence of volatility spillover from the Islamic stock market to exchange rates until 2018 in Turkey, and this finding is consistent with the results in Table 4. However, we find a causality relationship running from the exchange rates to the Islamic stock market in 2016 and to the end of 2017, but this causality does not seem to be persistent, because the null hypothesis can rarely be rejected. On the other hand, when we examine causality test results running from the exchange rates to the Islamic stock market, mid-2018 comes to the fore. In other words, the null hypothesis of no volatility spillover from the exchange rates to the Islamic stock market can be strongly rejected only at the end of the sample period. This finding is consistent with theoretical expectations, because the volatility of the exchange rates in Turkey significantly increased between 2018 and 2019 due to speculative attacks in August 2018, and hence, extreme movements in the exchange rates were observed in Turkey. The sharp rise in exchange rates negatively affected the whole economy in Turkey. Moreover, capital markets were also affected negatively by an increase in the volatility of the stock market. Consequently, there seem to be volatility spillovers from the exchange rates to the Islamic stock market after August 2018.

5. Conclusion

In this study, the volatility spillover effect is investigated between the Islamic stock market and exchange rates using the causality-in-variance test developed by Hafner and Herwartz (2006). The Dow Jones Islamic market indexes are considered for three major emerging countries, namely India, Malaysia, and Turkey. We also consider local currencies against the US Dollar as exchange rates. In order to examine whether the relationship between the variables changes over time, the time-varying volatility spillover effect is also investigated using a rolling-sample approach.

The causality-in-mean test results show that the Islamic stock market is the Granger cause of exchange rates in all countries. On the other hand, the causality-in-variance test results show a lack of causality relationship between the Islamic stock market and exchange rates in India and Malaysia. As in the causality-in-mean test results, we find the presence of a volatility spillover effect from the Islamic stock market to exchange rates in Turkey. The causality relationship from capital markets to exchange rates provides evidence in favor of the Portfolio Balance Model.

The time-varying causality-in-variance test results offer a different picture, since there is no causal link between the Islamic stock market and the foreign exchange markets in India and Malaysia. On the other hand, the time-varying test results show that the presence of volatility spillover in at least one direction between exchange rates and the Islamic stock market at specific periods. The time-varying test results show evidence of volatility spillover from the foreign exchange market to the Islamic stock market, then the spillover effect in the opposite direction. This finding is consistent with the Trade Balance Model which indicates that changes in the exchange rates affect the stock market. These results are consistent with the empirical results found in Mishra (2004), Abdalla and Murinde (1997) and Singh (2015).

We cannot validate any persistent causality relationship between the Islamic stock market and the foreign exchange market in Malaysia, until the beginning of 2017. On the other hand, we find evidence in favor of volatility spillover running from the Islamic stock market to the foreign exchange market after 2017. Moreover, we can detect bidirectional volatility spillovers between the Islamic stock market and the foreign exchange market after 2018. This result shows that the degree of interconnectedness between the Islamic stock market and the exchange rate market has increased, especially since 2018.

The time-varying test results for Turkey indicate the existence of volatility spillover from the Islamic stock market to exchange rates, until 2018. This finding is consistent with the empirical results found in Kanas (2000), Caporale, Pittis, and Spagnolo (2002), Yang and Doong (2004), Koseoglu and Cevik (2013). These were studies in which the presence of volatility spillover effect running from the stock market to the exchange market were found. On the other hand, when we examine causality test results running from exchange rates to the Islamic stock market, the middle of 2018 comes to the fore. In other words, we determine volatility spillover from the exchange rates to the Islamic stock market after August 2018. The fact that exchange rates affect the Islamic stock market is an important data source for economic policies. In order for the exchange rate shocks not to affect macroeconomic indicators negatively, structural reforms must be carried out immediately to reduce foreign dependency. In foreign dependent economies, exchange rate attacks negatively affect macroeconomic indicators and expectations. Reducing foreign dependency, particularly in terms of intermediate and capital goods, will increase the soundness of the economy against exchange rate shocks.

The findings are important both for investors and decision-makers for improving their hedging and diversification strategies. The presence of causality between the Islamic stock market and exchange rates indicates that diversification opportunities are limited. Our empirical results are also important for policymakers to conduct exchange rates policy. This is because causality-in-mean test results show that the foreign exchange market is affected by the stock market. In addition, the time-varying test results show that there is no persistent causality relationship from exchange rates to the Islamic market until 2018, in Malaysia and Turkey, and hence, it can be said that Shariah screening makes the Islamic stock markets more stable. Exchange rates

Please cite this article as: Erdoğan, S et al., Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2020.04.003

affect the Islamic stock markets only if there are external manipulative attacks.

Conflict of interest

We have no conflict of interest.

Acknowledgment

This paper is an extended version of the paper titled 'Relationship Between Foreign Exchange Rate and Participation Index in Turkey' presented at the International Congress of Management, Economy and Policy (ICOMEP) that was held on 02−03 November 2019, in Istanbul.

References

Abdalla, I. S. A., & Murinde, V. (1997). Exchange rate and stock price interactions in emerging financial markets: Evidence on India, Korea, Pakistan, and the Philippines. *Applied Financial Economics, 7*(1), 25−35.

Abd Majid, M. S. (2016). Dynamic interactions between the islamic stock prices and macroeconomic variables: Evidence from Malaysia. *DLSU Business & Economics Review, 26*(1), 92−100.

Abd Majid, M. S., & Yusof, R. M. (2009). Long-run relationship between Islamic stock returns and macroeconomic variables: An application of the autoregressive distributed lag model. *Humanomics, 25*(2), 127−141.

Aggarwal, R. (1981). Exchange rates and stock prices: A study of the U.S. Capital markets under floating exchange rates. *Akron Business and Economic Review*, 7−12. January.

Aggarwal, R., Inclan, C., & Leal, R. (1999). Volatility in emerging markets. *Journal Of Financial And Quantitative Analysis, 34*(33−55), 999.

Ajmi, A. N., Hammoudehb, S., Nguyenc, D. K., & Sarafrazi, S. (2014). How strong are the causal relationships between islamic stock markets and conventional financial systems? Evidence from linear and nonlinear tests. *Journal of International Financial Markets, Institutions and Money, 28*, 213−227.

Andreou, E., Matsi, M., & Savvides, A. (2013). Stock and foreign exchange market linkages in emerging economies. *Journal of International Financial Markets, Institutions and Money, 27*, 248−268.

Bahmani-Oskooee, M., & Domac, I. (1997). Turkish stock prices and the value of Turkish lira. *Canadian Journal of Development Studies, 18*(1), 139−150.

Bahmani-Oskooee, M., & Saha, S. (2016). Do exchange rate changes have symmetric or asymmetric effects on stock prices? *Global Finance Journal, 31*, 57−72.

Bollerslev, T. (1986). Generalized autoregressive conditional heteroscedasticity. *Journal of Econometrics, 31*(3), 307−327.

Buberkoku, O. (1997). The relationship between stock prices and exchange rates: Evidence from developed and developing countries. *ISE Review, 13*(52), 1−16.

Caporale, G. M., Pittis, N., & Spagnolo, N. (2002). Testing for causality-in-variance: An application to the east asian markets. *International Journal of Finance & Economics, 7*, 235−245.

Cevik, E.İ., Atukeren, E., & Korkmaz, T. (2018). Oil prices and global stock markets: A time-varying causality-in-mean and causality-in-variance analysis. *Energies, 11*, 1−22.

Cevik, E.İ., & Bugan, M. F. (2018). Regime-dependent relation between Islamic and conventional financial markets. *Borsa Istanbul Review, 18*(2), 114−121.

Cevik, E.İ., Korkmaz, T., & Atukeren, E. (2012). Business confidence and stock returns in the USA: A time-varying markov regime-switching model. *Applied Financial Economics, 22*(4), 299−312.

Cheung, Y. W., & Ng, L. K. (1996). A causality-in-variance test and its application to financial market prices. *Journal of Econometrics, 72*, 33−48.

Chkili, W., & Nguyen, D. K. (2014). Exchange rate movements and stock market returns in a regime-switching environment: Evidence for BRICS countries. *Research in International Business and Finance, 31*, 46−56.

Dahir, A. M., Mahat, F., Ab Razak, N. H., & Bany-Ariffin, A. N. (2018). Revisiting the dynamic relationship between exchange rates and stock prices in BRICS countries: A wavelet analysis. *Borsa Istanbul Review, 18−2*, 101−113.

Dornbusch, R., & Fischer, S. (1980). Exchange rates and the current account. *The American Economic Review, 70*(5), 960−971.

El Khamlichi, A., Sarkar, K., Arouri, M., & Teulon, F. (2014). Are islamic equity indices more efficient than their conventional counterparts? Evidence from major global index families. *Journal of Applied Business Research, 30*(4), 1137−1150.

Erdoğan, S., Gedikli, A., & Cevik, E.İ. (2019). The impact of macroeconomic variables on participation 30 index in Turkey. *Econometrics Letters, 6*(2), 25−34.

Frankel, J. A. (1983). Monetary and portfolio-balance models of exchange rate determination. In J. Bhandari, & B. Putnam (Eds.), *Economic interdependence and flexible exchange rates*. Cambridge: MIT Press.

Granger, C. W. J., Huang, B.-N., & Yang, C. W. (2000). A bivariate causality between stock prices and exchange rates: Evidence from recent Asian flu. *The Quarterly Review of Economics and Finance, 40*, 337−354.

Gunduz, L., & Hatemi-J, A. (2002). *On the causal relationship between stock prices and exchange rates: Evidence from MENA region*. https://ssrn.com/abstract=317081. https://doi.org/10.2139/ssrn.317081.

Hafner, C. M., & Herwartz, H. (2006). A Lagrange multiplier test for causality invariance. *Economics Letters, 93*, 137−141.

Haider, A., Shah, I. H., Ashraf, R. U., Ghauri, S. M. K., & Ibne, H. (2015). Standardization of Islamic market indices. *International Journal of Commerce and Management, 25*(2), 240−256.

Hillebrand, E. (2005). Neglecting parameter changes in GARCH models. *Journal of Econometrics, 129*, 121−138.

Hkiri, B., Hammoudeh, S., Aloui, C., & Yarovaya, L. (2017). Are islamic indexes a safe haven for investors? An analysis of total, directional and net volatility spillovers between conventional and islamic indexes and importance of crisis periods. *Pacific-Basin Finance Journal, 43*, 124−150.

Hussin, M. Y. M., Muhammad, F., Abu, M. F., & Awang, S. A. (2012b). Macroeconomic variables and Malaysian islamic stock market: A time series analysis. *Journal of Business Studies Quarterly, 3*(4), 1−13.

Hussin, M. Y. M., Muhammad, F., Hussin, M. F. A., & Abdul Razak, A. (2012a). The relationship between oil price, exchange rate and islamic stock market in Malaysia. *Research Journal of Finance and Accounting, 3*(5), 83−92.

Ibrahim, M. H. (1999). Macroeconomic variables and stock prices in Malaysia: An empirical analysis. *Asian Economic Journal, 13*(2), 219−231.

Isa, N. M., Abdullah, A., & Hassan, Z. (2012). *Relationship between macroeconomic variables and Malaysia available Shariah indices*. MPRA. Paper No. 69397.

Jebran, K., & Iqbal, A. (2016). Dynamics of volatility spillover between stock market and foreign exchange market: Evidence from asian countries. *Financial Innovation, 2*(3), 1−20.

Kanas, A. (2000). Volatility spillovers between stock returns and exchange rate changes: International evidence. *Journal of Business Finance & Accounting, 27*, 447−467.

Kenourgios, D., Naifar, N., & Dimitriou, D. (2016). Islamic financial markets and global crises: Contagion or decoupling? *Economic Modelling, 57*, 36−46.

Koseoglu, D. S., & Cevik, E. I. (2013). Testing for causality in mean and variance between the stock market and the foreign exchange market: An application to the major Central and Eastern European countries. *Czech Journal of Economics and Finance (Finance a uver), 63*(1), 65−86.

Kumar, K. K., & Sahu, B. (2017). Dynamic linkages between macroeconomic factors and islamic stock indices in a non-islamic country India. *The Journal of Developing Areas, 51*(1), 193−205.

Lamoureux, C. G., & Lastrapes, W. D. (1990). Persistence in variance, structural change and the GARCH model. *Journal of Business & Economic Statistics, 68*, 225−234.

Please cite this article as: Erdoğan, S et al., Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2020.04.003

Lee, C.-H., Doong, S.-C., & Chou, P. I. (2011). Dynamic correlation between stock prices and exchange rates. *Applied Financial Economics, 21*(11), 789−800.

Liu, L., & Wan, J. (2012). The relationships between Shanghai stock market and CNY/USD exchange rate: New evidence based on cross-correlation analysis, structural cointegration and nonlinear causality test. *Physica A, 391*, 6051−6059.

Luqman, R., & Kouser, R. (2018). Asymmetrical linkages between foreign exchange and stock markets: Empirical evidence through linear and nonlinear ARDL. *Journal of Risk and Financial Management, 11*(3), 1−13.

Mishra, A. K. (2004). Stock market and foreign exchange market in India: Are they related? *South Asia Economic Journal, 5*(2), 209−232.

Mohsina, H., & Islam, K. U. (2017). Impact of macroeconomic variables on islamic stock market returns: Evidence from nifty 50 Shariah index. *Journal of Commerce and Accounting Research, 6*(1), 37−44.

Mustapha, I. M., Bacha, O. I., & Mansur, M. (2017). *Dynamics of Islamic stock market returns and exchange rate movements in the ASEAN Countries in a regime-switching environment: Implications for the Islamic investors and risk hedgers*. MPRA. Paper No. 82218.

Paltrinieri, A., Floreani, J., Kappen, J. A., Mitchell, M. C., & Chawla, K. (2019). Islamic, socially responsible, and conventional market comovements: Evidence from stock indices. *Thunderbird International Business Review, 61*, 719−733.

Participation 30 Index. (2019). *Presentation*. http://www.katilimendeksi.org/content/userfiles/files/ke30_sunum.pdf. (Accessed 16 October 2019).

Participation 30 Index Rules Booklet.(2019). http://www.katilimendeksi.org/content/userfiles/files/kural_kitapcik_30_1.pdf. (Accessed 16 October 2019).

Rana, M. E., & Akhter, W. (2015). Performance of islamic and conventional stock indices: Empirical evidence from an emerging economy. *Financial Innovation, 1*(15), 1−15.

Rashid, M., Hassan, M. K., & Yein, N. Y. (2014). Macroeconomics, investor sentiment, and islamic stock price index in Malaysia. *Journal of Economic Cooperation & Development, 35*(4), 221−236.

Raza, N., Ibrahimy, A., & Ali, A. (2015). Gold and islamic stocks: A hedge and safe haven comparison in time-frequencycy domain for BRICS. In *Forthcoming in: Proceedings of the asia pacific Conference on Business and social sciences*. Kuala Lumpur.

Sakti, M. R. P., & Harun, M. D. Y. (2013). Relationship between islamic stock prices and macroeconomic variables: Evidence from Jakarta stock exchange islamic index. *Global Review of Islamic Economics and Business, 1*(1), 71−84.

Sanso, A., Arago, V., & Carrion, J. L. (2004). Testing for change in the unconditional variance of financial time series. *Revista de Economia Financiera, 4*, 32−53.

Sikhosana, A., & Aye, G. C. (2018). Asymmetric volatility transmission between the real exchange rate and stock returns in South Africa. *Economic Analysis and Policy, 60*, 1−8.

Singh, G. (2015). Relationship between exchange rate and stock price in India: An empirical study. *The IUP Journal of Financial Risk Management, XII*(2), 18−29.

Sui, L., & Sun, L. (2016). Spillover effects between exchange rates and stock prices: Evidence from BRICS around the recent global financial crisis. *Research in International Business and Finance, 36*, 459−471.

Tsagkanos, A., & Siriopoulos, C. (2013). A long-run relationship between stock price index and exchange rate: A structural nonparametric cointegrating regression approach. *Journal of International Financial Markets, Institutions and Money, 25*, 106−118.

Tsai, I.-C. (2012). The relationship between stock price index and exchange rate in asian markets: A quantile regression approach. *Journal of International Financial Markets, Institutions and Money, 22*, 609−621.

Turgut, T. (2017). Causality between stock prices and exchange rates in Turkey: Empirical evidence from the ARDL bounds test and a combined cointegration approach. *International Journal of Financial Studies, 5*(1), 1−10. www.us.spindices.com.

Yang, S., & Doong, S. (2004). Price and volatility spillovers between stock prices and exchange rates: Empirical evidence from the G-7 countries. *International Journal of Business and Economics, 3*, 139−153.

Zeren, F., & Koç, M. (2016). Time varying causality between stock market and exchange rate: Evidence from Turkey, Japan and England. *Economic Research - Ekonomska Istraživanja, 29*(1), 696−705.

Please cite this article as: Erdoğan, S et al., Volatility spillover effects between Islamic stock markets and exchange rates: Evidence from three emerging countries, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2020.04.003