Do Instabilities in National Macroeconomic

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Do Instabilities in National Macroeconomic Factors Contribute to Channeling Volatility Spillover from the Global to the Islamic Equity Market?

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Abstract

This study investigates the impact of macroeconomic instabilities on returns volatility spillover that is transmitted from the global to the Islamic equity market. The economic factors examined are the exchange rate, inflation rate, interest rate, and production growth. To achieve the purpose of the study, we utilize three analysis tools: a GARCH(p,q) model to derive values of volatility for all variables; an asymmetry dynamic conditional correlation (ADCC) model to produce a measure of volatility spillover as the dependent variable; and a panel data regression technique to assess the causality significance of macroeconomic factors to volatility spillover. This study is the first which expands such approaches. We observe monthly data of world and Islamic market indices, exchange rates, consumer price indices, interest rates, and industrial

production indices. The data, which range from May 2002 to February 2019, are taken from the world market, and twenty-three economies, which consist of fourteen developed and nine emerging markets that have Islamic stock indices. In several sections, we provide important additional analysis for five stock markets in Central European economies, which are compared to the others. The finding suggests that the presence of volatility spillover on the Islamic markets that originates from the global market is affected by the internal instabilities of macroeconomic factors, except for industrial production instability for developed markets, including Central European markets. An implication of the study is that regulators should anticipate and prevent adverse consequences of volatility spillover by arranging their internal economic policy to control inflation rates, interest rates, and industrial production growth, as well as exchange rate flexibility. Moreover, market practitioners should include both global market volatility and macroeconomic instabilities in their prediction to create minimum risk.

Keywords: volatility spillover, Islamic equity, GARCH model, ADCC, panel data

JEL: F36, G15, C10, C23

Introduction

Many studies have investigated the relationship between the equity market and real economic activities. Interest in this area is mainly because equity markets are recognized as playing a prominent role in an economy's economic and business cycle developments (Zakaria and Shamsuddin 2012). Due to their important role as a financial channel for savings and investment for investor wealth, corporate performance, and economic development, it has drawn the attention of researchers and practitioners. They continue to examine the behavior and condition of the equity markets, as well as domestic financial-economic factors and factors originating from the global market that change their development.

Although maximizing stock returns for an investor in the equity market is an expectation that is accompanied by high risk, many recent articles pay more attention to creating minimum risk with the same rate of returns. This risk could be observed through the volatility of the stock price. Therefore, the study of return volatility is important as it attempts to predict its pattern individually and to identify its determinants. In particular, how global market volatility and macroeconomic instability affect market returns become an interesting issue to be investigated further. Accordingly, investors develop their analysis by involving macroeconomic factors while national policymakers manage and control them to achieve benefits from the integration process more than its economic costs.

In line with the increased process in global economic and financial market integration to establish a single market and regional monetary unions, such as in South East Asia, Gulf, Latin America, and Eastern Europe, the sensitivity of an equity market could rise. As a result, the domestic equity market will become more responsive to the

volatility of global and regional markets. For instance, Prasad et al. (2018) found that larger equity markets from advanced western economies, particularly the US, dominate volatility transmission to other markets. They concluded that the level of volatility in one market relative to that in other markets is the most important factor in increasing transmitted spillovers. In addition, they include macroeconomic news as another important determinant for volatility spillover.

A market-oriented policy such as deregulation of interest and exchange rates and reductions in the restrictions to international fund flow has driven world market integration (Balli et al. 2015). However, this process has been accompanied by instability in market conditions, such as increased return volatility from global market volatility and financial fragility. We predict that a higher degree of equity return volatility is generally associated with countries characterized as having lower macroeconomic stability. Accordingly, such policy should consider not only the advantages of world market integration but also volatility spillover in market returns.

Volatility spillover has been the focus of many studies. Due to globalization and financial market liberalization, integrated domestic financial assets might not be protected from shocks from world markets. The returns volatility in an integrated domestic market would be influenced by the pattern of returns volatility in the world market (Jebran et al. 2017; Najmudin 2019). We predict that the endurance capability of an equity market could reduce this volatility spillover effect. Investigations into the factors that cause volatility spillover are thus necessary, and they will provide clear information and frameworks for decision-makers to control their policies so that equity market stability desired by market participants would be realized.

The financial economics literature has extensively examined the effect of macroeconomic variables on returns volatility and reported valuable findings. This issue has been observed in many economies, for instance, Finland (Liljeblom and Stenius 1997), the UK (Morelli 2002), Ghana (Adjasi 2009), Nigeria (Oseni and Nwosa 2011), Malaysia (Zakaria and Shamsuddin 2012), the US and 61 other economies (Georgiadis 2016), India (Haokip 2018), and Indonesia (Robiyanto et al. 2019), with various methods and observation periods. However, the literature has not provided evidence on the effect of national macroeconomic instability on volatility transferred from the global to a domestic Islamic market.

Prior studies found that various national macroeconomic volatilities, such as production growth as well as interest, exchange, and inflation rates, are explanatory variables for market returns volatility. We propose the explanatory variables as found in prior studies as potential determinants for the volatility spillover. Moreover, one of the weaknesses of prior studies lies in the measure of volatility spillover when it applies as a consequence factor. The advancement of analytical methods is necessary because of the consideration that the spillover volatility process changes over time due to the dynamic development of changing economic and business factors (Guesmi and Teulon 2014). Unlike previous studies, where market returns volatility has a position as an endogenous variable in examining the causality from macroeconomic variables,

we design the volatility spillover for a similar position. In addition, most studies emphasize conventional equities in both developed and emerging markets when investigating this issue. Studies on volatility spillover and its determinants that observe and involve the Islamic equity market are still rare, however. The results of such a study are interesting as the response to macroeconomic volatility could vary between an Islamic equity market and its conventional counterpart.

As the volatile nature of market returns provides important implications for policymakers and market practitioners, the purpose of this study is to investigate the connection between volatility spillover and several macroeconomic factors. We attempt to analyze how the strength of national economic stability can have a vital role in monitoring unwanted effects, particularly the volatility from the global market.

Literature review

The link between macroeconomic factors and stock price movement has been examined in the financial literature in two categories. The first studies assessed the link at the first moments, with the findings mostly suggesting that macroeconomic factors play a significant role in explaining patterns of equity market returns. The second studies assessed the link at second moments. The findings of the studies have a varied conclusion about how volatilities in macroeconomic factors affect equity market volatility. The link in the former studies analogically has a similar framework with the latter studies, which assumed that volatilities in macroeconomic factors such as production growth play an important role in determining equity market volatility.

Following Morelli (2002), Liljeblom and Stenius (1997) theorize about a link between equity price and macro variables. The theoretical motivation for the link at second moments can be described by the discounted present value of expected future cash flows for equity price. It states that the conditional variance of equity price depends on conditional variances of expected future cash flows and future discount rates, and on conditional covariances between them. A change in future macroeconomic instability would drive a proportional change in equity returns volatility as corporate equity values at the aggregate level should depend on economic health (Adjasi 2009).

The link between volatilities in an equity market and the number of macroeconomic variables originates from the theoretical formulation that equity prices are determined by a simple discounted present-value model (Morelli 2002), as expressed in Eq. (1).

$$E_{t-1}P_t = E_{t-1}\sum_{k=1}^{\infty} D_{t+k}/(1+R_{1+k})^k, \quad (1)$$

where D_{t+k} denotes the future dividend at time $t + k$; $1/(1 + R_{t+k})^k$ is the discount rate at time $t + k$; and E_{t-1} denotes the conditional expectation.

Theoretically, a simple discount model states that the fundamental value of corporate equity equals the present value of expected future dividends (Oseni and Nwosa 2011). The future dividend ultimately reflects real economic activity. Currently, if all the available information is taken into account, there would be a close relationship between equity prices and expected future economic activity. Similarly, volatility in equity price should also depend on the volatility of expected future cash flows and the future discount rate. In other words, the equity market would be volatile when real economic activity fluctuates (Zakaria and Shamsuddin 2012).

In addition, the arbitrage pricing theory (APT) introduced by Ross (1976) offers space to include several factors, such as macroeconomic variables, in the model, where their roles could be as a function of returns volatility. Furthermore, Chinzara (2011) argues that the dividend discount model and the APT propose an important theoretical framework underlying the link between patterns in economic condition and equity price. Both models predict that the arrival of new information, such as the interest rate, would alter the equity return through a change in the expected dividend and discount rate. Accordingly, it would be logical that volatility in economic variables would become a function of current returns volatility.

When the integration of an equity market with a global market increases, the sensitivity of this market to volatility spillover would also increase and be more vulnerable to external shocks (Alotaibi and Mishra 2015). However, we predict that when volatilities in national economic factors are stable, the volatility spillover would not fluctuate, as volatility in market returns does not fully depend on a change in global market volatility. Indeed, fully closed economies would not experience a volatility spillover, but they would grow and develop more slowly in the long run. For this trade-off, a market openness and its consequences should be considered carefully before the policies are decided.

The significance of volatilities in macroeconomic factors on an equity market's volatility spillover could define the integration type of the market towards the global market. The significant effect of volatilities in macroeconomic factors indicates that an equity market is segmented as it is still restricted by domestic internal factors. Policymakers or regulators have a role in controlling equity market instability when volatility is transmitted from the global market. Conversely, the insignificant effect of the volatilities indicates that an unstable economic situation cannot prevent volatility moving from the global to the domestic equity market. It suggests that this equity market is integrated into moving together internationally with other equity markets.

To estimate volatility patterns accurately, it is very important to understand the link between different equity market types, their price determinants, and the underlying factors behind their price fluctuations (Karali and Ramirez 2014). Moreover, Georgiadis (2016) concludes that the spillover depends on a number of internal characteristics in an economy, including financial integration, market openness, exchange and interest rate, as well as industrial production growth. As a result, macroeconomic stability has become necessary for financial development (Adjasi 2009). Georgiadis confirms

that investment plans and financial sector returns are driven largely by macroeconomic fundamentals. Thus, volatility in the stock market can be influenced by uncertainty in macroeconomic variables.

Four determinants of volatility spillover were assessed by Yusof and Majid (2007) in Malaysia. They observed the causality of monetary policy variables such as narrow money supply, broad money supply, interest rates, and exchange rates on conditional volatilities of conventional and Islamic stock markets. They used the Kuala Lumpur Composite Index (KLCI) as a measure for the conventional stock market return and the Rashid Hussain Berhad Islamic Index (RHBII) as a measure of the Islamic stock market return. The evidence suggests that the volatility of the KLCI is affected by interest rate volatility. In contrast, the volatility of RHBII is not affected by the volatility of the interest rate.

The results from Adjasi (2009) show that higher volatility in prices, which is an indicator of inflation volatility, and interest rates increase the stock return volatility. Inflation could reduce earnings after taxes, so then it has a negative effect on stock returns, and interest rate changes help predict equity market returns over a long period. Similarly, Chinzara (2011) reports that volatilities in inflation, as well as the price of gold and the price of oil, have a role in influencing stock market volatility. In addition, he finds that short-term interest rates and exchange rates are the most important.

Liberalization in the exchange rate and financial integration tend to amplify returns volatility spillover when developing countries have inflexible exchange rates (Georgiadis 2016). In other words, exchange rate volatility could influence the volatility of the equity markets due to international investors requiring foreign currencies to purchase equity in the international market (Leung et al. 2017). Moreover, Karali & Ramirez (2014) explain that the depreciation of a home currency against a foreign currency would increase returns on the foreign currency and drive investors to shift their fund from home securities to foreign securities, which would induce the equity price. Therefore, they assert that flexible exchange rates could help economies mitigate external shocks on the equity market.

A number of prior studies revealed determinants of volatility spillover in market returns. Liljeblom and Stenius (1997) employed simple weighted moving averages and GARCH (generalized autoregressive conditional heteroskedasticity) estimations as the analysis method and observed monthly data from January 1920 to 1991 in Finland. They utilized industrial production, money supply, inflation, terms of trade, and trading volume as the variables, and found weak evidence for a link between stock market volatility and the growth of stock market trading volume. Applying ARCH (autoregressive conditionally heteroscedastic) and GARCH models, Morelli (2002) analyzed the effects of volatility in industrial production, real retail sales, money supply, inflation, and exchange rate on conditional stock market volatility in the UK covering the period January 1967 to December 1995. He concluded that the volatility in the macro-variables observed does not influence stock market volatility. Observing in Ghana, Adjasi (2009) found that higher volatility in inflation and interest rates increases stock price volatility, while higher volatility in money supply reduces stock price volatility.

Recent studies, such as Prasad et al. (2018), apply the methodology from Diebold and Yilmaz (2012) to observe 16 stock markets. Using daily data over the period January 6, 2000 to June 13, 2014, Prasad et al. (2018) main finding is that larger stock markets from advanced western economies, particularly the US, dominate volatility transmission to other markets. Meanwile, Abbas et al. (2018) observed G–7 countries (the US, the UK, Canada, Japan, Germany, France, and Italy). They applied exponential GARCH and vector autoregressive (VAR) models to analyze equity market indices, the industrial production index, the consumer price index, broad money supply, the treasury bill rate, the exchange rate, and the crude oil price on a monthly basis. They reported a weak volatility transmission from macroeconomic factors to equity market volatility at the individual level, but the collective impact of volatility transmission is highly significant. The volatility of industrial production growth and the price of oil are identified as the most significant macroeconomic factors that could influence the directions of equity markets.

Data and methods

The first dataset includes monthly data for each market index from May 2002, the earliest month where complete Islamic market indices for the twenty-three markets became available, until February 2019. The indices' data are collected from nine emerging markets (the Czech Republic, Hungary, India, Indonesia, Korea, Malaysia, the Philippines, Poland, and Turkey), fourteen developed markets (Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Singapore, Spain, Sweden, and the UK), and the world market. The Central European markets observed in the analysis are the Czech Republic, Hungary, and Poland, as well as Austria and Germany. Including the five markets as the sample, the result of this study could generalize statistically the population of markets that have incomplete data, such as Slovenia and Slovakia. The data set of twenty-three Islamic equity markets and world market indices are employed to calculate the returns on each market index. It would be used further to find the values of conditional variance as a measure of conditional volatility and coefficient set of asymmetric dynamic conditional correlation between the global market and each Islamic equity market.

Morgan Stanley Capital International (MSCI) continuously reports the data of Islamic indices for all the twenty-three equity markets and the global market. We chose the MSCI ACWI (All Countries World Index) as a proxy for the global market index. Data on equity market indices were converted into continuously compounded returns by subtracting the natural logarithm of the previous month's index from the natural logarithm of the current month's index, then multiplying by 100 to convert them into percentage returns. We calculate monthly market returns as $R_{t,i} = \ln(P_{t,i}/P_{t-1,i})$. This equation means that the return for market index i at current month t ($R_{t,i}$) is the result of the natural logarithm of price level of market index i at current month t ($P_{t,i}$), which is divided by the price level of market index i at the previous month t ($P_{t-1,i}$).

The second dataset includes monthly macroeconomic data of each of the twenty-three economies, namely the exchange rate with the US dollar, the consumer prices index, the treasury bill rate or central bank policy rate, and the industrial production index. For further analysis, we changed the exchange rate and interest rate data in volatility form, utilizing the GARCH model. In addition, we use percentage changes (denoted as %Δ) in consumer price and industrial production index data to generate the inflation rate and economic growth indicators, respectively. The data are available at msci.com, bloomberg.com, and international financial statistics (IFS) reported by the International Monetary Fund (IMF).

The method for this study is composed of three steps, which employ the GARCH model, the asymmetric generalized dynamic conditional correlation (ADCC) model, and panel data estimation. In the first step, the GARCH(1,1) procedure is utilized to produce conditional volatilities of global and national equity market returns, exchange rates, inflation rates, interest rates, and industrial production growth, respectively. Several empirical studies have employed the GARCH(1,1) model to fit adequately the predicted volatility of equity market returns and all macroeconomic series; hence, a similar method was adopted for this study.

The GARCH model was introduced by Bollerslev (1986) and is the most commonly employed class of time series models for studying volatility. According to Chinzara (2011), the GARCH(p,q) model is a parsimonious procedure and avoids over-fitting. Moreover, the GARCH(1,1) model is usually able to cover volatility clustering in the data and is a widely popular choice for researchers assessing the dynamic volatility of equity markets (Balli et al. 2015). The GARCH methodology has been briefly comprehensively described in several studies; hence, it is unnecessary to go into detail in this section. This process would generate a value series of return volatilities in the global market and twenty-three Islamic national equity markets.

The mean equation as the first equation of the AR-GARCH-M(p,q) model is expressed in Eq. (2).

$$Y_{i,t} = c + \beta_1 R_{i,t-1} + \beta_2 \sigma_{i,t} + \varepsilon_t. \tag{2}$$

The variance equation, as the second equation, is expressed in Eq. (3).

$$\sigma^2_{i,t} = \alpha_0 + \alpha_p \varepsilon^2_{i,t-p} + \lambda_q \sigma^2_{i,t-q}, \tag{3}$$

where $Y_{i,t}$ is equity market returns and macroeconomic series, respectively of economy i at time t; $\sigma_{i,t}$ is the square root of conditional variance of the series on economy i at time t; ε_t is error term at time t; $\sigma^2_{i,t}$ is the conditional variance of the error term at time t; ε^2_{t-p} is the squared error term at time $t - p$; σ^2_{t-q} is conditional variance at time $t - q$.

In the second step, the ADCC model is applied to obtain the measure of volatility spillover. This measure was generated from the econometric technique proposed

by Cappiello et al. (2006). They introduce the model to relate the asymmetric dynamic and time-varying patterns among financial markets. Utilizing this model, we created the volatility spillover measure by linking volatility in the global market to volatility in each Islamic market observed. This process produces a series of dynamic correlation coefficients for each equity market and obtains twenty-three data series. This measure becomes the dependent variable of panel estimation in the third step analysis.

Since the ADCC model has been used widely in many studies, for instance, Muharam et al. (2018) and Majdoub et al. (2016), this study only presents a short description. The basic advantage of this approach is applying the main features of standard GARCH models and explicitly creating a model of the time variations in covariance and correlation matrices. This approach is a simple generalization of the DCC-GARCH model created by Engle (2002), by involving the asset-specific correlation evolution coefficients and asymmetric dynamics in correlation.

In the last step, using the panel estimation technique, we examined the determinants' causality of volatility spillover for a series of whole monthly periods from May 2002 to February 2019, and cross-sectional samples of twenty-three Islamic equity markets. Panel data models have a better ability than purely cross-section or time-series data. Baltagi (2005) expounds on the panel data approach, which has advantages to control individual heterogeneity, such as firms and countries, to avoid biased results. For investigating the potential determinants of volatility spillover (*VSO*), we test the explanatory variables, including exchange rate volatility (*VFX*), inflation rate volatility (*VINF*), interest rate volatility (*VINT*), and industrial production growth volatility (*VIPG*). This step will prove the magnitudes of all four macroeconomic volatilities as the independent variables of volatility spillover.

The equation for the causality of explanatory variables on volatility spillover is expressed in Eq. (4). The coefficients of β_i (*beta* i) indicate whether the volatility of the remaining economic variables influences the volatility spillover from global to Islamic markets. In another section, we use the term of instability in national macroeconomic factors that means volatilities in macroeconomics factors.

$$VSO_{iG,t} = \alpha + \beta_1 VFX_{i,t} + \beta_2 VINF_{i,t} + \beta_3 VINT_{i,t} + \beta_4 VIPG_{i,t} + \mu_t, \quad (4)$$

where:
$VSO_{i,t}$ – volatility of asymmetric dynamics conditional correlation of returns between the Islamic equity market of country *i* and global market at period *t*;
$VFX_{i,t}$ – exchange rate volatility of country *i* with the USD at period *t*. It was conditional variance of exchange rate between country *i* – USD which resulted from $VFX_{i,t} = \omega_i + \alpha_i \varepsilon^2_{i,t-1} + \beta_i h_{i,t-1}$;
$VINF_{i,t}$ – inflation rate volatility of country *i* at period *t*;
$VINT_{i,t}$ – interest rate volatility of country *i* at period *t*;
$VIPG_{i,t}$ – industrial production growth volatility of country *i* at period *t*;
μ_t – *error term* at period *t*.

Results and discussion

Table 1 presents a descriptive summary of monthly Islamic market index returns for all twenty-three equity market samples between May 2002 and February 2019, totaling 201 observations for each market. It includes mean, standard deviation, maximum, and minimum values for nine emerging Islamic markets and fourteen developed Islamic markets. The nine emerging Islamic markets are the Czech Republic (CZ), Hungary (HN), India (IN), Indonesia (ID), Korea (KR), Malaysia (MY), Philippines (PH), Poland (PL), Turkey (TR). The fourteen developed Islamic markets are Austria (AT), Belgium (BL), Canada (CD), Denmark (DM), Finland (FN), France (FR), Germany (GM), Italy (IT), Japan (JP), the Netherlands (NT), Singapore (SG), Spain (SP), Sweden (SW), and the United Kingdom (UK).

For the emerging Islamic markets, the monthly average returns varied, with values ranging from –0.26 percent for Hungary to 0.86 percent for the Philippines. India and Indonesia have near similar average returns with the Philippines, i.e., 0.82 percent and 0.85 percent, respectively. However, the highest returns in the Philippines market was not accompanied by the highest risk, as measured by the standard deviation of returns (0.89) and the spread of returns (50.01 percent) ranging from a maximum value of 24.40 percent to a minimum of –25.61 percent. Similarly, the lowest returns in the Hungarian equity market were not accompanied by the lowest risk. The standard deviation (12.39) and the spread of returns (142.79) of this market had the highest values. Table 1 also shows Malaysia's Islamic market is a safe investment for international investors; the volatility is the lowest (5.13) in emerging Islamic markets. Two Islamic markets in Central Europe have lower market returns than emerging market returns in other regions. It appears that the Hungarian market has negative returns while the Polish market has lower returns of 0.35 percent. In addition, the highest risk for emerging markets is also found in a Central European market. The standard deviation of the Hungarian market is the highest in emerging markets.

For developed Islamic markets, Italy's equity market has the lowest average returns (0.09 percent), in contrast to the Danish market, which has the highest average returns (1.13 percent). Both markets have a similar standard deviation of returns of 6.38 and 6.17, respectively. In addition, the Finnish, French, Japanese, and UK markets have similar characteristics, in which the average monthly returns show 0.21, 0.23, 0.20, and 0.25 percent, respectively. The same characteristic in the average returns is also found for the markets in Austria, Belgium, Canada, Germany, Netherlands, and Sweden. Their average monthly returns range from 0.40 percent to 0.58 percent. The average returns for the two Central European markets (Austria and Germany) appear to be in the middle of the developed market returns of other regions.

The highest returns volatility in developed Islamic markets appear in Central European markets, i.e., Austria. Its standard deviation of returns is 8.97, which is close to the standard deviation of returns in the Finnish market (8.12). The other developed markets have similar characteristics, ranging from 4.95 (the UK) to 6.85 (Sweden). By contrast, the

lowest returns volatility in both emerging and developed markets is found in the Japanese market (4.43). It is a safer and more prudent investment than in the Malaysian Islamic equity market, which has the lowest returns volatility in emerging markets (5.13).

Table 1. Descriptive summary of monthly Islamic market indices returns

Emerging Islamic market returns					Developed Islamic market returns				
	Mean	St. Dev	Max.	Min.		Mean	St. Dev	Max.	Min.
CZ	0.62	8.35	19.8	−35.4	AT	0.51	8.97	24.8	−45.1
HN	−0.26	12.39	22.4	−120.4	BL	0.40	5.56	15.8	−22.1
IN	0.82	7.85	29.0	−36.1	CD	0.43	6.63	21.4	−35.0
ID	0.85	8.89	25.6	−51.6	DM	1.13	6.17	13.1	−27.2
KR	0.50	7.25	25.0	−24.3	FN	0.21	8.12	23.8	−29.4
MY	0.46	5.13	16.0	−23.7	FR	0.23	5.62	13.2	−22.1
PH	0.86	8.09	24.4	−25.6	GM	0.43	6.79	18.8	−30.6
PL	0.35	8.84	24.4	−38.6	IT	0.09	6.38	21.8	−21.4
TR	0.50	11.46	42.6	−46.7	JP	0.20	4.43	10.5	−17.4
					NT	0.41	6.67	18.1	−28.4
					SG	0.35	5.84	18.2	−36.6
					SP	0.72	6.48	21.2	−30.8
					SW	0.58	6.85	22.4	−31.1
					UK	0.25	4.95	12.4	−19.4

Source: data processed from www.msci.com (accessed: 4.10.2019).

Table 2 presents standard deviation values as one indicator for the instabilities of all macroeconomic variables, i.e., inflation and interest rates, industrial production growth, and change in the exchange rate, respectively. The inflation rate in most emerging economies, such as Poland, the Philippines, and South Korea, are stable at 0.33, 0.34, and 0.36, respectively. Interest rates are less stable in most emerging economies, particularly in Malaysia, South Korea, and India, ranging from 0.31 to 2.27. On the other hand, instability of the inflation rate for developed economies appears lower in Italy (0.20), Belgium (0.27), and the UK (0.29). It also shows that lower instability in the interest rate is found in Japan (0.22) and Singapore (0.90), while the other economies have similar conditions, ranging from 1.38 for the UK to 1.55 for Germany.

In addition, for emerging markets, the instability of the exchange rate is higher in Turkey and three Central European economies (Hungary, Poland, and the Czech Republic). Compared to emerging markets, the instability of the exchange rate in developed markets is more stable. Table 2 also shows that most developed markets have the same exchange rate movement and instability, namely Belgium (BL), Finland (FN), France (FR), Italy (IT), Netherlands (NT), Spain (SP), and the two Central European economies (Austria and Germany).

The main purpose of this study is to examine the influence of four macroeconomic volatilities on volatility spillover of the Islamic equity market. In a similar approach with Chinzara (2011), Zakaria and Shamsuddin (2012), and Alotaibi and Mishra (2015),

the volatility of each variable in this study is constructed using the GARCH(1,1) procedure. We perform volatility modeling steps by tracking the procedure to obtain the values of returns volatilities in each Islamic equity market and the global market. The procedure is also used to obtain volatility values of the four macroeconomic variables. In addition, the volatility spillover in this study means returns volatility in an Islamic equity market that is spilled over from returns volatility of the global market. We measure the volatility spillover by applying the ADCC technique, resulting in the dynamic correlation of volatilities between an Islamic equity market and global equity market, and making it a dependent variable in panel data estimation.

Table 2. Standard deviation of inflation rate, interest rate, industrial production growth, and change in exchange rate

Emerging markets					Developed markets				
	Inflation rate	Interest rate	Production growth	Exchange rate		Inflation rate	Interest rate	Production growth	Exchange rate
CZ	0.44	1.51	8.82	3.58	AT	0.35	1.50	9.14	2.88
HN	0.49	3.56	9.12	4.34	BL	0.27	1.52	7.82	2.88
IN	0.79	1.18	5.55	2.31	CD	0.36	1.28	3.89	2.76
ID	0.76	2.27	4.88	2.76	DM	0.38	1.58	9.24	2.92
KR	0.36	1.16	6.53	3.20	FN	0.31	1.49	8.61	2.88
MY	0.44	0.31	4.89	2.02	FR	0.32	1.40	14.62	2.88
PH	0.34	2.09	6.71	1.61	GM	0.36	1.55	9.40	2.88
PL	0.33	1.37	6.69	4.13	IT	0.20	1.44	28.68	2.88
TR	0.94	10.54	9.42	4.86	JP	0.30	0.22	7.94	2.63
					NT	0.48	1.50	7.21	2.88
					SG	0.52	0.90	10.90	1.60
					SP	0.60	1.50	15.20	2.88
					SW	0.41	1.54	13.23	3.39
					UK	0.29	1.38	6.10	2.59

Source: data processed from international financial statistics – International Monetary Fund.

Table 3 presents the coefficients of each of the four macroeconomic variables and the significance on volatility spillover (*VSO*) given by the pooled least squares model, the fixed effects model, and the random effects models. The four independent variables are exchange rate volatility (*VFX*), inflation rate volatility (*VINF*), interest rate volatility (*VINT*), and industrial production growth volatility (*VIPG*). Based on the three kinds of panel data estimation models, it could be decided which is the appropriate model to use to explain and discuss the coefficients of the variables. To make the results easier to interpret, Table 3 presents the estimation results analyzing not only all equity market samples but also each type of market, i.e., emerging and developed markets.

The Pooled LS model with 4623 observations for all twenty-three equity markets and 201 monthly periods was employed, and the results suggest that the volatility spillover of market returns is significantly affected by all volatilities of the exchange rate,

inflation rate, interest rate, and industrial production growth. Only interest rate volatility negatively affects volatility spillover, which is the opposite of the other three independent variables. Compared to fixed EM, the result is different in the significance of production growth volatility, which has no effect on volatility spillover, and in the value of adjusted R-squares (20 percent), which is greater than the value of adjusted R-squares obtained by the pooled LS model (0.5 percent). To select which of the pooled LS and fixed EM models was appropriate, we applied the Chow test, which showed that the fixed EM estimation is more appropriate.

Table 3. Results from panel data estimation models on volatility spillover

Variable		*C*	*VFX*	*VINF*	*VINT*	*VIPG*	Adj. R^2	*N*
All markets	*PLS*	***46.08	***1.04	***4.19	*–12.12	*1.357	0.005	4623
	FEM	***36.19	***1.58	***37.71	**–16.05	0.029	0.200	4623
	REM	***38.24	***1.59	***30.36	*–12.90	0.072	0.020	4623
Emerging markets	*PLS*	***23.12	*0.96	***11.22	–4.31	***12.57	0.031	1809
	FEM	***8.98	*0.96	***34.11	*–10.04	***26.66	0.109	1809
	REM	**10.51	*0.96	***31.29	*–9.51	***25.37	0.052	1809
Developed markets	*PLS*	***48.54	***13.26	***3.81	***–865.37	–0.26	0.056	2814
	FEM	***34.39	***15.62	***47.63	**–716.45	0.13	0.175	2814
	REM	***41.39	***15.69	***21.58	***–739.74	0.13	0.072	2814

This table presents the coefficients that result from the panel data regression using three models – pooled least squares (*PLS*), the fixed effects model (*FEM*), and the random effects model (*REM*) – on determinants of volatility spillover (*VSO*). The explanatory variables tested are exchange rate volatility (*VFX*), inflation rate volatility (VINF), interest rate volatility (*VINT*), and industrial production growth volatility (*VIPG*). The asterisks denote that the corresponding coefficient is significant respectively at the 1% level (***), the 5% level (**), and the 10% level (*).
Source: data processed from msci.com, bloomberg.com, and IFS-IMF.

Comparing all coefficients of each independent variable between the fixed and random EM estimation, particularly the values, significance, and signs, the results appear to be similar. To obtain the appropriate estimation from the panel data estimator techniques between both models, we selected the model by applying the Hausman test. The test showed that panel estimation of fixed EM is more appropriate, and the specification is better. As a result, the fixed EM estimation shows that exchange rate and inflation rate volatilities have a positive effect on volatility spillover, which is indicated by probability-values at the 1% level on positive coefficients of the exchange rate (1.577) and inflation rate (37.712); interest rate volatility has a negative effect on volatility spillover (**–16.046); production growth volatility has no effect on volatility spillover (0.029). It is expressed in the model specification as follows:

$$VSO_{iG,t} = ***36.192 + ***1.577\ VFX_{i,t} + ***37.712\ VINF_{i,t} - **16.046\ VINT_{i,t} + 0.029\ VIPG_{i,t}.$$

For nine emerging markets, we follow similar steps as applied in all twenty-three market samples and use the Chow and Hausman tests on three types of model estimation. We decide that the pooled LS and random EM models are inappropriate. The same decision was reached from the two tests for fourteen developed markets, which suggest that the model specification of fixed EM is better as the basis to interpret the estimation results. Subsequently, the model specification for emerging markets and developed markets are expressed respectively as follow:

$$VSO_{iG,t} = ***8.982 + *0.964\ VFX_{i,t} + ***34.109\ VINF_{i,t} - *10.036\ VINT_{i,t} + ***26.660\ VIPG_{i,t},$$

$$VSO_{iG,t} = ***34.386 + ***15.618\ VFX_{i,t} + ***47.627\ VINF_{i,t} - **716.436\ VINT_{i,t} + 0.131\ VIPG_{i,t}.$$

Employing 1089 observations, the estimation for emerging markets suggests that volatility spillover is affected significantly by all four macroeconomic variables. Specifically, it is positively affected by the exchange rate, inflation rate, and production growth volatilities, and negatively by interest rate volatility. Meanwhile, the estimation for developed markets, which employed 2814 observations, suggests that production growth volatility has no effect on volatility spillover. The coefficients of determination (adjusted *R*-squares) for the two types of samples are 0.109 and 0.175, respectively. It means that all macroeconomic variables in the estimation contribute to explaining the variation of volatility spillover amounts of 10.9 percent and 17.5 percent for emerging and developed markets, respectively.

The coefficients of exchange rate volatility (*VFX*) and inflation rate volatility (*VINF*) have positive values in three estimation results for all Islamic equity markets and each emerging and developed market sample. These indicate that when instabilities in an economy's exchange and inflation rates are greater, the volatility spillover of its Islamic equity market from the global market would be greater. Leung et al. (2017) state that exchange rate volatility influences the equity market because international investors need foreign currencies to purchase securities in international markets. Adjasi (2009) states that higher volatility in the inflation rate increases stock price volatility. The inflation rate should not be too high or low so that the goods prices is not be very expensive or cheap. This stability consequently leads to the returns volatility of a company's equity becoming lower and prevents volatility spillover from the other equity markets.

Conversely, the coefficients of interest rate volatility (*VINT*) in three estimation results have a negative direction. It suggests that when the interest rate's instability is greater, the volatility spillover of its Islamic equity market from the global market would be weaker. This finding corroborates Abbas et al. (2018), who examine equity market indices, the treasury bill rate, and the exchange rate. They concluded that there is a high collective impact from macroeconomic factors on equity market vola-

tility. This finding is similar to Adjasi (2009), who suggests that interest rate volatility could increase equity price volatility. Logically, this investment mechanism would occur in the link between interest rate volatility and the volatility spillover of the Islamic equity market.

The positive direction appears in the coefficients of production growth volatility (*VIPG*) for emerging markets, but its effect is insignificant for all emerging market and developed market samples. This evidence indicates that the greater the instability in an economy's production growth, the greater the volatility spillover of its Islamic emerging market. A similar finding was documented by Abbas et al. (2018), who concluded that industrial production growth volatility could influence the directions of equity markets, hence equity market volatility. The evidence for developed markets is in line with the result from Liljeblom and Stenius (1997), who found that industrial production has a weak link with equity market volatility. This is asserted by Morelli (2002), who stated that volatility in industrial production does not affect market volatility.

The findings of this study have important information for investors and national policymakers. Tracing the causality of macroeconomic stability on equity market volatility is important to ensure which factors determine the volatility in equity markets, making them easier to analyze and predict, and to the investment plans, make decisions, and exercise control. The sizable volatility spillover originating from the global market to a national equity market could be mitigated by controlling the macroeconomic factors. Policymakers should strengthen their equity markets by building a line of counterattacks from the global market and managing their decision on the stability of economic factors.

Our contribution solves the issues covering the instability of national macroeconomic factors proposed as determinant variables of spillover volatility from the global market index movement to the Islamic equity market. The results of this study could fill the gaps in the empirical research by supplying various figures of volatility spillover among the global market and Islamic equity markets. It provides conclusions about factors that influence volatility spillover and complements the body of knowledge in financial economics, especially Islamic financial assets, which are growing, and by using sophisticated research models.

Conclusion

Controversial findings on the presence of volatility spillover are present in existing studies, but the determinants have not been explored. Most prior studies on the volatility spillover issue emphasize how volatilities in an economy's macroeconomic factors influence market returns volatility. This study differs in the exogenous variable, which involves global market volatility and creates volatility spillover in an equity market that is focused on Islamic equity. In addition, it attempts to explain the poten-

tial effect of instabilities in four macroeconomic variables on the volatility spillover of Islamic equity markets.

Panel data estimation, in particular, the fixed effects model, was applied to test for causality for all twenty-three Islamic markets. The result empirically suggests that the instabilities of exchange and inflation rates positively affect volatility spillover. It means the higher the two instabilities of exchange and inflation, the higher the volatility in the Islamic market. Inversely, interest rate instability has a negative effect, while production growth instability has no effect on volatility spillover.

To obtain clear information because of the heterogeneous characteristics, we divided the market samples into developed and emerging markets. The results for all markets are not very different from the findings for developed market samples such as Austria and Germany in the Central European Region. Furthermore, inferential tests for Islamic emerging markets show that all four macroeconomic variables significantly affect volatility spillover. Specifically, increased instabilities of the exchange rate, inflation rate, and production growth, as well as decreased instability of the interest rate, could increase the volatility spillover from the global to Islamic emerging markets such as the Czech Republic, Hungary, and Poland in the Central European Region.

When the global market experiences higher volatility, the policies decided by the government or economic regulator should be able to prevent the unwanted effect, make the equity market stable, and attract market participants. The significance of controllable instruments by policymakers for the macroeconomic factors investigated in this study could be considered to solve the volatility problem in the equity market. National economic factors are sources of significant information for policymakers in making decisions and in the equity market. Policy management accompanied by prudent decisions in the macroeconomic and fiscal fields would stabilize the fluctuations of financial asset prices and equity market activities.

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Czy niestabilność krajowych czynników makroekonomicznych przyczynia się do przenoszenia zmienności stóp zwrotu z globalnego na islamski rynek akcji?

Niniejsze badanie dotyczy wpływu niestabilności makroekonomicznej na przenoszenie zmienności stóp zwrotu z globalnego na islamski rynek akcji. Badane czynniki ekonomiczne to kurs walutowy, stopa inflacji, stopa procentowa i wzrost produkcji. Aby osiągnąć cel badania, wykorzystano trzy narzędzia analityczne: model GARCH (p, q) do wyliczania wartości zmienności dla wszystkich zmiennych, model ADCC w celu uzyskania miary wpływu zmienności jako zmiennej zależnej oraz technikę regresji danych panelowych do oceny znaczenia przyczynowości czynników makroekonomicznych w przenoszeniu zmienności. Niniejsze badanie jest pierwszym, które rozszerza takie podejście. Obserwowano miesięczne dane dotyczące światowych i islamskich indeksów rynkowych, kursów walutowych, wskaźników cen konsumpcyjnych, stóp procentowych i wskaźników produkcji przemysłowej. Dane z okresu od maja 2002 do lutego 2019 roku pochodzą z rynku światowego i dwudziestu trzech

gospodarek – czternastu rozwiniętych i dziewięciu wschodzących rynków posiadających islamskie indeksy giełdowe. W kilku sekcjach przedstawiono ważne dodatkowe analizy dla pięciu rynków akcji w gospodarkach Europy Środkowej, które są porównywane z innymi rynkami. Wyniki badania sugerują, że na występowanie efektu przenoszenia zmienności wywodzącej się z rynku globalnego na rynki islamskie wpływa wewnętrzna niestabilność czynników makroekonomicznych, z wyjątkiem niestabilności produkcji przemysłowej na rynkach rozwiniętych, w tym na rynkach Europy Środkowej. Z badania wynika, że regulatorzy powinni przewidywać niekorzystne konsekwencje przenoszenia zmienności i zapobiegać im poprzez zorganizowanie wewnętrznej polityki gospodarczej w celu kontrolowania stóp inflacji, stóp procentowych i wzrostu produkcji przemysłowej, a także elastyczności kursu walutowego. Ponadto praktycy rynkowi powinni uwzględnić w swoich prognozach zmienność rynków globalnych i niestabilność makroekonomiczną, tak aby minimalizować ryzyko.

Słowa kluczowe: przenoszenie zmienności, kapitał islamski, model GARCH, model ADCC, dane panelowe

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