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Abstract

The main objective of this article is to analyze the interdependencies in terms of volatility (transmission, contagion) between conventional stock markets and their Islamic counterparts currently considered as a new investment alternative, in calm periods and in times of financial fragility and crisis. We use updated data including the recent financial instability periods and a relevant methodology recently used in this context based on the Quantile Regression-based GARCH model. The article results lead to very interesting conclusions. First, it has been found that Islamic stock markets are not totally immune to the global financial crisis. Second, a very strong interdependence is sensed from the conventional stock markets to the Islamic ones, especially, from the conventional Developed markets to the Islamic Emerging and Arab markets and to Islamic Developed markets. Finally, it has been proved that the interdependencies from conventional to Islamic markets are propagated between Islamic markets. Our findings thus suggest that the Islamic finance industry does not seem to be able to provide a good cushion against the economic and financial shocks affecting conventional markets.

Key words: Quantile Regressions; financial fragility; Subprime crisis; Islamic stock markets; conventional stock markets.

JEL classification: F15; C58; G1.

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1. Introduction

Born in the 70s, Islamic finance is currently experiencing significant growth across the world and has become more and more as a competitor of the conventional financial system. It was able to arouse the interest of a broad range of investors and countries affected by the crisis, wishing to boost their economies by providing new funding streams. Indeed, after the oil shocks of the 70s, Islamic financial products were created to absorb the massive supply of capital coming from wealthy investors holders of petrodollars. Islamic finance refers to financial activities in accordance with the *Shariah*, as meaning that it prohibits investment in sectors considered as illicit (*haram*) in Islam, such alcohol, tobacco, rearms, gambling, nuclear power and military weapons activities. This compliance with the *Shariah* is one of the fundamental principles of the Islamic Financial System (IFS). The practice of Islamic finance requires the backing of all financial transactions in real assets and also obliges the contracting parties to share profits and losses (*mudhambah* and *musharakah*). Funding arrangements specifically based on this mechanism of *mudhambah* and *musharakah* are supposed to encourage economic development through the success of committed projects (Bala and Zaha, 2009).

Besides banking activities, Islamic finance has been extended to financial market activities including the management of funds and index management. The first Islamic index "Socially Aware Muslim Index" was launched on the market in 1998. Since then, the range of Islamic indices was extended, and the Islamic index investors propose today a wide range of *Sharia* indices.

The recent craze for Islamic finance is explained by the fact that some Islamic financial institutions have been practically immunized against the 2008 financial crisis (Boumediene and Caby, 2009). Therefore, several market participants have seen Islamic financial products as alternative investment vehicles to conventional products. Indeed, during the last two

decades this sector has experienced a colossal growth rate which was currently estimated between 10 and 15% (Brack, 2007; McKenzie, 2011).

In spite of the remarkable expansion of Islamic finance due to several factors, especially the petrodollars inflow and the excess liquidity in the Gulf countries, studies on Islamic finance have gained ground recently, in particular following the occurrence of the global financial crisis. Indeed, a major part of the financial literature has been interested in analyzing the performance of Islamic indices by asking the question of whether Islamic indices were more or less profitable than conventional indices (Hussein, 2004; Hakim and Rashidian, 2002). They mainly address the differences in risk and return characteristics between the Islamic investment and the conventional ones (Dewandaru et al. 2015; Abul Basher et al. 2014; Milly and Sultan, 2012; Hayat and Kraussl, 2011; Abdullah et al. 2007). Nevertheless, the literature remains limited on the risk transmission between these markets (in terms of volatility). Furthermore the results are much divergent and no consensus has been reached to date. It should be noted that researches allowing quantifying and examining volatility and risks of Islamic finance assets mainly including the transmission of volatility and contagion are very rare. In fact, there are only few studies that have tried to capture the Islamic equity markets dynamics. This research field is of major interest to the extent that it allows providing the investment decision support tools in new financial products that are little known. In fact, investment decisions are taken following the assessment of the market.

The intention of this study is to present a clearer and more homogeneous picture of the dependence structure for these global indices, using updated data including the recent financial instability periods in the world and a relevant methodology recently used in this context based on the Quantile Regression (QR) based GARCH model.

The main objective is to analyze the interdependencies in terms of volatility, firstly between conventional stock markets and their Islamic counterparts and secondly between Islamic stock

markets, in calm periods and in times of financial fragility and crisis. Furthermore, we try to verify the existence or not of the transmission and the contagion[1] phenomena from conventional markets which are most often characterized by broad co-movements, especially in periods of high financial fragility, to the Islamic markets currently considered as a new investment alternative. This analysis may constitute a help support to make investment decision by international investors.

To achieve our objective, we adopted a methodology based on relevant empirical techniques. Indeed, the volatility of various stock markets has been measured using a standard GARCH specification which has always proved a very high pertinence in measuring the volatility, especially for high frequency data (Ramlall, 2010; Nikkinen et al. 2008; Charles and Darne, 2006; Bollerslev et al. 1994). The interdependence analysis was performed by applying the QR technique which presents one of the most relevant econometric tools in the treatment of data characterized by the non-linearity aspect and in our knowledge rarely used in this context of interdependence analysis. One of the strengths of this work, compared to previous studies, is the examination of interdependencies in times of financial fragility and in time of the last global financial crisis (subprime crisis). Indeed, to determine high financial fragility periods we adopted the Bai and Perron (1998, 2003) technique which consists in determining the different dates of structural breaks. This technique is very relevant in the processing of data related to stock markets that are generally characterized by the presence of multiple regimes in the variance (Bensafta and Semedo, 2011; Nguyen, 2008).

Since the risk management is a function of the structure dependence between the Islamic and conventional stock markets. Resulting evidence of this work has several implications for market regulators and international investors who wish to invest in Islamic and/or conventional stock markets.

[1] Contagion, as defined by the World Bank, is the transmission of shocks in times of financial crises.

The remainder of this article is organized as follows. Section 2 presents a brief literature review. Section 3 outlines the empirical methodology. Section 4 describes the data and their statistical properties. Section 5 reports the empirical results. Section 6 concludes the article.

2. Literature review

Conventional financial markets have shown in recent decades a strong vulnerability to financial crises that have spread across markets and provoked economic depressions. Therefore, the financial architecture marked the emergence of the Islamic finance industry, which is mainly based on the *Sharia* principles, as a new investment alternative that can endure financial crises in a more efficient manner than conventional counterparts and provide a solution for international investors seeking to protect their investments against the crises vagaries.

Recently, the Islamic finance literature has seen strong growth. It focuses on the characteristics of Islamic finance, the relative performance of the new financial system compared to other conventional and socially responsible investments and interdependencies between Islamic stock markets and their conventional counterparts.

The literature on equity indices in Islamic finance is not as abundant as that which deals with socially responsible indices. Nevertheless, it shows a lack of unanimity on the outperformance or underperformance of this category of indices, for two reasons. First, in accordance with modern financial theory, Islamic equity indices can be assumed riskier than their conventional counterparts due to the lack of diversification (Albaity and Ahmad, 2008). Furthermore, these indices could be more profitable than their conventional counterparts due to the fact that the included companies have passed the financial and extra-financial filter criteria (Hussein and Omran, 2005; Atta 2000).

Regarding the analysis of interdependencies, most of the Islamic literature deals with Islamic banks and equity returns. Indeed, Hakim and Rashidian (2002) use the causality and cointegration tests to examine the linkages between the Islamic equity index and each of the U.S. Wilshire 5000 index and the U.S. three-month Treasury bill. The empirical evidence show that the Islamic index is not correlated with and not caused by either the U.S. Wilshire 5000 index or the U.S. three-month Treasury bill. Dania and Malhotra (2013) using a VAR methodology, they examine the nature of volatility spillover among four major Islamic indices and their corresponding "conventional" indices of North America, European Union, Far East, and Pacific nation markets. The results show evidence of a positive and significant spillover from conventional market on their corresponding Islamic markets. More recently, Al-Khazali et al. (2014) use stochastic dominance analysis in order to examine whether Islamic stock markets outperform their conventional counterparts by comparing nine Dow Jones Islamic indices to their Dow Jones conventional counterparts. First, they find that all conventional indices stochastically dominate Islamic indices except the European market. However, the European, U.S., and global Islamic stock indices dominate conventional ones during the 2007–2012 period. Second, they conclude that Islamic indexes outperform their conventional peers during the recent global financial crisis.

In their recent research, Ajmi et al. (2014) use the heteroscedasticity-robust linear Granger causality and nonlinear Granger causality tests to analyze the links between the Islamic and global conventional stock markets, and between the Islamic stock market and several global economic and financial shocks. The empirical results lead to the rejection of the hypothesis of decoupling of the Islamic market from their conventional counterparts. Indeed, they show evidence of significant linear and nonlinear causality between the Islamic and conventional stock markets. They also show potent causality between the Islamic stock market and financial and risk factors. Majdoub and Mansour (2014) using a multivariate GARCH models,

attempt to analyze the conditional correlations across the US market and a sample of five Islamic emerging markets. The estimation results show first, that the US and Islamic emerging equity markets are weakly correlated over time and second, that no sheer evidence supports that the US market spills over into the Islamic emerging equity markets. Ho et al. (2014) conduct an empirical study of the comparative performance of Islamic and conventional indices during various crisis and non crisis periods. The authors explore whether there is a difference in the mean return between Islamic and conventional indices and whether the difference is statistically significant. They use a matched-pair comparison of 12 global conventional and Islamic indices and measure the risk-adjusted performance using the Sharpe ratio, Treynor index, and Jensen's alpha derived from the capital asset pricing model. The study concludes that Islamic indices perform better than conventional ones during crisis periods because of their lower volatility and betas.

Hammoudeh et al. (2014) using a copula approach shows that the global Islamic equity market index (Dow Jones Islamic Market Index) exhibits significant dependence with three major global conventional equity indices (Asia, Europe, and United States). Moreover, this dependence varies over time for all cases except the S&P 500 index and is also asymmetric between bear and bull markets in some cases. They conclude that the Sharia-compliance rules are not restrictive enough to make the global Islamic equity market index very different from the conventional indices.

In addition to exploring the causal linkages between the Islamic and conventional equity markets, various attentions are paid to examining volatility structure. Some argue that Islamic equity markets are not supposed to transmit volatility (in calm and financial crisis periods) to and from conventional equity markets because they are fundamentally different (Dewi and Ferdian, 2010; Dridi and Hassan, 2010; Chapra, 2008).

Yusef and Majid (2007) examine the extent to which volatility in the Islamic and conventional stock markets in Malaysia is sensitive to the volatility in the U.S. interest rates. They find that the U.S. interest rate volatility affects the conventional stock market volatility but not the Islamic stock market volatility, implying that the stabilizing interest rate would have insignificant impact on the volatility of the Islamic stock markets. Akhtar et al. (2013) argue that characteristics of Islamic financial markets reduce volatility linkages between Islamic and conventional stocks, bonds and bills. Indeed, they find that volatility linkages that involve at least one Islamic asset are lower than volatility linkages between two conventional assets after controlling for country and asset-specific characteristics. These authors also indicate that this result is stronger during financial crises and is not driven by the oil sector.

More recently, Chau et al. (2013) examine the impact of this political uncertainty on stock market volatility in MENA countries, using a variety of GARCH models. They provide evidence that political turmoil has increased stock market volatility, mainly through the Islamic indices. Kassab (2013) using the GARCH model, explores the persistence of volatility of the Islamic and conventional markets. Results show that the volatility persistence of both markets is highly significant, with the DJIM index being less volatile than the conventional index in the long run and presenting less risk at crisis periods.

From the previous literature review, we can note that despite the multiplicity of previous empirical work focuses on the analysis of interdependencies between Islamic and conventional stock markets, the literature is limited on the risk transmission between these markets (in terms of volatility). Furthermore, the results are much divergent and no consensus has been reached to date. In the same context, this paper attempts to fill the gap in the literature regarding the volatility transmissions between Islamic and conventional stock markets as well as focusing on these linkages in the financial instability periods (simple

transmission) and in the financial subprime crisis period (contagion) using the Quantile regression methodology which used newly in this context.

3. Econometric methodology

In examining financial literature, we can identify that the majority of previous studies which analyze the interdependencies between several variables are mainly based on econometric techniques founded mostly on the correlation coefficients. As known, these techniques only considers symmetric linear links between variables and cannot provide distinction between dependence during up and down markets or between large and small stock price movements. In fact, we were more motivated to think about using a more relevant technique in order to capture the multifaceted dependence between financial time series, namely the Quantile regression (QR) developed by Koenker and Bassett (1978).

QR is an extension of the traditional least squares estimation of the conditional mean to a compilation of models for different conditional quantile functions. Compared to standard linear regression techniques which summarize the average relationship between a set of regressors and the outcome variable based on the conditional mean function which provides only a partial view of the relationship, as we might be interested in describing the relationship at different points in the conditional distribution, the QR provides that potentiality. More precisely, it provides a more detailed picture than classic linear regression, as it focuses on the entire conditional distribution of the dependent variable, not only on its mean (Koenker, 2005). Indeed, as the median regression estimator minimizes the symmetrically weighted sum of absolute errors to estimate the conditional median (quantile) function, other conditional quantile functions are estimated by minimizing an asymmetrically weighted sum of absolute errors, where the weights are functions of the quantile of interest. Moreover, QR technique gives information on the average dependence as well as the upper and lower tail dependence. Thus, quantile regression is robust to the presence of outliers.

Through financial literature, QR showed its relevance to some kind of economic and financial data such as truncated and censored dependent variable outcomes with fat-tailed distributions, nonlinear models (Haultfoeuille and Givord, 2014). That why, several studies in past decades have adopted this technique to analyze several areas of applied econometrics and finance. In economic term, applications include investigations of wage structure (Buchinsky and Leslie, 2010), earnings mobility (Eide and Showalter, 1999; Buchinsky and Hunt, 1999), educational attainment (Eide and Showalter, 1998). This technique is also used in the financial sector, especially for solving the problems related to the Value at Risk and option pricing (Engle and Manganelli, 2004; Morillo, 2000), and to model the dependence of financial variables and to study the structure and level of dependence (Chuang et al. 2009; Lee and Li, 2012; Baur, 2013).

The QR fonction is given as following:

$$Q_y(\tau \mid x) = inf\left\{b \mid F_y(b \mid x) \geq \tau\right\} = \sum\nolimits_k \omega_k(\tau) x_k = x'\omega(\tau) \qquad \text{(Eq. 1)}$$

Where y is a dependent variable that is assumed to be linearly dependent on x vector and $F_y(b \mid x)$ is the conditional distribution function of y given x. The x vector is composed by all conditional volatility series generated by fitting the AR(1)-GARCH(1,1) model.

It should be noted that the choice of the standard GARCH specification is far from being arbitrary. Indeed, many authors argue, first, that the standard GARCH specification is the most appropriate to predict volatility given the existence of ARCH effect in the series of returns, especially when it comes to high frequency data (Ramlall, 2010; Nikkinen et al. 2008; Charles and Darne, 2006; Bollerslev et al., 1992). Second, the choice of the GARCH model is made after a comparison with a non-linear EGARCH specification. The criteria used to determine the performance include the information criteria of Akaike and Schwarz and the

log-likelihood value comparaison. Result show a strong relevance of a standard GARCH compared to the EGARCH specification[2].

It is important to note that the inclusion of the autoregressive term in the mean equation is used to test the weak-form efficiency hypothesis. Indeed, according Fontaine and Nguyen (2006), setting efficiency as null hypothesis, all of the information revealed by the periods t-2, t-3, ..., 1 is assumed to be fully incorporated into the returns observed in t -1. Therefore, the inclusion of delayed returns from a period in the equation generating stock returns seems sufficient to test the weak-form efficiency.

In QR equation (Eq. 1), $\omega(\tau), \tau \in [0,1]$ represent the QR coefficient, that can determines the dependence relationship between vector *x* and the τ^{th} conditional quantile of *y*. Dependence is unconditional if no exogenous variables are included in *x*. The values of $\omega(\tau)$ determine the complete dependence structure of *y*. The dependence of *y* based on a specific explanatory variable in vector *x* could be: (*i*) constant where the values $\omega(\tau)$ do not change for different values of τ ; (*ii*) monotonically increasing (decreasing) where $\omega(\tau)$ increases (decreases) with the value of τ ; and (*iii*) symmetric (asymmetric) where the value of τ is similar (dissimilar) for low and high quantiles.

The coefficients $\omega(\tau)$ for a given τ are estimated by minimizing the weighted sum of absolute errors as following:

$$\hat{\omega}(\tau) = \arg\min \sum_{t=1}^{T} \left(\tau - 1_{\{y_t < x_t' \omega(\tau)\}} \right) \left| y_t - x_t' \omega(\tau) \right| \qquad \text{(Eq. 2)}$$

The solution to this problem is obtained using the programming algorithm suggested by Kroenker and D'orey (1987). We use also the pair boostrapping procedure introduced by Buchinsky (1995) in order to obtain the standard errors for the estimated coefficients because

[2] For the sake of concision, the test results are not reported here, but they are available under request addressed to the corresponding author.

it provides asymptotically valid standard errors under misspecifications of the QR function and heteroscedasticity.

In order to analyze interdependencies in periods of financial instability, we proceed to determine the structural break dates in the conditional volatility series by applying the Bai and Perron (1998, 2003) econometric technique before introducing them subsequently in the general equation of QR.

In Monte Carlo experiments, Bai and Perron (2006) find that the method of Bai and Perron (1998) is powerful enough to detect structural breaks. We consider the following regression model with *m* breaks and *m +1* regimes.

$$V_{i,t} = \lambda_0 + \lambda V_{i,t-1} + \varepsilon_{i,t} \qquad \text{(Eq. 3)}$$

$V_{i,t}$ is the estimated volatility in period *t*. If there are *m* multiple structural breaks (T_1 , …, T_m) in the time path of $V_{i,t}$. Bai and Perron (1998, 2003) explicitly treat structural break points as unknown, and estimates of the break points are generated using the ordinary least squares method (OLS). Indeed, Eq. (3) is estimated by OLS regression for each T_m. The breakpoints estimations are generated by minimizing the sum of squared residuals.

As we try to introduce the variables of financial instability and financial crisis in order to investigate the different effects that the conditioning variables have on the quantile function in the quiet and crises periods and to distinguish between simple transmission and contagion. Thus, our empirical model is specified as follows :

$$Q_y(\tau \mid X) = \alpha(\tau) + \sum_k \lambda_k(\tau) X_k + D_1\left[\eta(\tau) + \sum_k \theta_k(\tau) X_k\right] + D_2\left[\gamma(\tau) + \sum_k \beta_k(\tau) X_k\right] \qquad \text{(Eq. 4)}$$

Where D_1 and D_2 are the financial subprime crisis and the financial instability dummy variables. They take the value “one” if the dependent variable experiences, respectively, a financial crisis, a financial instability in period *t* and “zero” otherwise. For each quantile τ , the additional marginal effects of the different conditional variables is given by $\eta(\tau)$ and

$\theta_k(\tau)$ parameters in the financial crisis period, by $\gamma(\tau)$ and $\beta_k(\tau)$ parameters in times of financial fragility. While the effects in the calm periods is given by the parameters $\lambda(\tau)$ and $\alpha_k(\tau)$. So, the QR model in equation (Eq. 4) allows one to examine the nature of dependence structure eventually existing between the volatility stock markets; second, how the dependence structure is affected by different regressors; and finally, how the financial crisis and the financial instability have affected the dependence structure and the co-movement between the volatility stock markets.

4. Data and descriptive analysis

Our analysis sample specifically includes Global Islamic Indices namely: the DJIM Index, as well as its conventional counterparts, the DJ Emerging Markets Index, the DJ Arab Markets Index, the DJ Arab Markets excluding Saudi Arabia Index, the DJ Gulf Cooperation Council (GCC) Index, the DJ Canada Index, le DJ United Kingdom (UK) Index, the DJ United State (US) Index, the DJ Europe, the DJ Asia/Pacific Index, the DJ World Developed Index. The choice of DJIM is justified by the fact that it is the most used and most comprehensive representative of Islamic stocks. It has the most adequate time series for the Sharia-based stocks.

We use daily frequency data expressed in U.S. dollars, covering the period from January 1, 2001 to January 18, 2016 and extracted from the DATASTREAM database wherein market returns are computed based on the log differences of the daily market price index. Our sample period covers major international events such as the Brother Lehman collapse (September 15, 2008) and the extreme market movements around the 2008-2009 global financial crisis and the 2009-2012 Eurozone crisis.

It should be noted that in order to analyze the interdependencies in terms of volatility between stock markets in question, we use the volatility series generated from the AR(1)-GARCH(1,1).

Table 1 presents the descriptive statistics of daily returns. Regarding this table we can make the following remarks: First, according to the Jarque-Bera test, market returns are significantly departed from normality. Second, the Dickey-Fuller unit root test clearly shows that the distributions of market returns are stationary at the 1% confidence level, since the ADF calculated value is strictly below the critical threshold. Finally, the Engle's (1982) test for conditional heteroskedasticity rejects the null hypothesis of no ARCH effect in monthly returns. This justifies the use of the GARCH specification.

5. Empirical results and discussions

5.1. Empirical results

In this study, we use the standard GARCH model to measure the conditional volatility for all conventional and Islamic stock markets.

Tables 2 and 3 present the empirical results of the standard GARCH parameter estimation and make a detailed descriptive analysis of volatility series. We note that the parameters of the conditional variance equation for all markets are positive, statistically significant at 1% confidence level and satisfy the conditions of theoretical stability $(\omega > 0, \alpha \geq 0 \text{ and } \beta \geq 0)$. Moreover, conditional volatility persistence is verified, because the risk premium $(\alpha + \beta)$ is superior to 0.9. The standardized residuals diagnostic (Table 2 and 3, part III) suggests that the AR(1)-GARCH(1, 1) specification seems to be adequate to explain the stock market returns variations, since the residuals and squared residuals are not serially correlated. In addition, we note the absence of ARCH effect among residual series.

In order to compare the extent of stock markets conditional volatility, we present, in Tables 2 and 3 (part II) a summary of some descriptive statistics. We can remark, first, that Islamic

stock markets are more volatile than their conventional counterparts and second, conventional wisdom of "high risk, high returns" is also applicable to Islamic stock markets, where markets with higher returns are the most volatile.

It is interesting to note that for most conventional and Islamic stock markets, past returns have a predictive power on future returns since the coefficient associated to the autoregressive term is statistically significant.

With reference to our primary objective which consists in analyzing the interdependencies among the conventional and Islamic financial markets in calm periods and in times of financial instability, we use the Bai and Perron (1998, 2003) structural breaks test. We determined the break point dates for all the volatility series generated from a standard GARCH specification. These dates are considered as financial fragility and crisis periods.

A simple observation of the Table 4 results shows very strong interdependencies between stock markets, both conventional and Islamic, because of the existence of a strong similarity between the structural break dates. These interdependencies are considered as simple volatility transmission in times of financial fragility or as contagion in times of financial crises. Indeed, the results show that several break point dates coincide with the last supbrime crisis period. Thereby interdependencies are considered in this case as contagion.

It should be mentioned that these results are only preliminary. In fact, we tried in what follows to analyze interdependencies between the stock markets by the implementation of a more relevant and sophisticated econometric technique in this context (QR model).

It is important to mention that by reference to the financial literature related to application of the quantile regression technique, we implemented seven quantile, from the lower $(\tau = 0.05)$ to the higher one $(\tau = 0.95)$. However, we just reported in Tables 5 and 6 the results of three major quantiles $(\tau = 0.05, 0.5 \text{ and } 0.95)$ which relate, most frequently, the maximum of information. Indeed, these three quantiles allows us considering extreme situations inherent to

financial markets, respectively bearish movements, mean movements and bullish movements. We report further the standard errors which are obtained using the pairs bootstrapping procedure (Buchinsky, 1995).

The decision rule concerning the possible existence of interdependencies between markets is based on the significance of the estimated coefficients for all the three quantiles and by reference to the analysis of the changes in the quantile regression coefficients obtained by applying the F-test for the equality of coefficients at low and high quantiles. This allows us to judge the nature of co-movement (symmetric or asymmetric).

The main objective of this paper is firstly to analyze the interdependencies between Islamic stock markets and their conventional counterparts which are generally characterized by large co-movements especially in times of financial instability; this has led to unavoidable financial phenomena, namely, transmission of volatility and contagion. Secondly, it is essential to check whether the effect of conventional markets on Islamic markets is effectively transmissible between Islamic markets. In other term, we try to examine the transmission/contagion linkages between Islamic markets, in order to verify the degree of risk associated with these markets that are currently considered as good investment sites compared to conventional markets.

It should remember that in order to analyze interdependencies between Islamic stock markets and also between them and their conventional counterparts, we took into account a very important factor that characterizes all stock markets in the world, namely, financial instability. The empirical implementation of this instability is materialized in part by the consideration of the detected structural breaks in conditional volatility series. The empirical significance of such variable can lead us to conclude for the existence of a simple volatility transmission or contagion (the transmission in times of financial crisis), since the structural break points do not necessarily coincide with the financial crisis period and may be just related to financial

instability phases. Moreover, and in order to identify the impact of the subprime crisis on the nature of interdependencies, we integrate the crisis variable. The statistical significance of this variable is immediately significant of the existence of contagion between stock markets.

When reading the Tables 5 and 6, which reports the estimation results of the quantile regression model, we can deduce that the model is able to describe and assess, in an appropriate manner, the interdependence of volatility series. Indeed, the explanatory power of the exogenous variables associated with each quantile ($\tau = 0.05, 0.5$ et 0.95) is generally high.

In the light of the results reported in Table 5 (Part I and II)[3] we can notice a very strong interdependence between conventional and Islamic markets. Indeed, in calm period the transmission is effective at a rate of 61% (α coefficient is significant for 49 linkages among 80). The transmission in times of financial fragility is at 25% (β coefficient is significant for 20 linkages among 80), whose almost 9% of this transmission is qualified as contagion, since the financial fragility periods generally coincides with the last financial crisis dates. In total the contagion phenomenon is verified for 19 linkages with a rate of almost 24%.

These results indicate first, a strong connection, in financial terms, between conventional and Islamic markets and secondly, the importance of the subprime crisis in the deteriorating financial and economic situation.

A more detailed reading of results is evident through the analysis of interdependencies according to four main axes, namely, i) Conventional Arab and Emerging markets vs. Islamic Arab and Emerging markets, ii) Conventional Arab and Emerging markets vs. Islamic Developed markets, iii) Conventional Developed markets vs. Islamic Arab and Emerging markets, iv) Conventional Developed markets vs. Islamic Developed markets.

[3] Table 7 summarizes the results provided in Tables 5 (Part I and II) and 6.

The results relatively show a strong interdependence from conventional Emerging and Arab markets to their Islamic counterpart, i.e. a rate of 62% (α coefficient is significant for 5 linkages among 8). However, this interdependence is qualified as simple transmission given the absence of interdependencies linkages in times of financial fragility and crisis (β and θ coefficients are not significant). So we can relatively conclude that Emerging and Arab markets, both conventional and Islamic, remained slightly away from financial instability and the effects of the subprime crisis.

In against part, we can remark a stronger interdependence between conventional Developed markets and their Islamic counterpart. Indeed, we register a rate of almost 75% in calm periods (α coefficient is significant for 29 linkages among 36). The transmission in times of financial fragility is around 28% (β coefficient is significant for 10 linkages among 36), whose almost 11% is qualified as contagion (the immediate significance of β and θ coefficients for 4 linkages among the 10 recorded linkages in times of financial fragility). In total, the transmission in times of financial crisis is around a rate of 39%.

These results show a very strong interdependence between conventional and Islamic Developed markets in calm periods as well as in periods of financial fragility and crisis. This can be explained by the fact that these developed countries are generally the most affected by financial instability situations and especially by the subprime crisis across the world.

An average interdependence level is usually recorded from conventional Emerging and Arab markets to Islamic Developed markets, with a rate of 46% in calm periods. Low rates are found for the interdependence in times of financial instability and crisis, respectively, of 17% and 8%. These results are obviously explained by the low power of Emerging and Arab markets on Developed ones in terms of shared transactions.

In against part, we notice a strong interdependence from conventional Developed markets to the Islamic Emerging and Arab markets. Indeed, the transmission is effective at a rate of 58%

in periods of financial fragility, whose almost 16% is qualified as contagion. This shows the high potential of developed markets on conventional and Islamic Emerging and Arab markets. The effect of the conventional developed stock market's volatility on the volatility of their counterparts Islamic as presented in Table 5 (in bold and italic character) is generally significant for all quantiles of these markets. The co-movement between them intensifies from the lower to the upper quantiles, indicating that the dependence increases during the bullish market and vice versa. Indeed, the trend in correlations among the stock markets is not uniform across time when different quantiles are considered. Applying the Fisher test for the equality of coefficients at low and high quantiles, the null of equality is rejected, thus confirming that the estimates for the lower and upper quantiles are statistically different. Therefore, the conventional developed stock market's and the Islamic developed stock markets display an asymmetric co-movement as the intensity of dependence increases when these markets are booming but dependence loses intensity when the markets are bearish. However, since the onset of the financial crisis, we led to the same results as the calm periods. Indeed, the intensity of dependence increases when these markets are booming and reversely when the markets are bearish.

Looking to the Arab and Emerging Islamic stock markets we can make the same conclusions as for the Islamic Developed stock markets. The corresponding F-test for the equality of coefficients across quantiles is unable to reject the null hypothesis. As a result, the dependence structure has intensified across quantiles and the conventional Developed stock market's volatility movement has a similar impact on the quantiles of the Arab and Emerging Islamic markets volatility. In addition, the co-movement increases during the financial fragility and crisis periods.

At present, we can conclude to the existence of very strong interdependencies from conventional markets to Islamic markets. These interdependencies are generally recorded in

periods of financial instability and during the subprime crisis. It is also important to mention that the interdependencies are more important from conventional Developed markets to their Islamic counterparts and to the Islamic Emerging and Arab markets. At this stage, it is evident to examine whether the interdependence linkages, initially observed between conventional and Islamic markets, are transmitted or not between the Islamic markets.

The results reported in Table 6 show a strong interdependence in terms of volatility between 7 markets in the sample. With reference to our first judgment criterion (The absolute significance through quantile). Mainly, we can identify 31 significant linkages among the 42 linkages that exist between the Islamic markets, with a rate of 74%. This rate is significant either of a simple transmission of volatility, or more serious, the transmission in times of financial crisis (contagion).

In a deeper reading of the estimation results in order to distinguish between the linkages considered as a simple transmission and those considered as contagion; it is evident to interpret at first, the results associated with the coefficient which reflects interdependencies in periods of structural breaks and secondly, the results related to the coefficient which takes account of interdependencies just in times of crisis (subprime crisis).

By reference to the β coefficient, we can conclude that the transmission/contagion of volatility is effective between the Islamic stock markets. Indeed, we can identify 15 linkages among the 42 linkages that exist between Islamic markets, with an interdependence rate of almost 36%. From these 15 linkages, 5 are considered as contagion linkages (Islamic markets vs. Islamic Europe ; Islamic markets vs. Islamic UK ; Islamic Europe vs. Islamic Asia Pacific ; Islamic UK vs. Islamic Asia Pacific and Islamic Canada vs. Islamic world). Indeed, the significance of the β coefficient coincides with the significance of the θ coefficient, which proves that the structural break dates are mainly the crisis dates (this is verified from

the structural break dates reported in Table 4). The other linkages are significant of a simple transmission.

Regarding contagion, the results show a total of 19 interdependencies linkages among the 42 identified between Islamic markets in question, i.e., a rate of 45%, which means that the last subprime crisis was participated at 45% in the increase of interdependencies among Islamic stock markets. This important rate reflects no doubt the importance of this crisis in the disturbance of the entire global economy.

Finally, the estimation results related to the interdependence between Islamic stock market volatilities show strong dependence at calm periods and at financial crisis periods, and exhibit asymmetric co-movement, having lower tail independence and upper tail dependence structure.

5.2. Discussions

From the empirical analyzes results, several implications for regulators of stock markets, policy makers and international investors can be highlighted. It should be noted that evidence of the significant dependence between conventional and Islamic stock markets involves that Islamic equity investment cannot generally provide a stable and viable alternative for risk-averse investors who want to hedge their investments against the turbulence of global stock markets.

In particular, notwithstanding the Islamic financial system characteristics based on the prohibition of *Riba* practice and the selection of certain products (*Sharia*), Islamic Indices (Dow Jones Islamic Market Indices) do not operate as a barrier or a refuge during financial instability periods for stock market investors. Indeed, the empirical results show a very strong co-movement between conventional and Islamic stock indices. This is more evidently explained by the fact that Islamic and conventional stock markets are influenced by many

common economic and financial factors. Consequently, Islamic stock markets are also exposed to significant economic and financial shocks that affect the global financial system.

In brief, it is clear that instability, as an intrinsic feature of the current financial system, has not spared the Islamic financial institutions. These latter could not escape the effect of the second round of the financial crisis (subprime crisis). This crisis, initially banking, morphed into a systemic crisis through the contagion effect. The reforms concerning prudential supervision that have been implemented by the Basel Committee, have failed to end the system deficiencies. Indeed, said reforms have acted only on the regulation of banks and the mastery of individual risks.

It is paramount to implement new policies whose main purpose is to limit the devastating effects of crises and master systemic risk (macro-prudential policy). The implementation of such policies can undoubtedly strengthen the Islamic financial system, consolidate its achievements in terms of stability, and reduce the crisis contagion effect.

Aside from any corrective action, it is relatively correct to say that the Islamic finance industry does not seem to be able to provide a good cushion against the economic and financial shocks affecting conventional markets.

6. Conclusion

Motivated primarily by the interest increasingly accrued on Islamic stock markets following the global financial crisis and the lack of consensus on the nature of interdependence between Islamic and conventional financial markets in the literature, especially in extreme and time-varying market conditions. This study analyzes the interdependencies in terms of volatility, firstly, between conventional stock markets and their Islamic counterparts and secondly, between the Islamic stock markets in calm periods and in times of financial fragility and crisis.

The main objective is to check the existence or not of the transmission and contagion phenomena from conventional markets which are most often characterized by broad co-movements, especially, in periods of high financial fragility, to the Islamic markets currently considered a new investment alternative. The study focuses on seven Islamic stock markets and ten conventional stock markets selected in different regions.

For the implementation of this analysis, we used three relevant econometric techniques. In the first place we used the standard GARCH specification in order to determine the different volatility series. In the second place and to determine the financial fragility periods, we used the Bai and Perron (1998, 2003) break points test. Finally, we used the quantile regression technique which represents one of the most relevant estimates techniques in the context of interdependencies analysis, especially when it comes to high frequency financial data. Indeed, this model takes into account the non-linearity that characterizes most often high-frequency financial series through the implementation of several coefficients related to several quantile, which makes results more reliable and robust.

Empirical results based on descriptive analyzes of returns and volatility show that conventional stock markets are more volatile than their Islamic counterparts and that conventional wisdom of "high risk, high returns" is also applicable to Islamic stock markets where markets with higher returns are more volatile.

On the other hand, the results based on the break point test suggest, first of all, that volatility transmission is effective between Islamic stock markets and between them and their conventional counterpart. Indeed, some similarities between break point dates are recorded between these two markets types. Similarly, it should be noted that Islamic stock markets are not totally immune to the global financial crisis since the break point dates coincide with the last subprime crisis period.

The results of the quantile regression confirms the preliminary findings of the Bai and Perron (1998, 2003) test and show very strong interdependencies from the conventional stock markets to the Islamic ones, especially from the conventional developed markets to the Islamic emerging and Arabs markets and to Islamic Developed markets. These interdependencies are sometimes synonymous for a simple transmission in times of financial fragility and sometimes for contagion in times of financial crisis (subprime crisis). Indeed, the empirical results show that the two phenomena are effective among conventional and Islamic markets, but with a lower dependence from conventional Emerging and Arabs markets to the Islamic Developed markets in financial fragility and crisis periods.

The results of the interdependencies analysis among Islamic markets show strong transmission and contagion effects, which justifies that the interdependencies initially found among conventional and Islamic markets are propagated to Islamic markets.

Our findings are generally consistent with prior research. Indeed, Hammoudeh and Gupta (2015) provide evidence of risk transfers between conventional and Islamic stock markets, and that contagion is effective during global financial crisis. Saadaoui and Boujelbene (2015) show that there is a transmission mainly during the crisis period which means that the crisis affects all the financial assets whether Islamic or not. Ajmi et al. 2013 confirm the existence of a significant potent linear and nonlinear causality between the Islamic stock market and the conventional stock markets.

As demonstrated that Islamic stock markets are vulnerable to financial instability and global financial shocks, it is important that policy makers should take preventive measures in order to minimize the crisis effects and ensure the stability of Islamic markets during economic and financial uncertainty periods. Our empirical results point out that the general belief that the Islamic financial markets are immune from the negative impact of financial shocks because of its nature without interest is flawed. For which it is important that stakeholders, policy makers

and even academics and researchers *Sharia* must work together to equip the Islamic financial markets with appropriate techniques and tools in order to mitigate the impact of financial shocks on Islamic markets. The results of this study highlight the urgency of these initiatives. Indeed, prudent risk management and best financial practices are relevant and crucial for both Islamic and conventional financial markets.

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Table 1. Basic statistics of conventional and Islamic stock markets daily returns

	Mean (%)	Standard deviation (%)	Skewness	Kurtosis	Jarque-Bera	ADF Statistics	Q(6)	Q(12)	ARCH (12)
Conventional markets									
Emerging markets	0.008	1.209	-0.534	10.595	12820^{+++}	-56.651^{+++}	319.34^{+++}	332.61^{+++}	158.794^{+++}
Arab markets	-0.021	1.207	-1.580	20.443	36322^{+++}	-47.897^{+++}	51.547^{+++}	54.404^{+++}	38.395^{+++}
Arab markets excluding S.A	-0.018	1.008	-1.262	16.203	20885^{+++}	-31.911^{+++}	83.061^{+++}	99.500^{+++}	32.672^{+++}
GCC	-0.024	1.311	-1.485	21.117	38955^{+++}	-48.519^{+++}	40.549^{+++}	43.858^{+++}	38.870^{+++}
Canada	0.020	1.383	-0.747	12.525	20255^{+++}	-33.530^{+++}	71.313^{+++}	83.740^{+++}	154.446^{+++}
United Kingdom	0.006	1.311	-0.136	11.590	16094^{+++}	-35.529^{+++}	67.687^{+++}	85.929^{+++}	157.583^{+++}
United State	0.022	1.213	-0.249	11.006	14021^{+++}	-76.951^{+++}	32.771^{+++}	47.203^{+++}	147.883^{+++}
Europe	0.012	1.314	-0.136	9.910	10421^{+++}	-34.765^{+++}	54.113^{+++}	70.275^{+++}	134.929^{+++}
Asia Pacific	-0.002	1.237	-0.083	7.962	5372^{+++}	-70.367^{+++}	15.980^{++}	21.013^{+}	85.732^{+++}
World	0.014	0.994	-0.365	10.555	12553^{+++}	-50.655^{+++}	118.070^{+++}	121.940^{+++}	147.883^{+++}
Islamic markets									
Islamic Emerging markets	0.010	1.316	-0.342	8.868	7605^{+++}	-60.005^{+++}	197.490^{+++}	207.370^{+++}	105.478^{+++}
Islamic markets (G)	0.021	1.028	-0.352	9.865	10379^{+++}	-50.670^{+++}	119.790^{+++}	123.300^{+++}	183.306^{+++}
Islamic Canada	0.013	1.741	-0.808	13.335	23846^{+++}	-33.417^{+++}	64.351^{+++}	73.346^{+++}	102.446^{+++}
Islamic UK	0.011	1.364	-0.104	9.419	8989^{+++}	-46.471^{+++}	59.375^{+++}	75.774^{+++}	155.675^{+++}
Islamic US	0.026	1.252	-0.133	9.608	9531^{+++}	-54.751^{+++}	28.799^{+++}	39.086^{+++}	131.507^{+++}
Islamic Europe	0.018	1.320	-0.055	9.623	9560^{+++}	-34.958^{+++}	54.697^{+++}	71.307^{+++}	143.841^{+++}
Islamic Asia pacific	0.010	1.427	-0.245	8.124	5774^{+++}	-68.315^{+++}	28.649^{+++}	35.214^{+++}	104.626^{+++}
Islamic World	0.021	1.028	-0.352	9.865	10379^{+++}	-50.670^{+++}	119.790^{+++}	123.300^{+++}	183.306^{+++}

Notes: The table presents basic statistics of monthly returns. Q (6) and Q (12) are statistics of the Ljung-Box autocorrelation test applied on returns with lags between 6 and 12. ARCH (12) is the statistics of the conditional heteroskedasticity test proposed by Engle (1982) using the residuals of the AR (1) model. ADF is the statistics of the ADF unit root test proposed by Dickey and Fuller (1981). The ADF test is conducted without time trend or constant. $^{+}$, $^{++}$ and $^{+++}$ denote that the null hypothesis of tests (no-autocorrelation, normality, no-stationarity and homogeneity) are rejected at respectively 10%, 5% and 1% levels. The study period is from January 1, 2001 to January 18, 2016.

Table 2. Parameters estimation of AR(1)-GARCH(1,1) and diagnostic tests for conditional volatility - Conventional stock markets

	Emerging markets	Arab markets	Arab markets excluding S.A	GCC	Canada	United Kingdom	United State	Europe	Asia Pacific	World
Panel I: Estimated parameters										
ω	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)**	0.000 (0.000)***	0.000 (0.000)***	0.001 (0.000)***	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)*	0.000 (0.000)***
ϕ	0.251 (0.014)***	0.057 (0.057)***	0.097 (0.023)***	0.046 (0.019)**	0.084 (0.014)***	-0.007 (0.014)	-0.027 (0.016)*	0.011 (0.015)	0.033 (0.015)**	0.157 (0.015)***
α	0.106 (0.005)***	0.077 (0.003)***	0.082 (0.004)***	0.080 (0.003)***	0.069 (0.004)***	0.080 (0.005)***	0.087 (0.005)***	0.084 (0.005)***	0.085 (0.005)***	0.081 (0.006)***
β	0.887 (0.005)***	0.913 (0.003)***	0.909 (0.003)***	0.918 (0.003)***	0.928 (0.004)***	0.909 (0.006)***	0.900 (0.006)***	0.909 (0.005)***	0.905 (0.006)***	0.910 (0.005)***
$(\alpha+\beta)$	0.993	0.990	0.991	0.998	0.997	0.989	0.987	0.993	0.990	0.991
Log-likelihood	16792.310	8990.254	9382.803	8808.037	16056.110	16247.800	16666.720	16261.560	16183.780	17771.600
Panel II: Basic statistics of conditional volatility										
Mean (%)	0.014	0.015	0.011	0.019	0.02	0.017	0.015	0.018	0.016	0.010
Standard deviation (%)	0.022	0.021	0.014	0.028	0.033	0.026	0.022	0.025	0.017	0.015
Minimum	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00003	0.00002	0.00003	0.00001
Maximum	0.00315	0.00196	0.00144	0.00248	0.00387	0.00356	0.00279	0.00294	0.00239	0.00192
Jarque-Bera	1299960^{+++}	32100^{+++}	55944^{+++}	32589^{+++}	774702^{+++}	883563^{+++}	601178^{+++}	458176^{+++}	552367^{+++}	697481^{+++}
ADF test	-6.986^{+++}	-5.595^{+++}	-5.417^{+++}	-5.357^{+++}	-7.477^{+++}	-6.618^{+++}	-6.718^{+++}	-6.451^{+++}	-7.654^{+++}	-6.895^{+++}
Q(12)	51162^{+++}	24251^{+++}	24737^{+++}	24936^{+++}	56303^{+++}	53564^{+++}	53001^{+++}	53525^{+++}	48827^{+++}	54441^{+++}
Panel III: Diagnostic of standardized residuals										
Mean	-0.040	-0.074	-0.053	-0.068	-0.031	-0.036	-0.039	-0.038	-0.029	-0.035
Standard deviation	0.999	0.998	0.999	0.998	0.999	0.999	1.000	0.999	0.999	1.000
Minimum	-5.287	-9.045	-6.749	-9.061	-8.313	-5.583	-6.486	-6.025	-4.848	-5.624
Maximum	4.024	10.319	5.577	4.766	3.911	4.776	3.381	3.870	5.217	3.698
Skewness	-0.337	-0.937	-0.847	-1.494	-0.460	-0.219	-0.470	-0.254	-0.235	-0.308
Kurtosis	4.211	17.910	8.673	15.400	4.951	3.930	4.666	3.867	4.072	4.111
Jarque-Bera	418.312^{+++}	26092.780^{+++}	4049.758^{+++}	18796.860^{+++}	1013.433^{+++}	229.935^{+++}	797.555^{+++}	220.022^{+++}	298.350^{+++}	351.403^{+++}
Q(12)	22.695^{++}	33.257^{+++}	58.600^{+++}	28.929^{+++}	6.411	14.997	12.768	11.440	9.763	11.191
$Q^2(12)$	9.713	11.011	13.625	10.991	5.003	11.420	20.204^{+}	18.019	12.742	13.324
ARCH(12) test	9.702	11.154	13.284	10.684	5.035	11.264	20.117^{+}	18.263	12.589	13.978

Notes: *, ** and *** indicate that coefficients are, respectively, statistically significant at 10%, 5% and 1% levels. $^{+}$, $^{++}$ and $^{+++}$ indicate that the null hypothesis of statistical tests (no-autocorrelation, normality, homogeneity and no-stationary under the ADF test) is rejected, respectively, at 10%, 5% and 1% levels.

Table 3. Parameters estimation of AR(1)-GARCH(1,1) and diagnostic tests for conditional volatility - Islamic stock markets

	Islamic Emerging markets	Islamic markets (G)	Islamic Canada	Islamic UK	Islamic US	Islamic Europe	Islamic Asia pacific	Islamic World
Panel I: Estimated parameters								
ω	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)**	0.000 (0.000)***
ϕ	0.182 (0.014)***	0.147 (0.014)***	0.090 (0.014)***	-0.021 (0.014)	-0.030 (0.015)*	-0.027 (0.014)*	0.056 (0.016)***	0.147 (0.014)***
α	0.103 (0.006)***	0.082 (0.005)***	0.063 (0.003)***	0.063 (0.004)***	0.086 (0.005)***	0.075 (0.005)***	0.080 (0.005)***	0.081 (0.006)***
β	0.889 (0.005)***	0.908 (0.005)***	0.934 (0.003)***	0.929 (0.004)***	0.901 (0.006)***	0.919 (0.004)***	0.912 (0.005)***	0.908 (0.005)***
$(\alpha+\beta)$	0.992	0.990	0.997	0.992	0.987	0.994	0.992	0.989
Log-likelihood	16202.590	17498.720	14862.450	15882.100	368.517	16136.090	16274.850	17498.720
Panel II: Basic statistics of conditional volatility								
Mean (%)	0.017	0.010	0.031	0.019	0.016	0.018	0.016	0.010
Standard deviation (%)	0.021	0.015	0.049	0.024	0.021	0.024	0.018	0.015
Minimum	0.00002	0.00002	0.00004	0.00002	0.00003	0.00002	0.00002	0.00002
Maximum	0.00289	0.00201	0.00536	0.00292	0.00270	0.00302	0.00245	0.00201
Jarque-Bera	384073^{+++}	875209^{+++}	455451^{+++}	564143^{+++}	581823^{+++}	563104^{+++}	624536^{+++}	875209^{+++}
ADF test	-8.616^{+++}	-6.822^{+++}	-5.218^{+++}	-6.761^{+++}	-6.398^{+++}	-6.873^{+++}	-7.535^{+++}	-6.822^{+++}
Q(12)	47400^{+++}	53428^{+++}	56383^{+++}	55245^{+++}	51.132^{+++}	54596^{+++}	50885^{+++}	53428^{+++}
Panel III: Diagnostic of standardized residuals								
Mean	-0.033	-0.035	-0.026	-0.036	-0.039	-0.032	-0.025	-0.035
Standard deviation	0.999	1.000	0.999	0.999	1.000	0.999	0.999	1.000
Minimum	-5.082	-5.869	-7.887	-5.583	-6.486	-5.973	-5.142	-5.624
Maximum	4.302	3.946	4.379	4.776	3.381	4.225	4.979	3.698
Skewness	-0.272	-0.312	-0.536	-0.219	-0.470	-0.245	-0.270	-0.308
Kurtosis	4.060	4.169	5.421	3.930	4.666	3.850	4.061	4.111
Jarque-Bera	309.376^{+++}	382.266^{+++}	1527.367^{+++}	229.935^{+++}	797.555^{+++}	209.727^{+++}	309.079^{+++}	351.403^{+++}
Q(12)	12.544	10.504	9.388	15.543	12.037	10.594	13.791	10.504
Q^2(12)	20.151	16.553	4.536	15.801	17.010	19.477^{+}	12.917	20.595^{+}
ARCH(12) test	20.866	16.897	4.557	15.706	17.378	19.341^{+}	12.876	20.897^{+}

Notes: *, ** and *** indicate that coefficients are, respectively, statistically significant at 10%, 5% and 1% levels. $^{+}$, $^{++}$ and $^{+++}$ indicate that the null hypothesis of statistical tests (no-autocorrelation, normality, homogeneity and no-stationary under the ADF test) is rejected, respectively, at 10%, 5% and 1% levels.

Table 4: Empirical results of Bai and Perron's (1998, 2003) test, number and date of structural breaks ($\varepsilon = 0.05$)

Conventional stock markets									
Emerging markets	Arab markets	Arab markets excluding S.A	GCC	Canada	UK	US	Europe	Asia pacific	World
6	4	5	4	7	6	10	8	9	8
25 Jul 2007	21 Jan 2008	03 Jan 2007	03 Jan 2007	25 Feb 2003	29 Apr 2003	14 Apr 2003	17 Apr 2003	17 Apr 2003	30 Apr 2003
13 Sep 2007	25 Aug 2009	07 Aug 2008	07 Aug 2008	02 Apr 2003	26 Jul 2007	05 Jun 2003	25 Jun 2003	18 Jan 2008	25 Jul 2003
25 Mar 2008	13 Nov 2011	12 Mar 2010	12 Mar 2010	09 Nov 2007	15 Oct 2007	12 Sep 2003	18 Jan 2008	22 Feb 2008	26 Jul 2007
16 Feb 2009	13 Jun 2014	17 Oct 2011	13 Jun 2014	26 Dec 2007	05 Feb 2008	24 Jul 2007	11 Jul 2008	11 Sep 2008	12 Oct 2007
26 Oct 2009		19 May 2014		11 Jul 2008	27 Oct 2009	18 Sep 2007	12 Sep 2008	25 Dec 2008	04 Dec 2008
24 Jan 2012				10 Feb 2010	08 Aug 2012	03 Jun 2008	16 Jan 2009	01 Jan 2009	18 May 2009
				10 Aug 2012		04 Dec 2008	11 Jun 2010	14 Jun 2010	27 Oct 2009
						17 Jun 2009	12 Sep 2012	12 Aug 2010	27 Jan 2012
						23 Oct 2009		13 Sep 2013	
						25 Jan 2012			

Islamic stock markets							
Islamic Emerging markets	Islamic markets (G)	Islamic Canada	Islamic UK	Islamic US	Islamic Europe	Islamic Asia pacific	Islamic World
7	4	5	6	8	6	6	7
13 May 2003	15 Apr 2003	02 Apr 2003	18 Apr 2003	04 Apr 2003	18 Apr 2003	02 May 2003	15 Apr 2003
25 Jul 2007	26 Jul 2007	11 Feb 2007	16 Jul 2007	18 Aug 2003	26 Jul 2007	22 Aug 2003	22 Aug 2003
12 Sep 2007	27 Oct 2009	12 Nov 2007	13 Sep 2007	24 Jul 2007	13 Sep 2007	27 Jul 2007	26 Jul 2007
25 Dec 2007	27 Jan 2012	18 Dec 2007	01 Jan 2008	18 Sep 2007	01 Jan 2008	26 Oct 2007	12 Sep 2007
05 Feb 2008		14 Aug 2012	27 Oct 2009	11 Jan 2008	27 Oct 2009	28 Oct 2009	03 Dec 2007
27 Oct 2009			10 Aug 2012	02 Apr 2009	09 Aug 2012	30 Jan 2012	27 Oct 2009
08 Aug 2012				23 Oct 2009			27 Oct 2012
				25 Jan 2012			

Notes: This table reports the structural breaks identified in the volatility series of various conventional and Islamic stock markets generated from the standard GARCH model. We sequentially test the hypothesis of *l* breaks vs. *l+1* breaks, employing the Sup FT (l+1/l) statics.

Table 5. Interdependence between Islamic and Conventional stock market's volatility

Part I

			Islamic indices											
	Dependent variables		Islamic Emerging markets			Islamic markets (G)			Islamic Canada			Islamic UK		
	Quantile order		$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}
Conventional indices	Emerging markets	α	***0.645****** ***(0.014)***	***0.843****** ***(0.021)***	***1.324****** ***(0.064)***	***0.053****** ***(0.008)***	***0.061****** ***(0.004)***	***0.048****** ***(0.007)***	***0.259****** ***(0.036)***	***0.143****** ***(0.025)***	***0.116****** ***(0.036)***	-0.023 (0.023)	-0.047** (0.018)	-0.022 (0.036)
		β	-0.005 (0.085)	0.023 (0.079)	0.250** (0.103)	0.022 (0.036)	-0.004 (0.029)	0.014 (0.034)	-0.51*** (0.163)	0.022 (0.160)	-0.452* (0.248)	0.000 (0.056)	0.218*** (0.051)	0.054 (0.054)
		θ	0.092*** (0.037)	-0.022 (0.043)	-0.526*** (0.096)	0.025 (0.016)	0.013 (0.014)	0.030* (0.017)	0.342*** (0.102)	-0.16** (0.066)	0.412 (0.274)	0.072* (0.042)	-0.068*** (0.025)	0.045 (0.068)
	Arab markets	α	-0.05*** (0.015)	0.010 (0.024)	-0.026 (0.041)	***-0.04****** ***(0.008)***	***-0.01****** ***(0.003)***	***-0.02****** ***(0.011)***	***-0.26****** ***(0.078)***	***-0.090***** ***(0.038)***	***0.150**** ***(0.082)***	***-0.152****** ***(0.036)***	***-0.075***** ***(0.029)***	***0.234****** ***(0.038)***
		β	0.316 (0.268)	-0.002 (0.258)	0.190 (0.356)	-0.025 (0.236)	-0.084 (0.183)	-0.194 (0.169)	-1.428 (0.894)	-0.617 (0.551)	-1.969* (1.068)	-0.344** (0.161)	-0.156 (0.106)	0.381 (0.242)
		θ	-0.042 (0.158)	-0.025 (0.177)	-0.236 (0.298)	***0.122***** ***(0.047)***	***0.118***** ***(0.054)***	***0.071**** ***(0.018)***	***1.049**** ***(0.536)***	***1.384****** ***(0.285)***	***2.038***** ***(0.857)***	0.186 (0.173)	0.052 (0.091)	-0.706*** (0.223)
	Arab markets excluding S. A	α	***-0.02****** ***(0.011)***	***0.019***** ***(0.008)***	***-0.043***** ***(0.021)***	***0.011****** ***(0.003)***	***-0.01****** ***(0.002)***	***-0.03****** ***(0.002)***	***0.053**** ***(0.031)***	***-0.025***** ***(0.023)***	***-0.09****** ***(0.019)***	***-0.023***** ***(0.009)***	***-0.042****** ***(0.007)***	***-0.055****** ***(0.019)***
		β	0.033 (0.10)	0.026 (0.072)	0.141 (0.132)	0.018 (0.071)	0.079 (0.064)	0.031 (0.073)	-0.441 (0.366)	0.476 (0.304)	0.436 (0.373)	-0.045 (0.082)	-0.005 (0.081)	-0.116** (0.050)
		θ	0.089 (0.057)	0.040 (0.057)	-0.092 (0.128)	-0.09*** (0.024)	-0.06*** (0.018)	-0.005 (0.020)	0.485*** (0.133)	0.249 (0.191)	-0.181 (0.201)	0.129* (0.068)	0.039 (0.048)	0.150** (0.064)
	GCC	α	0.049*** (0.009)	-0.006 (0.019)	0.032 (0.030)	0.033*** (0.006)	0.010*** (0.002)	0.005 (0.006)	0.233*** (0.057)	0.116*** (0.026)	-0.064 (0.057)	***0.121****** ***(0.024)***	***0.065****** ***(0.021)***	***-0.162****** ***(0.028)***
		β	-0.342 (0.222)	-0.086 (0.214)	-0.348 (0.334)	0.216 (0.169)	0.069 (0.121)	0.196 (0.136)	***1.991***** ***(0.827)***	***0.762**** ***(0.423)***	***1.523**** ***(0.834)***	0.386** (0.173)	0.135 (0.089)	-0.287 (0.225)
		θ	-0.021 (0.121)	0.027 (0.149)	0.272 (0.276)	-0.060 (0.044)	-0.071 (0.052)	-0.061 (0.052)	***-1.00**** ***(0.525)***	***-1.21****** ***(0.272)***	***-1.185**** ***(0.695)***	-0.221 (0.173)	-0.032 (0.079)	0.537** (0.219)
	Canada	α	-0.005 (0.015)	0.064*** (0.013)	0.008 (0.031)	***0.049****** ***(0.006)***	***0.063****** ***(0.004)***	***0.08****** ***(0.007)***	***1.426****** ***(0.031)***	***1.665****** ***(0.031)***	***2.218****** ***(0.055)***	***0.143****** ***(0.015)***	***0.178****** ***(0.015)***	***0.213****** ***(0.021)***
		β	***-0.192**** ***(0.113)***	***-0.218**** ***(0.118)***	***-1.15**** ***(0.262)***	***-0.076***** ***(0.035)***	***-0.068**** ***(0.036)***	***-0.071**** ***(0.033)***	***-0.32****** ***(0.122)***	***-0.62****** ***(0.111)***	***-0.93****** ***(0.160)***	-0.018 (0.023)	-0.023 (0.071)	-0.097** (0.047)
		θ	***0.145****** ***(0.022)***	***0.207****** ***(0.035)***	***0.20****** ***(0.056)***	0.047*** (0.013)	0.005 (0.011)	-0.054* (0.012)	-0.025 (0.093)	-0.15** (0.061)	-0.337* (0.200)	-0.056*** (0.018)	-0.047 (0.038)	-0.037 (0.031)
	UK	α	0.005 (0.035)	-0.003 (0.025)	-0.159*** (0.033)	-0.0127 (0.008)	-0.018* (0.009)	-0.01*** (0.005)	***-0.03****** ***(0.058)***	***-0.43****** ***(0.051)***	***-0.229***** ***(0.091)***	***0.509****** ***(0.027)***	***0.723****** ***(0.036)***	***1.238****** ***(0.041)***
		β	0.465*** (0.159)	0.156 (0.113)	-0.469** (0.191)	***0.195***** ***(0.083)***	***0.099***** ***(0.046)***	***0.095**** ***(0.051)***	0.602** (0.232)	-0.19 (0.171)	-0.43** (0.216)	-0.138 (0.122)	-0.092 (0.097)	-0.339*** (0.082)
		θ	-0.043 (0.091)	0.132 (0.096)	0.701*** (0.201)	-0.033 (0.037)	-0.002 (0.033)	-0.038 (0.034)	***0.679****** ***(0.172)***	***1.183****** ***(0.233)***	***1.557****** ***(0.212)***	0.279*** (0.106)	0.051 (0.074)	-0.225** (0.112)
	US	α	***-0.12****** ***(0.024)***	***-0.08****** ***(0.021)***	***-0.04****** ***(0.011)***	-0.002 (0.013)	0.037*** (0.011)	0.083*** (0.016)	***-0.18****** ***(0.047)***	***-0.082**** ***(0.056)***	***0.210****** ***(0.067)***	***-0.384****** ***(0.030)***	***-0.359****** ***(0.034)***	***-0.185****** ***(0.048)***
		β	-0.224 (0.212)	0.124 (0.107)	0.071 (0.175)	-0.029 (0.046)	-0.008 (0.048)	-0.006 (0.053)	-0.72*** (0.219)	-0.55** (0.257)	-0.159 (0.274)	***-0.180***** ***(0.084)***	***-0.234****** ***(0.086)***	***-0.177**** ***(0.099)***
		θ	0.034 (0.063)	0.056 (0.047)	-0.048 (0.181)	***-0.11****** ***(0.024)***	***-0.059**** ***(0.031)***	***-0.071***** ***(0.033)***	0.368*** (0.105)	0.498* (0.255)	-0.065 (0.280)	***0.343****** ***(0.034)***	***0.446****** ***(0.064)***	***0.279****** ***(0.067)***

(*Continued on next page*)

Table 5 Part I (continued)

Dependent variables		Islamic Emerging markets			Islamic markets (G)			Islamic Canada			Islamic UK		
Quantile order		$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}
Europe	α	-0.330	-0.015	0.692***	***-0.22*****	***-0.22*****	***-0.63*****	0.143***	0.260***	0.090	-0.040	0.026	-0.139***
		(0.244)	(0.164)	(0.264)	***(0.083)***	***(0.062)***	***(0.080)***	(0.050)	(0.056)	(0.099)	(0.029)	(0.032)	(0.037)
	β	**-4.81*****	**-2.684****	**4.503*****	0.500	0.282	0.723*	-0.769**	0.291	1.028***	0.025	0.070	0.176**
		(1.648)	**(1.270)**	**(2.450)**	(0.508)	(0.501)	(0.436)	(0.341)	(0.264)	(0.362)	(0.130)	(0.123)	(0.081)
	θ	-0.258	-0.155	-1.536	0.141	-0.228	-0.183	***-0.73*****	***-1.309*****	***-1.64*****	-0.039	-0.127	-0.069
		(0.516)	(0.715)	(1.428)	(0.339)	(0.258)	(0.188)	***(0.146)***	***(0.230)***	***(0.308)***	(0.111)	(0.085)	(0.125)
Asia pacific	α	0.362	-0.022	-0.571**	***0.187****	***0.173****	***0.596*****	***0.058****	***0.139*****	***0.106*****	0.016	0.030***	0.072*
		(0.248)	(0.155)	(0.225)	***(0.079)***	***(0.069)***	***(0.087)***	***(0.024)***	***(0.018)***	***(0.026)***	(0.015)	(0.007)	(0.043)
	β	***4.286*****	***2.391****	***-4.709****	-0.811	-0.417	-0.832*	0.205	-0.072	0.163*	-0.039	-0.142***	-0.043
		(1.530)	***(1.209)***	***(2.492)***	(0.499)	(0.519)	(0.440)	(0.171)	(0.094)	(0.096)	(0.033)	(0.046)	(0.041)
	θ	0.056	0.023	1.095	-0.194	0.215	0.198	0.114**	0.239*	-0.061	0.071*	0.158***	0.017
		(0.476)	(0.659)	(1.400)	(0.323)	(0.254)	(0.171)	(0.108)	(0.141)	(0.158)	(0.042)	(0.038)	(0.048)
World	α	***0.282*****	***0.184*****	***-0.321****	***0.888*****	***0.865*****	***0.821*****	***-0.42*****	***-0.581*****	***-1.33*****	1.067***	0.722***	0.113
		(0.043)	***(0.056)***	***(0.168)***	***(0.035)***	***(0.025)***	***(0.040)***	***(0.130)***	***(0.149)***	***(0.161)***	(0.078)	(0.103)	(0.117)
	β	***0.942****	***0.646****	***0.706****	***0.425*****	***0.209****	***0.105****	***2.749*****	***-1.708****	***1.097****	0.506**	0.163	0.613**
		(0.395)	***(0.382)***	***(0.338)***	***(0.158)***	***(0.132)***	***(0.118)***	***(0.616)***	***(0.735)***	***(1.016)***	(0.216)	(0.269)	(0.249)
	θ	***-0.195****	***-0.60*****	***-0.123****	0.052	0.013	0.135*	***-1.19*****	***-0.267****	***-0.163*****	***-1.17*****	***-0.829*****	***-0.606*****
		(0.088)	***(0.190)***	***(0.071)***	(0.092)	(0.073)	(0.069)	***(0.452)***	***(0.665)***	***(0.957)***	***(0.126)***	***(0.202)***	***(0.152)***
Const		-0.000***	0.000***	0.000***	-0.000***	0.000***	0.000***	0.000	0.000***	0.000***	0.000***	0.000***	0.000***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
γ *(B.P)*		-0.000**	-0.000**	-0.000*	-0.000***	-0.000***	-0.000	0.000	-0.000	-0.000	0.000***	0.000***	0.000***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
η *(Crises)*		-0.000***	-0.000**	-0.000*	-0.000***	-0.000***	-0.000**	-0.000**	-0.000*	0.000	0.000	0.000***	0.000***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pseudo R^2		0.732	0.845	0.963	0.837	0.919	0.976	0.697	0.812	0.942	0.798	0.872	0.951

Table 5. Interdependence between Islamic and Conventional stock market's volatility

Part II

			Islamic indices											
	Dependent variables		Islamic US			Islamic Europe			Islamic Asia pacific			Islamic World		
	Quantile order		$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}
Conventional indices	Emerging markets	α	-0.011	0.008	0.013	***0.048****	***0.058****	***0.031****	***0.228****	***0.215****	***0.258****	***0.059****	***0.077****	***0.087****
			(0.013)	(0.013)	(0.008)	***(0.018)***	***(0.006)***	***(0.011)***	***(0.011)***	***(0.013)***	***(0.016)***	***(0.006)***	***(0.003)***	***(0.006)***
		β	0.151**	-0.022	-0.079	-0.025	0.172***	0.012	-0.031	0.103*	-0.044	0.061*	-0.018	-0.059***
			(0.069)	(0.026)	(0.065)	(0.048)	(0.047)	(0.042)	(0.082)	(0.056)	(0.098)	(0.038)	(0.016)	(0.019)
		θ	-0.037	0.012	0.069***	0.060	-0.11***	-0.023	0.053	0.001	0.058	0.011	0.003	0.052***
			(0.033)	(0.024)	(0.017)	(0.046)	(0.034)	(0.035)	(0.042)	(0.026)	(0.049)	(0.018)	(0.015)	(0.276)
	Arab markets	α	-0.044***	-0.003	0.005	-0.03***	-0.06***	0.021	0.016	0.002	0.029	-0.035***	-0.012***	-0.000
			(0.011)	(0.013)	(0.011)	(0.022)	(0.017)	(0.027)	(0.032)	(0.027)	(0.031)	(0.011)	(0.004)	(0.007)
		β	-0.130	0.078	0.414***	***-0.46****	***-0.53****	***-0.381***	0.199	0.415	0.248	-0.099	0.023	-0.079
			(0.152)	(0.133)	(0.111)	***(0.154)***	***(0.172)***	***(0.175)***	(0.319)	(0.498)	(0.873)	(0.240)	(0.087)	(0.174)
		θ	0.168	-0.066	-0.398***	0.253**	0.381***	0.172	0.193	0.191**	0.564**	0.038	0.160**	0.062
			(0.153)	(0.096)	(0.075)	(0.116)	(0.143)	(0.156)	(0.182)	(0.091)	(0.235)	(0.078)	(0.069)	(0.057)
	Arab markets excluding S. A	α	***0.029****	***0.011****	***-0.033****	***-0.05****	***-0.05****	***-0.06****	0.006	0.015	0.057***	0.003	-0.011***	-0.026***
			(0.007)	***(0.003)***	***(0.004)***	***(0.011)***	***(0.004)***	***(0.011)***	(0.009)	(0.013)	(0.008)	(0.004)	(0.002)	(0.004)
		β	0.119	0.227***	0.007	***0.139****	***0.213****	***0.123****	-0.175	-0.154	-0.271	0.157***	0.044	0.098**
			(0.105)	(0.061)	(0.049)	***(0.072)***	***(0.049)***	***(0.071)***	(0.180)	(0.149)	(0.387)	(0.040)	(0.028)	(0.049)
		θ	-0.135***	-0.13***	-0.023	0.041***	-0.079*	-0.009	-0.082	-0.057**	-0.024	-0.102***	-0.027	-0.001
			(0.052)	(0.025)	(0.033)	(0.056)	(0.042)	(0.052)	(0.070)	(0.027)	(0.048)	(0.026)	(0.023)	(0.024)
	GCC	α	0.033***	0.001	0.002	0.036**	0.055***	-0.010	-0.018	-0.006	-0.038	0.030***	0.011***	0.003
			(0.008)	(0.009)	(0.009)	(0.014)	(0.014)	(0.019)	(0.024)	(0.019)	(0.028)	(0.008)	(0.002)	(0.005)
		β	0.076	-0.063	-0.240**	***0.408****	***0.421****	***0.252****	0.212	-0.253	0.045	0.099	-0.019	0.019
			(0.139)	(0.102)	(0.095)	***(0.173)***	***(0.150)***	***(0.148)***	(0.249)	(0.441)	(0.475)	(0.179)	(0.075)	(0.135)
		θ	-0.081	0.073	0.317***	-0.236*	-0.283**	-0.078	-0.065	-0.093	-0.443**	0.011	-0.135**	-0.057
			(0.130)	(0.076)	(0.059)	(0.134)	(0.122)	(0.127)	(0.191)	(0.068)	(0.193)	(0.081)	(0.059)	(0.056)
	Canada	α	***0.072****	***0.090****	***0.068****	***-0.018****	***0.065****	***0.150****	***0.025****	***0.054****	***0.167****	***0.043****	***0.059****	***0.077****
			(0.007)	***(0.006)***	***(0.011)***	***(0.011)***	***(0.012)***	***(0.019)***	***(0.007)***	***(0.013)***	***(0.015)***	***(0.005)***	***(0.004)***	***(0.007)***
		β	***-0.084****	***-0.12****	***-0.172****	***-0.15****	***-0.27****	***-0.23****	-0.39***	-0.13***	-0.026	***-0.054****	***-0.093****	***-0.091****
			(0.047)	***(0.035)***	***(0.027)***	***(0.044)***	***(0.031)***	***(0.058)***	(0.101)	(0.045)	(0.078)	***(0.021)***	***(0.012)***	***(0.014)***
		θ	-0.002	0.027	0.038**	0.191***	0.104***	0.031	***0.086****	***-0.07****	***-0.17****	0.054***	0.035***	-0.013
			(0.015)	(0.018)	(0.017)	(0.025)	(0.019)	(0.024)	***(0.031)***	***(0.018)***	***(0.024)***	(0.012)	(0.009)	(0.014)
	UK	α	***-0.050****	***-0.05****	***-0.062****	-0.016	0.010	0.381***	-0.11***	-0.13***	0.052	***-0.022****	***-0.023****	***-0.031****
			(0.019)	***(0.010)***	***(0.019)***	(0.026)	(0.031)	(0.026)	(0.018)	(0.020)	(0.034)	***(0.007)***	***(0.010)***	***(0.011)***
		β	0.261***	0.004	0.043	0.053	0.101	-0.041	-0.696**	-0.47***	-0.093	0.038	0.050	0.021**
			(0.083)	(0.061)	(0.048)	(0.103)	(0.075)	(0.084)	(0.185)	(0.153)	(0.203)	(0.061)	(0.037)	(0.036)
		θ	0.033	0.221***	0.135**	0.146*	0.086	-0.24***	0.398***	0.247***	0.112	-0.007	0.017	0.010
			(0.066)	(0.046)	(0.056)	(0.088)	(0.069)	(0.077)	(0.113)	(0.054)	(0.093)	(0.037)	(0.022)	(0.037)
	US	α	***0.463****	***0.561****	***0.719****	***-0.25****	***-0.12****	***-0.091****	***-0.29****	***-0.19****	***-0.23****	0.009	0.018**	0.051***
			(0.036)	***(0.023)***	***(0.021)***	***(0.033)***	***(0.024)***	***(0.050)***	***(0.021)***	***(0.026)***	***(0.021)***	(0.010)	(0.009)	(0.019)
		β	0.104	0.133***	-0.052	***0.143****	***-0.094****	***-0.013****	***-0.38****	***-0.223****	***-0.354****	0.059	0.017	0.024
			(0.071)	(0.049)	(0.064)	***(0.076)***	***(0.051)***	***(0.007)***	***(0.187)***	***(0.096)***	***(0.208)***	(0.066)	(0.031)	(0.039)
		θ	-0.006	-0.066	-0.136***	0.158***	0.160***	0.085	***0.288****	***0.157****	***0.314****	-0.019	-0.012	-0.024
			(0.073)	(0.041)	(0.033)	(0.053)	(0.051)	(0.069)	***(0.077)***	***(0.056)***	***(0.056)***	(0.027)	(0.033)	(0.034)

(*Continued on next page*)

Table 5 Part II (continued)

Dependent variables		Islamic US			Islamic Europe			Islamic Asia pacific			Islamic World		
Quantile order		$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}
Europe	α	***-0.182****	***-0.168****	***-0.173****	***0.567****	***0.687****	***0.543****	***-0.024****	***0.047****	***-0.139****	***-0.041****	***-0.060****	***-0.051****
		(0.024)	***(0.015)***	***(0.018)***	***(0.018)***	***(0.027)***	***(0.027)***	***(0.013)***	***(0.023)***	***(0.030)***	***(0.009)***	***(0.010)***	***(0.016)***
	β	-0.132	-0.009	-0.144**	-0.134	-0.023	0.053	0.149	0.253**	0.074	-0.063	-0.050*	-0.020
		(0.082)	(0.063)	(0.055)	(0.092)	(0.093)	(0.086)	(0.151)	(0.115)	(0.254)	(0.068)	(0.030)	(0.033)
	θ	0.045	-0.003	0.025	0.084	-0.228	0.091	-0.192	-0.292***	-0.184***	0.004	0.013	-0.000
		(0.061)	(0.037)	(0.060)	(0.084)	(0.258)	(0.086)	(0.128)	(0.044)	(0.066)	(0.048)	(0.030)	(0.031)
Asia pacific	α	-0.018**	-0.001	0.017*	0.017	0.030***	0.028	***0.377****	***0.524****	***0.645****	***-0.019****	***-0.012****	***-0.027****
		(0.009)	(0.013)	(0.009)	(0.011)	(0.006)	(0.023)	***(0.011)***	***(0.017)***	***(0.019)***	***(0.004)***	***(0.003)***	***(0.006)***
	β	-0.070	-0.025	-0.048	0.071	-0.120***	-0.084***	0.272***	0.089***	0.015	-0.002	-0.001	0.017
		(0.046)	(0.024)	(0.039)	(0.047)	(0.039)	(0.031)	(0.104)	(0.069)	(0.154)	(0.044)	(0.023)	(0.022)
	θ	***0.141****	***0.086****	***0.057****	0.005	0.215	0.119***	0.005	0.017	0.003	***0.044****	***0.037****	***-0.022****
		(0.031)	***(0.018)***	***(0.023)***	(0.048)	(0.254)	(0.031)	(0.052)	(0.033)	(0.045)	***(0.015)***	***(0.016)***	***(0.014)***
World	α	***0.917****	***0.796****	***0.745****	***0.758****	***0.341****	***0.016****	***0.819****	***0.588****	***0.565****	***0.901****	***0.923****	***0.899****
		(0.081)	***(0.052)***	***(0.059)***	***(0.064)***	***(0.053)***	***(0.011)***	***(0.050)***	***(0.067)***	***(0.052)***	***(0.030)***	***(0.023)***	***(0.036)***
	β	-0.347*	-0.093	0.559***	***0.292****	***0.635****	***0.656****	2.595***	0.988**	0.590	0.060	0.195**	0.116
		(0.214)	(0.241)	(0.201)	***(0.252)***	***(0.137)***	***(0.214)***	(0.798)	(0.439)	(0.806)	(0.137)	(0.077)	(0.091)
	θ	***-0.309****	***-0.497****	***-0.438****	***-1.023****	***-0.164****	***-0.288****	***-1.10****	***-0.107***	***0.314****	***-0.178****	***-0.191****	***-0.077****
		(0.195)	***(0.088)***	***(0.106)***	***(0.156)***	***(0.068)***	***(0.146)***	***(0.247)***	***(0.125)***	***(0.056)***	***(0.070)***	***(0.084)***	***(0.062)***
		-0.000	0.000***	0.000***	0.000***	0.000***	0.000***	-0.00***	-0.000***	-0.000***	-0.000***	0.000***	0.000***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
γ *(B.P)*		0.000	0.000***	0.000***	0.000**	0.000***	0.000	-0.000**	-0.000***	-0.000	-0.000*	-0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
η *(Crises)*		-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000	-0.000	0.000***	0.000***	-0.000***	-0.000***	-0.000***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pseudo R^2		0.819	0.902	0.971	0.825	0.898	0.964	0.712	0.834	0.947	0.848	0.921	0.976

Notes: This table presents the quantile regression estimates for the conventional and Islamic markets according to the empirical model defined by Eq. (3). The numbers in parentheses are the bootstrapped standard errors. *, ** and *** indicate that coefficients are significant at 10%, 5% and 1% level, respectively. Absolute significance through three quantiles is in bold type and italic. The additional marginal effects of the different conditional variables is given by $\eta(\tau)$ and $\theta_k(\tau)$ parameters in the financial crisis period, by $\gamma(\tau)$ and $\beta_k(\tau)$ parameters in times of financial fragility. While the effects in the calm periods is given by the parameters $\lambda(\tau)$ and $\alpha_k(\tau)$.

Table 6. Interdependence between Islamic stock market's volatility

Dependent variables		Islamic markets			Islamic Europe			Islamic Canada			Islamic UK		
Quantile order		$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}
Independent variables													
Islamic markets	α	-	-	-	0.001 (0.018)	0.020 (0.019)	0.023** (0.011)	***0.253****** ***(0.032)***	***0.324**** ***(0.145)***	***0.259***** ***(0.121)***	0.008 (0.011)	0.020 (0.013)	-0.031 (0.029)
	β	-	-	-	-0.096 (0.119)	-0.127 (0.099)	-0.159** (0.071)	-0.253* (0.133)	-0.424 (0.418)	-0.374 (0.835)	0.049 (0.054)	0.295** (0.113)	0.239*** (0.082)
	θ	-	-	-	0.042 (0.046)	0.037 (0.035)	0.047 (0.034)	***-0.28****** ***(0.074)***	***0.452***** ***(0.217)***	***0.808****** ***(0.199)***	-0.011 (0.058)	-0.090** (0.040)	-0.025 (0.050)
Islamic Europe	α	-0.036 (0.041)	-0.022 (0.031)	-0.193*** (0.057)	-	-	-	***-0.73****** ***(0.104)***	***-0.66****** ***(0.082)***	***-0.42***** ***(0.112)***	***0.619****** ***(0.014)***	***0.827****** ***(0.018)***	***0.950****** ***(0.034)***
	β	***-1.244****** ***(0.282)***	***-1.07****** ***(0.239)***	***-0.805****** ***(0.222)***	-	-	-	-1.89*** (0.322)	-1.152 (0.791)	0.720 (0.735)	-0.094 (0.074)	0.169* (0.099)	-0.165 (0.102)
	θ	***0.463****** ***(0.169)***	***0.753****** ***(0.171)***	***0.673****** ***(0.160)***	-	-	-	***0.886****** ***(0.221)***	***0.852***** ***(0.287)***	***0.891**** ***(0.571)***	***0.151****** ***(0.051)***	***0.117***** ***(0.058)***	***0.102***** ***(0.064)***
Islamic Canada	α	0.027*** (0.008)	0.014* (0.008)	0.003 (0.011)	***-0.05****** ***(0.007)***	***-0.024***** ***(0.011)***	***-0.02****** ***(0.004)***	-	-	-	-0.007 (0.005)	0.007 (0.007)	0.031*** (0.011)
	β	0.071 (0.083)	-0.161* (0.084)	-0.632*** (0.086)	***0.137****** ***(0.044)***	***0.131****** ***(0.026)***	***0.145****** ***(0.040)***	-	-	-	-0.020 (0.035)	-0.144*** (0.037)	-0.090* (0.046)
	θ	-0.017 (0.023)	0.035 (0.022)	0.091** (0.042)	0.057*** (0.015)	0.017 (0.016)	-0.050** (0.024)	-	-	-	0.064*** (0.019)	0.016 (0.012)	-0.049*** (0.016)
Islamic UK	α	0.163*** (0.023)	0.116*** (0.025)	0.124 (0.081)	***0.542****** ***(0.021)***	***0.747****** ***(0.021)***	***0.880****** ***(0.014)***	***0.535****** ***(0.088)***	***0.405****** ***(0.078)***	***0.550***** ***(0.092)***	-	-	-
	β	***0.926****** ***(0.232)***	***0.799****** ***(0.233)***	***0.898****** ***(0.284)***	-0.023 (0.105)	0.002 (0.119)	-0.147 (0.152)	1.668*** (0.182)	0.686 (0.606)	-1.81*** (0.354)	-	-	-
	θ	***-0.441****** ***(0.145)***	***-0.76****** ***(0.117)***	***-0.621****** ***(0.147)***	0.174*** (0.062)	-0.018 (0.036)	0.061 (0.044)	***1.361****** ***(0.182)***	***1.827***** ***(0.221)***	***1.658***** ***(0.668)***	-	-	-
Islamic US	α	***-0.253****** ***(0.044)***	***-0.24****** ***(0.041)***	***-0.239****** ***(0.062)***	***-0.53****** ***(0.051)***	***-0.15****** ***(0.049)***	***-0.17****** ***(0.023)***	***-0.63****** ***(0.124)***	***-1.08****** ***(0.091)***	***-1.61****** ***(0.292)***	***-0.304****** ***(0.041)***	***-0.257****** ***(0.021)***	***-0.241****** ***(0.033)***
	β	0.023 (0.186)	-0.314 (0.248)	-0.439*** (0.294)	0.226*** (0.064)	0.170 (0.165)	0.142 (0.141)	***-0.797***** ***(0.336)***	***-0.628**** ***(0.452)***	***-2.52****** ***(0.591)***	-0.193 (0.209)	-0.385** (0.149)	-0.540*** (0.106)
	θ	0.062 (0.162)	0.134 (0.158)	0.237* (0.141)	***0.295****** ***(0.101)***	***-0.167***** ***(0.070)***	***-0.157***** ***(0.068)***	0.017 (0.205)	-0.227 (0.181)	-0.468 (0.545)	***0.572****** ***(0.060)***	***0.548****** ***(0.054)***	***0.477****** ***(0.108)***
Islamic Asia pacific	α	***0.288****** ***(0.015)***	***0.607****** ***(0.015)***	***1.179****** ***(0.068)***	0.013 (0.023)	0.002 (0.019)	0.057*** (0.016)	***0.158****** ***(0.044)***	***0.425****** ***(0.074)***	***0.519***** ***(0.239)***	***-0.051****** ***(0.017)***	***-0.096****** ***(0.012)***	***-0.056****** ***(0.019)***
	β	-0.064 (0.114)	-0.59*** (0.201)	-0.848*** (0.184)	***0.235**** ***(0.122)***	***0.322****** ***(0.058)***	***0.215***** ***(0.092)***	-1.07*** (0.267)	-0.849 (0.826)	-0.370 (0.534)	***-0.191****** ***(0.042)***	***-0.221****** ***(0.073)***	***-0.123****** ***(0.34)***
	θ	0.103* (0.054)	0.202*** (0.075)	-0.174 (0.161)	***-0.016**** ***(0.059)***	***-0.133***** ***(0.052)***	***-0.14****** ***(0.039)***	***0.397****** ***(0.123)***	***-0.52****** ***(0.135)***	***-1.59****** ***(0.299)***	***0.286****** ***(0.034)***	***0.301****** ***(0.045)***	***0.200****** ***(0.072)***
Islamic World	α	***0.519****** ***(0.111)***	***0.634****** ***(0.089)***	***0.918****** ***(0.166)***	***1.273****** ***(0.114)***	***0.641****** ***(0.101)***	***0.691****** ***(0.049)***	***1.576****** ***(0.284)***	***2.914****** ***(0.217)***	***1.419**** ***(0.310)***	***0.846****** ***(0.069)***	***0.643****** ***(0.049)***	***0.365***** ***(0.146)***
	β	0.645 (0.478)	2.241*** (0.448)	3.844*** (0.497)	-0.53** (0.221)	-0.446 (0.361)	0.076 (0.329)	***2.541***** ***(1.094)***	***1.982**** ***(1.028)***	***4.835****** ***(1.441)***	0.363 (0.471)	0.567 (0.362)	0.501* (0.282)
	θ	0.136 (0.399)	-0.382 (0.337)	-0.651** (0.276)	***-0.67****** ***(0.223)***	***0.268***** ***(0.119)***	***0.111**** ***(0.152)***	***2.066****** ***(0.531)***	***1.703****** ***(0.632)***	***1.646***** ***(0.786)***	***-1.38****** ***(0.129)***	***-1.178****** ***(0.127)***	***-0.783****** ***(0.169)***
γ *(B.P)*		-0.000* (0.000)	-0.000 (0.000)	-0.000** (0.000)	-0.000** (0.000)	-0.00*** (0.000)	-0.00*** (0.000)	0.000* (0.000)	0.000 (0.000)	0.000 (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
η *(Crises)*		-0.000 (0.000)	-0.00*** (0.000)	-0.00* (0.000)	-0.00*** (0.000)	-0.00*** (0.000)	0.000** (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000* (0.000)	0.000*** (0.000)	0.000*** (0.000)
Pseudo R^2		0.518	0.667	0.826	0.722	0.841	0.933	0.382	0.534	0.803	0.727	0.838	0.925

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Table 6 (continued)

Dependent variables		Islamic US			Islamic Asia pacific			Islamic World		
Quantile order		$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}	$Q_{0.05}$	Q_{50}	Q_{95}
Independent variables										
Islamic markets	α	***-0.05*** *(0.012)*	***-0.11*** *(0.011)*	***-0.07*** *(0.013)*	***0.301*** *(0.024)*	***0.515*** *(0.023)*	***0.817*** *(0.042)*	***0.030*** *(0.007)*	***0.043*** *(0.005)*	***0.019*** *(0.009)*
	β	***-0.194**** *(0.102)*	***-0.17*** *(0.061)*	***-0.237**** *(0.139)*	***-0.262**** *(0.138)*	***-0.156**** *(0.091)*	***-0.347**** *(0.136)*	***-0.14*** *(0.029)*	***-0.029**** *(0.017)*	***-0.012**** *(0.022)*
	θ	-0.002 (0.039)	0.050* (0.029)	-0.035 (0.046)	0.214*** (0.056)	-0.034 (0.058)	-0.260** (0.116)	0.096*** (0.015)	-0.009 (0.015)	0.037 (0.027)
Islamic Europe	α	***-0.24*** *(0.019)*	***-0.28*** *(0.020)*	***-0.19**** *(0.042)*	-0.049 (0.038)	0.066 (0.041)	-0.105 (0.123)	***0.092*** *(0.024)*	***0.156*** *(0.010)*	***0.131*** *(0.013)*
	β	0.124 (0.101)	0.278*** (0.086)	-0.175 (0.138)	-0.229 (0.267)	-0.506** (0.232)	-0.034 (0.467)	***-0.13*** *(0.037)*	***-0.09*** *(0.029)*	***-0.054**** *(0.045)*
	θ	-0.126 (0.089)	-0.152* (0.087)	-0.262** (0.122)	-0.441*** (0.166)	-0.206 (0.158)	0.982*** (0.261)	0.195*** (0.034)	0.059* (0.036)	0.116 (0.094)
Islamic Canada	α	***-0.02*** *(0.008)*	***-0.012**** *(0.005)*	***-0.017**** *(0.002)*	0.007 (0.004)	0.067*** (0.010)	0.037* (0.021)	***0.010**** *(0.006)*	***0.011*** *(0.002)*	***0.014*** *(0.002)*
	β	0.103*** (0.024)	0.047** (0.022)	-0.027 (0.049)	-0.078 (0.054)	-0.14*** (0.049)	-0.052 (0.070)	***0.045*** *(0.013)*	***0.026*** *(0.009)*	***0.058*** *(0.013)*
	θ	-0.017 (0.025)	-0.003 (0.012)	-0.036** (0.016)	-0.000 (0.017)	-0.036** (0.018)	-0.079* (0.044)	0.016 (0.010)	0.036*** (0.005)	0.007 (0.009)
Islamic UK	α	***-0.15*** *(0.022)*	***-0.10*** *(0.018)*	***-0.34*** *(0.049)*	-0.068*** (0.024)	-0.14*** (0.025)	-0.068 (0.104)	***0.082*** *(0.017)*	***0.057*** *(0.011)*	***0.078*** *(0.013)*
	β	-0.32*** (0.103)	-0.34*** (0.112)	-0.180 (0.161)	-0.190 (0.236)	0.243 (0.165)	0.084 (0.411)	0.078** (0.038)	0.046 (0.039)	-0.117* (0.068)
	θ	***0.475*** *(0.098)*	***0.413*** *(0.065)*	***0.462*** *(0.121)*	0.629*** (0.096)	0.504*** (0.089)	-0.285 (0.282)	-0.18*** (0.039)	-0.09*** (0.031)	-0.067 (0.066)
Islamic US	α	-	-	-	***-0.331*** *(0.049)*	***-0.13*** *(0.040)*	***0.632*** *(0.153)*	***0.348*** *(0.011)*	***0.397*** *(0.006)*	***0.461*** *(0.006)*
	β	-	-	-	-0.450* (0.256)	-0.55*** (0.168)	0.328 (0.439)	0.004 (0.022)	-0.019 (0.024)	-0.070** (0.033)
	θ	-	-	-	***0.354**** *(0.138)*	***0.104**** *(0.112)*	***-0.639**** *(0.249)*	***0.042**** *(0.025)*	***0.082*** *(0.017)*	***0.057*** *(0.013)*
Islamic Asia pacific	α	***-0.08*** *(0.014)*	***-0.018**** *(0.011)*	***-0.009**** *(0.004)*	-	-	-	0.004 (0.006)	0.031*** (0.008)	0.063*** (0.008)
	β	***0.353*** *(0.077)*	***0.252*** *(0.069)*	***0.338*** *(0.069)*	-	-	-	***0.266*** *(0.029)*	***0.121*** *(0.038)*	***0.165*** *(0.044)*
	θ	0.003 (0.074)	-0.039 (0.063)	0.036 (0.062)	-	-	-	-0.12*** (0.013)	0.000 (0.025)	-0.029 (0.027)
Islamic World	α	***1.989*** *(0.019)*	***2.149*** *(0.033)*	***2.323*** *(0.057)*	***0.980*** *(0.124)*	***0.581*** *(0.102)*	***0.763*** *(0.113)*	-	-	-
	β	-0.142 (0.188)	-0.139 (0.159)	-0.330** (0.137)	***1.566*** *(0.483)*	***1.536*** *(0.343)*	***1.482**** *(0.223)*	-	-	-
	θ	***-0.49*** *(0.135)*	***-0.46*** *(0.142)*	***-0.57*** *(0.100)*	***-0.919*** *(0.325)*	***-0.467**** *(0.233)*	***-0.318**** *(0.101)*	-	-	-
γ *(B.P)*		0.000 (0.000)	0.000* (0.000)	0.000** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000 (0.000)	-0.00*** (0.000)	-0.00*** (0.000)	0.000 (0.000)
η *(Crises)*		-0.00*** (0.000)	-0.000** (0.000)	0.000*** (0.000)	-0.00*** (0.000)	-0.00*** (0.000)	0.000** (0.000)	-0.00*** (0.000)	-0.00** (0.000)	-0.000 (0.000)
Pseudo R^2		0.727	0.818	0.916	0.513	0.648	0.815	0.755	0.886	0.964

Notes: This table presents the quantile regression estimates for the Islamic markets according to the empirical model defined by Eq. (3). The numbers in parentheses are the bootstrapped standard errors. *, ** and *** indicate that coefficients are significant at 10%, 5% and 1% level, respectively. Absolute significance through three quantiles is in bold type and italic. The additional marginal effects of the different conditional variables is given by $\eta(\tau)$ and $\theta_k(\tau)$ parameters in the financial crisis period, by $\gamma(\tau)$ and $\beta_k(\tau)$ parameters in times of financial fragility. While the effects in the calm periods is given by the parameter $\alpha_k(\tau)$.

Table 7. Summary empirical results

		$\alpha_{(1\%,5\%,10\%)}$	$\beta_{(1\%,5\%,10\%)}$	$\theta_{(1\%,5\%,10\%)}$
Conventional Vs. Islamic (Whole sample)	Number of significant linkages / Total linkages	49/80	20/80	19/80
	%	61,25	25	23,75
Conventional Arab and Emerging Vs. Islamic Developed	Number of significant linkages / Total linkages	05/08	00	01/08
	%	62,5	00	12,5
Conventional Arab and Emerging Vs. Islamic Arab and Emerging	Number of significant linkages / Total linkages	11/24	04/24	02/24
	%	45,8	16,6	08,3
Conventional Developed Vs. Islamic Arab and Emerging	Number of significant linkages / Total linkages	06/12	07/12	03/12
	%	50	58,3	25
Conventional Developed Vs. Islamic Developed	Number of significant linkages / Total linkages	27/36	10/36	14/36
	%	75	27,8	38,9
Islamic Vs. Islamic (Whole sample)	Number of significant linkages / Total linkages	31/42	15/42	19/42
	%	73,8	35,7	45,2

Note: This table shows a summary statement of all the quantile regression results presented in Table 5 and 6. It shows the number and percentage of relevant linkages for the three estimation alternatives, in calm periods (α coefficient), in times of financial fragility (β coefficient) and at the subprime crisis period (θ coefficient).

Fig.1. Changes in the quantile regression coefficients for Islamic Emerging stock markets

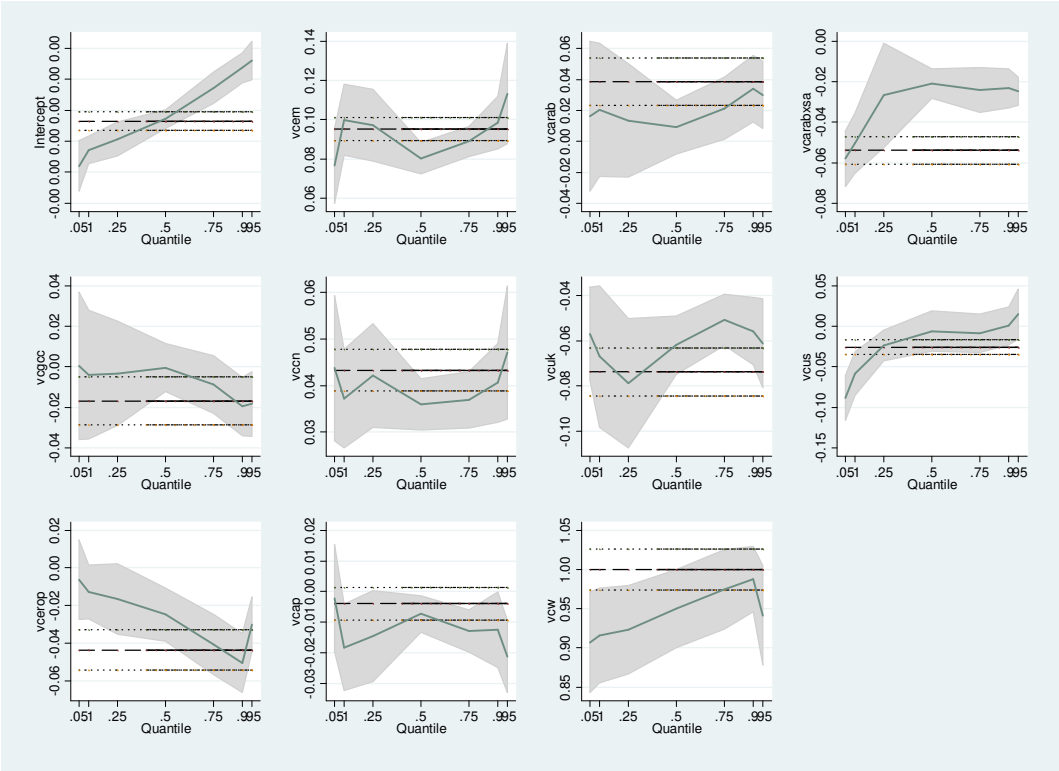

Fig.2. Changes in the quantile regression coefficients for Islamic United State stock markets