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Conventional and Islamic stock markets: What about financial performance?

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ABSTRACT

The main objective of this paper is to analyse the performance of both Islamic and conventional stock market indices, particularly during the financial subprime crisis period. For this purpose, we use updated data including the recent financial instability periods and a relevant methodology based on the time varying parameter model combined with a GARCH specification, a Granger non-causal test and a structural break points technique. The empirical results show that the weak efficiency hypothesis is relatively verified in the Islamic context than in the conventional one. Moreover, we can conclude that Islamic markets are not fully immunised against the effects of financial crises and the strong financial fragilities. The results of the Granger non-causality test suggest that the Islamic stock markets have succeeded to relatively escape important part of the last subprime crisis harmful effects. This may encourage investment in this type of markets and therefore allows the strengthening of economic growth.

1. Introduction

Islamic finance can be defined as part of the Shariah compliant finance industry, and thus presenting specificities related to the Islam principles in the field of business, which distinguishes it from conventional finance. This difference implies the existence of financial institutions whose referent is religious and assumes the supervision of their activities by a compliance monitoring committee. From the 80s, interest in Islamic finance knows greater growth and has acquired more notoriety especially where Islamic banks have succeeded to absorb the debt crisis shock that has hit the international banks in 1990. From this moment Islamic finance has been globally recognised as a fully fledged system. Subsequently,

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the international financial institutions have become interested in this new industry, the most significant example is the International Monetary Fund (IMF) who has drafted its first report on Islamic finance in 1987. The recent craze for Islamic finance is explained by the fact that some Islamic financial institutions have been practically immunised 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).

The same tendency of the 80s is checked during the past three decades. Indeed, a major part of the financial literature has been interested in analysing the performance of Islamic indices by asking the question of whether Islamic indices were more or less profitable than conventional indices (Alam et al. 2016; Rana and Akther, 2015; El Khamlichi et al. 2014; 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 results are much divergent and no consensus has been reached to date. Indeed, a number of studies have investigated and demonstrated the high level of Islamic finance performance compared to conventional finance (Arouri et al., 2013; Jawadi et al. 2014). Other studies noted significant diversification benefits when investing in Islamic finance assets (Hakim and Rashidian, 2002; Guyot, 2011), while Girard and Hassan (2008) and Kok et al. (2009) found contrary results. 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.

Modern financial theory teaches that the investment decisions in the stock markets depend mainly on the development level, the performance and the risk associated with it. Indeed, in their investment decisions, investors must take into account the informational efficiency concept because in an efficient market, investors are able to easily determine the risk and profitability of their investments, since there is no overvalued and/or undervalued title. Furthermore, because in an efficient market, the stock price adequately reproduces the firm perspectives, the capital will be allocated effectively to the most profitable investments, which is beneficial for market development and economic growth.

The main objective of this study is to analyse the performance of both Islamic and conventional stock market indices, particularly at normal time and during the financial Subprime crisis period. The performance is assessed by reference to one of the most important financial concepts, extremely useful in selecting investments, namely: the informational efficiency. Furthermore, we analyse the interdependence structure in terms of informational efficiency between Islamic stock markets. The originality of this work resides primarily in the use of specific econometric tools to the stock market context. Indeed, in order to test the hypothesis of weak efficiency, our empirical investigations are essentially based on time-varying model that takes into account the variability over time of various degrees of market efficiency. To our knowledge this econometric model is not yet applied in the context of Islamic finance. This analysis may constitute a help support to make investment decision by international investors.

To achieve our objective, we first adopt a different methodological approach to that used by previous studies and more specific to the stock market context, we treat initially the weak efficiency hypothesis. Given the evolutionary characteristics of stock markets, we consider the hypothesis according to which the weak efficiency of these markets evolve over time. This econometric model can detect both changes in the degree of efficiency and convergence speed towards the weak efficiency via the mutation of coefficients. One of the strengths of this work, compared to previous studies, is the examination of interdependencies between Islamic stock markets in normal time and during the last global financial crisis period. Indeed, to determine the interdependence structure, we adopted the Granger non-causality test and

the Bai and Perron (1998, 2003) technique, which consists of determining the different structural break dates. This technique is very relevant in the data processing related to stock markets that are generally characterised by the presence of multiple regimes in the variance (Bensafta and Semedo, 2011; Nguyen, 2008).

The investment decision is a function of the stock market performance. 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. The remainder of this article is organised 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

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 counterparts due to the fact that the included companies have passed the financial and extra-financial filter criteria (Atta, 2000; Hussein and Omran, 2005). In addition to these two divergent positions as to the performance of this category of indices, another current literature concludes that the performance of Islamic indices is similar to their conventional counterparts (El Khamlichi et al. 2014). In the following, we examine in detail several studies that have focused on analyzing the performance of Islamic and conventional indices.

Only a few studies have addressed the issues of performance in terms of informational efficiency among Islamic and conventional stock markets. Indeed, Obaidullah (2001) supports the idea that, in spite of ethical concerns, an Islamic stock market is not less efficient than a conventional one. Hassan (2004) empirically examines the market efficiency, the time-varying risk-return relationship for the DJIM index returns over the 1996-2000 period. Using the serial correlation, the variance ratio, the Dickey Fuller tests and the GARCH econometric framework, the author find that DJIM outperformed their conventional counterparts from 1996 to 2000 and underperformed them from 2001 to 2005. In the same way, Girard and Hassan (2008) find no convincing performance differences between Islamic and non-Islamic indices from January 1999 to December 2006. After controlling many ratios related to market risk, size, book-to-market, momentum, and local and global factors, the authors conclude that the difference in return between Islamic and conventional indices is not significant. Their findings suggest that the difference in performance of Islamic indices as compared to conventional indices is attributed to style differences between the two types of series. Guyot (2011) using the Wright's multiple rank test (2000), finds that Islamic indices from Dow Jones family present the same level of efficiency than conventional indices and highlights the influence of the subprime crisis on the degree of index integration.

Recently, El Khamlichi et al. (2014) study the efficiency of Islamic indices and their potential for diversification in comparison with the conventional benchmarks. The weak-form efficiency level is analyzed by testing the random walk hypothesis using variance ratio tests. The results show that Islamic indices have the same level of efficiency as conventional ones. Jawadi et al. (2015) analyze the weak-form informational efficient hypothesis for three major Islamic stock markets. Using recent data over the period May 2002–June 2012 and parametric and non parametric tests to investigate efficiency in the short and long horizons. The empirical results show that Islamic stock markets are generally efficient and more specifically emerging Islamic stock markets seem to be less efficient than developed Islamic markets.

From the previous literature review, one may notice a multiplicity of methodologies used in order to analyze the informational efficiency among Islamic and conventional stock markets. This paper attempts to explore the informational efficiency dynamics in normal times and around the last financial subprime crisis. The following section describes the methodology used in this study.

3. Empirical methodology

In this study, we were interested in the analysis of one of the major financial concepts that essentially orient investment decisions on both conventional and Islamic stock markets. Initially, we focused on the measurement and analysis of informational efficiency in order to compare Islamic stock markets to their conventional counterpart in terms of efficiency.

It is worth mentioning that in the financial literature, market efficiency has been defined in different ways, but until now, no standard conventional definition has been advanced. Therefore, it is important to clarify how to describe and measure the informational efficiency. We adopt in this context the definition provided by Fama (1970), according to which, an efficient market is one that is efficient in the treatment of information. Furthermore, in an efficient market, prices fully reflect all relevant and available information. According to Fama (1970, 1998), there are three types of efficiency and this depends on all the available information on the market, that is weak, semi-strong and strong efficiency.

Unlike financial traditional methods, we focus on the efficiency degree evolution over time. The idea behind this intuitive approach is based on the notion that the rapid maturation of stock markets through time involves major changes in the markets structure, a greater availability of the information and an increasing sophistication of markets participants. These changes likely induce the level of market efficiency to change through time (Arouri and Nguyen, 2010). Such feature, if it exists, cannot be taken into account only by a dynamic modeling of returns. For this purpose, we adopt the time-varying technique proposed by Zalewska-Mitura and Hall (1999), in which the autocorrelation coefficient of stock returns may vary depending on market conditions. Indeed, the weak form of efficiency can be tested by adopting the following model:

$$R_{i,t} = {}_{i,t}^{(0)} + {}_{i,t}^{(1)} R_{i,t-1} + U_{i,t} \tag{1}$$

$$U_{i,t} = h_{i,t} z_{i,t} \tag{2}$$

$$h_{i,t} = \sim_{i}^{(0)} + \sim_{i}^{(1)} U_{i,t-1}^{2} + \sim_{i}^{(2)} h_{i,t-1} \tag{3}$$

$${}_{i,t}^{(k)} = {}_{i,t-1}^{(k)} + \mid_{i,t}^{(k)}, \quad k = 0,1 \tag{4}$$

In these formulas, $R_{i,t}$ represents the Islamic and conventional stock market returns at time t, $\beta_{i,t}^{(0)}$ and $\beta_{i,t}^{(1)}$ respectively measure, for market i, the long-term trend and the potential serial dependency of stock market returns. They are allowed to change over time according to a first-order random-walk process. The idea behind this dynamic modeling is that time values of these unobserved factors are a function of underlying market fundamentals that drive stock market price formation (Arouri and Nguyen, 2010). h_t represents the conditional variance of model residuals $U_{i,t}$, which is assumed to follow the standard GARCH(1,1) specification proposed by Bollerslev (1986). The use of a standard GARCH specification was justified by the fact that many previous studies have shown the relevance of this model to the extent of the conditional volatility especially in the case of high frequency data. (Charles and Darne, 2006; Nikkinen et al., 2008; Ramlall, 2010). $z_{i,t}$ and $\eta_{i,t}^{(k)}$ represent random noises, assumed to be normally distributed with a mean of zero and respective variances of 1 and $V_{i,t}^{(k)}$. In order to apply the Kalman

filter, innovations in Eq.1 are further assumed to be uncorrelated with those in Eq.4. One can note that to validate the hypothesis of weak form efficiency, the estimated value of $\beta_{i,t}^{(1)}$ should be equal to 'zero' or statistically insignificant.

The estimation of this state-space model which is characterised by the presence of hidden variables requires the application of an optimal algorithm (the Kalman filter). Generally, the Kalman filter recursively delivers the optimal estimator of the system's current states, depending on the available information at that time, by a two-step process. To determine estimated values of the set of unknown parameters ($V_{i,t}^{(k)}, \alpha^{(0)}, \alpha^{(1)}, \alpha^{(2)}$), we have to construct a log-likelihood function based on the Kalman gain under the normality assumption (Harvey, 1995). Estimation of the model is then carried out using the quasi-maximum likelihood method introduced by Bollerslev and Wooldridge (1992), which provides asymptotic and robust estimates even though the conditional returns are not normally distributed. This model has been tested by Zalewska-Mitura and Hall (1999). Authors have shown that the model is quite powerful in the detection of the variability over time of various degrees of market efficiency in the case of the Kalman filter, except for a minimum number of observations at the beginning of the period.

Finally, to analyse the interdependencies among Islamic financial markets in terms of informational efficiency in normal periods and in time of the last subprime crisis, we adopted two different econometric techniques with the aim to optimise results. Indeed, the traditional technique of cause and effect has been implemented by the application of the non-causality Granger (1969) test. The test is applied to three sub-periods, a period before the crisis, a period during the crisis and another following the financial crisis. Secondly, we proceed to determine the structural break dates in the time varying predictability index by applying the Bai and Perron (1998, 2003) econometric technique which is of particular relevance and to our knowledge not yet used in the context of Islamic finance.

In this context, it is worth mentioning that, in Monte Carlo experiments, Bai and Perron (2006) have found 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.

$$^{1}_{i,t} = a_0 + a \; ^{1}_{i,t-1} + £_{i,t} \tag{5}$$

$\beta_{i,t}^{(1)}$ is the estimated time varying predictability index in period t. If there are *m* multiple structural breaks (T_1 , …, T_m) in the time path of $\beta_{i,t}^{(1)}$. 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. (5) is estimated by OLS regression for each T_m. The breakpoints estimations are generated by minimising the sum of squared residuals and are given by:

$$(\hat{T}_1,\ldots,\hat{T}_m) = \arg\min_{T_1,\ldots,T_M} S_T(T_1,\ldots,T_m) \tag{6}$$

In this expression, S_T is the sum of squared residuals issued from the estimation of *m* regressions. The selection procedure of structural breaks is based on the Bayesian Information Criteria (BIC).

To conduct this analysis, Bai and Perron (2006) impose some restrictions on the possible values of break dates. In particular, each break date must be asymptotically distinct and bounded by the borders of the sample. For this purpose, they impose different thresholds (trimming parameters) for the estimation of their model [$£ = (0.25; 0.15; 0.10; 0.05)$], with $£ = h/T$, where *T* is the sample size and *h* is the minimal permissible length of a segment. They recommend not to use a trimming parameter below 5% when taking into account the heteroscedasticity and the serial correlation. Indeed, we retain the threshold of 5% in our work.

4. Data and descriptive analysis

Throughout our work, we used daily data of a sample of Islamic and conventional markets. The stock markets choice was based on data availability. The market data were extracted from the Datastream database. It was expressed in USD, covering the period from January 1, 1996 to January 18, 2016 and included ten Global Islamic Indices namely: the DJIM Index, as well as its conventional counterparts, the DJ Emerging Markets Index, the DJ Canada Index, the DJ United Kingdom (UK) Index, the DJ United State (US) Index, the DJ Europe and the DJ Asia/Pacific Index. The choice of DJIM is justified by the fact that it is the most comprehensive and the most used representative of Islamic stocks. Our sample period covered 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.

Table 1 (see Appendix) presents the descriptive statistics of daily returns. We note that they are globally similar to the findings of previous studies. First, market returns are significantly departed from normality according to the Jarque-Bera test. Second, the study of stationary by the use of the Dickey-Fuller unit root test clearly shows that the distributions of market returns are stationary, even at the 1% confidence level, since the ADF calculated value is strictly below the critical threshold. Finally, the Engle's (1982) test for conditional heteroscedasticity rejects the null hypothesis of no ARCH effect in monthly returns. This justifies the use of the GARCH specification.

5. Empirical results and discussion

By examining the state-space model estimation results which are shown in Table 2 (see Appendix), we can remark that the mean of $\beta_{i,t}$ coefficient is usually very close to zero, which shows that past returns are not very helpful in anticipating future returns in the case of both conventional and Islamic markets. Then, we can conclude at the existence of the independence between the past prices and future prices.

A deeper reading of the results allowed us to firstly notice that the average values of $\beta_{i,t}^{(0)}$ coefficients, which represent the constant term in Eq. (1) of the estimated model, are close to zero and listed in the interval [0.006% ; 0.081%] for all the conventional markets and in the interval [0.001% ; 0027%] for all the Islamic markets. This suggests a low level of return predictability related to other potentials, such as macroeconomic effects, political events and external shocks (Arouri and Nguyen, 2010). Secondly, as regards to the $\beta_{i,t}^{(1)}$ coefficients, whose variations indicate the time-varying predictability (autocorrelation) levels in stock returns, their averages are not very different across markets and stand around an average of 8.95% for the conventional markets and 8.73% for the Islamic markets. This supports the hypothesis of serial independence between past and future returns, except for the conventional and Islamic emerging markets, the conventional Arab markets and the global market whose recorded coefficients are usually very high, indicating that past returns predict about 14% of the current returns evolution.

In light of these results, it is obvious to note that the weak efficiency hypothesis is more verified in the Islamic context than in the conventional context. Indeed, we note that the average coefficient of the time-varying predictability is consistently lower in the case of Islamic markets than in the case of conventional markets. So, we can conclude that Islamic markets are relatively more efficient in terms of informational efficiency than their conventional counterparts.

Finally, regarding the global significance of the two coefficients ($\beta_{i,t}^{(0)}$ and $\beta_{i,t}^{(1)}$), we suggest a relative stability over time given the lowest estimated values of the innovations variance issued from the stated equations (Eq. 4). Moreover, it seems that the GARCH (1,1) model seems to be performing to explain the variations of the conventional and Islamic stock market returns since it can detect the leptokurtic behaviour and the conditional heteroscedasticity in the returns. Indeed, the parameters of the conditional

variance equation are positive, statistically significant at 1% confidence level and satisfy the conditions of theoretical stability $\left(\alpha_i^{(0)} > 0,\ \alpha_i^{(1)} \geq 0 \text{ and } \alpha_i^{(2)} \geq 0\right)$.

In order to test the hypothesis of weak efficiency before and after the last subprime crisis and around financial instability periods which generally characterized by a high volatility level, it seems important to report the evolution of the time-varying predictability indices with a 95% confidence intervals, while taking into account the evolution of volatility.

Our analysis for the predictability index is based on the following reasoning: the assumption of weak efficiency is verified if the evolution is not significantly different from zero. A negative effect of a strong financial fragility/crisis on the efficiency is explained by the increase of the return predictability level during or just after a strong increase in volatility. Even though the market was not efficient before the volatility shock, the negative effect is a decline of the efficiency degree in the period following the volatility shock. Figure 1 (see Appendix) shows the evolution of both the time-varying predictability indices with 95% confidence intervals and the volatility.

In the light of Figure 1 (see Appendix), we can make some general remarks for all studied markets and specific comments inside groups that are identified based on the degree of efficiency. First, as noted by Zalewska-Mitura and Hall (1999), at the beginning of the period, observations arising from the application of the Kalman filter are too volatile. Second, we distinguish three groups of markets according to their degree of informational efficiency. The first group which includes two conventional markets (U.K. and U.S.) and two Islamic markets (Islamic U.K. and Islamic U.S.) evokes efficiency over the entire study period. Indeed, the zero line is located within the estimated confidence interval which leads to accept the null hypothesis of efficiency. A second group contains markets which are characterized by the inefficiency on several sub-periods at the beginning and the middle of the period, but gradually converge towards efficiency at the end, since the associated autocorrelation coefficients decline steadily over time, and are very close to zero. This group includes three conventional markets (Canada, Europe and Asia Pacific) and tree Islamic markets (Islamic Canada, Islamic Europe and Islamic Asia Pacific). The last group that is controversy to the previous groups, involving four markets, including one conventional market (Emerging markets) and two Islamic markets (Islamic Emerging markets and Islamic markets (G)). These markets are characterised by the absolute inefficiency on the entire period or by the efficiency for short period at the beginning of the study period, but show a degree of inefficiency increasingly important over time.

Moreover, we notice that the degree of efficiency varies from one market to another, which leads us to believe that the specific characteristics of each market, including the liquidity and the development level may explain the difference in the level of efficiency between markets. This fact is also mentioned by Arouri and Nguyen (2010) as well as Fontaine and Nguyen (2006). According to these authors, the lack of liquidity slows down the incorporation of available information in the stock price and in this case hinders the convergence process to efficiency.

Finally, we note that several changes in the trend of the time-varying predictability are realised at the time of financial crisis and at the financial fragility periods where one can notice a deterioration of the informational efficiency degree of both conventional and Islamic markets. To summarise, we can deduce that the weak efficiency hypothesis is relatively verified in the Islamic context than in the conventional one. However, this varies from one market to another depending on the specific characteristics of each of them. Moreover, we can conclude that Islamic markets are not fully immunised against the effects of financial crises and the strong financial fragilities. Our findings are in line with those of Albaity and Ahmad (2008), Hussein and Omran (2005) as well as Hassan (2004) when they find that the Dow Jones Islamic index is more efficient than the conventional counterpart.

Throughout the literature, it is obvious to conclude that there was a very strong interdependence in terms of efficiency between conventional stock markets which reflects the diversification opportunity in these markets. Our analysis of interdependencies between Islamic stock markets through the use of break-point test leads us to conclude at the existence of a strong interdependence between Islamic markets, especially during the subprime crisis. Indeed, from Table 3 (see Appendix), we notice a strong similarity between the structural break dates. This similarity is rather checked during the subprime crisis (2007-2009). This strong interdependence means that the predictability of returns from various Islamic markets depends on each other and that these markets are not totally immune to the effects of financial crises.

The results of the Granger non-causality test (see Table 4 in Appendix) confirms the preliminary findings of the Bai and Perron (1998, 2003) test and show very strong positive interdependencies between the Islamic stock markets. Indeed, many causal links were identified between these markets. Significant and always positive causal coefficients are synonym of informational inefficiency which is transmitted from one market to another. Nevertheless, one can notice a decrease in significant links during the financial crisis sub-period or at least a reduction in the causal coefficient value at this period. This finding allows us to conclude that Islamic markets have succeeded to relatively escape the last subprime crisis harmful effects. This has been explained in the literature by the fact that the Islamic equity markets are considered as “sin stocks” (Hong and Kacperczyk 2009) which are known to be more resilient in times of crisis, or “recession-proof”. Moreover, Islamic equity indices frequently contain the equities of small cap companies with low debt and may have the growth potentiality when the trend is up (Hussein and Omran 2005). The performance differences can also be attributed to the management style differences (Girard and Hassan 2008; Binmahfouz and Hassan 2012).

6. Conclusion

The informational efficiency is a very important concept, reflecting the effectiveness of the market policy investment. In recent years, the financial literature has focused on determining the degree of informational efficiency in Islamic stock markets, which are actually considered as good sites for investment. This paper joins the literature to test the hypothesis of weak efficiency on a sample of Islamic and conventional stock markets and to analyse the interdependencies in terms of informational efficiency of these two types of markets in normal times and in financial crisis times. In fact, the attention is focused primarily on modeling the weak efficiency, taking into account the evolutionary characteristics of Islamic and conventional stock markets. Indeed, we consider the argument that the weak efficiency of these markets evolves over time. Then, the attention is paid to determine the evolution of the interdependencies on three sub-periods (before, during and after financial crisis). Indeed, we adopted first, a technique developed by Bai and Perron (1998, 2003) that allowed us to determine the multiple structural breaks existing in the time-varying predictability indices and second, we used the Granger (1969) non-causality test.

Our results show firstly that the weak efficiency hypothesis is relatively verified in the Islamic context than in the conventional one. This is a good indicator for regulators of these markets, since a greater efficiency naturally leads to an increase in investment. Second, empirical results show that structural breaks detected in the Islamic time varying predictability indices coincide with the subprime crisis period. This strong interdependence means that these markets are not totally immuned to the effects of financial crises. Nevertheless, the results of the Granger non-causality test suggest that the Islamic stock markets have succeeded to relatively escape important part of the last subprime crisis harmful effects. This may encourage investment in this type of markets and therefore may allow for the strengthening of economic growth.

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APPENDIX

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^{+++}
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 States	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^{+++}
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^{+++}

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 heteroscedasticity 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, 1996 to January 18, 2016.

Table 2. Estimation results from the state space model with GARCH effects

	Conditional mean equation		State equations		Conditional variance equation				Likelihood value
	$_i^{(0)}$ (%)	$_i^{(1)}$ (%)	$V_i^{(0)}$	$V_i^{(1)}$	$\sim_i^{(0)}$	$\sim_i^{(1)}$	$\sim_i^{(2)}$	$\sim_i^{(1)}+\sim_i^{(2)}$	
Conventional markets									
Emerging markets	0.022 (0.000)	26.492 (0.049)	0.000** (0.000)	0.002* (0.001)	0.000** (0.000)	0.106** (0.005)	0.887** (0.005)	0.993	16548.975
Canada	0.033 (0.000)	10.276 (0.020)	0.000 (0.000)	-0.001** (0.000)	0.000** (0.000)	0.069** (0.004)	0.928** (0.004)	0.997	15720.990
United Kingdom	0.030 (0.000)	-3.215 (0.048)	-0.000 (0.000)	-0.004* (0.002)	0.001** (0.000)	0.080** (0.005)	0.909** (0.006)	0.989	15998.709
United States	0.017 (0.001)	-5.620 (0.053)	-0.000 (0.000)	0.003** (0.001)	0.000** (0.000)	0.087** (0.005)	0.900** (0.006)	0.987	14712.781
Europe	0.031 (0.000)	1.403 (0.050)	0.000 (0.001)	0.002 (0.001)	0.000** (0.000)	0.084** (0.005)	0.909** (0.005)	0.993	15970.633
Asia Pacific	-0.011 (0.001)	7.577 (0.034)	-0.000* (0.000)	-0.001 (0.000)	0.000* (0.000)	0.085** (0.005)	0.905** (0.006)	0.990	15941.030
Islamic markets									
Islamic Emerging markets	0.021 (0.001)	20.520 (0.012)	0.000 (0.000)	0.000 (0.006)	0.000** (0.000)	0.103** (0.006)	0.889** (0.005)	0.992	15951.888
Islamic markets (G)	0.006 (0.000)	15.849 (0.025)	-0.000* (0.000)	-0.000 (0.001)	0.001** (0.000)	0.082** (0.005)	0.908** (0.005)	0.990	13805.513
Islamic Canada	0.008 (0.001)	9.210 (0.007)	-0.000 (0.000)	0.000 (0.001)	0.000** (0.004)	0.063** (0.003)	0.934** (0.003)	0.997	14513.519
Islamic UK	0.021 (0.000)	-2.073 (0.047)	-0.000 (0.000)	0.004* (0.002)	0.002** (0.000)	0.063** (0.004)	0.929** (0.004)	0.992	15633.658
Islamic US	0.009 (0.000)	-4.532 (0.053)	-0.000 (0.000)	-0.004* (0.002)	0.000** (0.000)	0.086** (0.005)	0.901** (0.006)	0.987	16101.963
Islamic Europe	0.027 (0.001)	-1.407 (0.027)	0.000 (0.000)	0.002 (0.002)	0.000** (0.000)	0.075** (0.005)	0.919** (0.004)	0.994	15846.503
Islamic Asia Pacific	-0.008 (0.001)	5.447 (0.038)	0.000** (0.000)	0.001 (0.000)	0.000** (0.000)	0.080** (0.005)	0.912** (0.005)	0.992	16000.810

Notes: The standard deviations of estimated parameters are given in parenthesis. For the estimated parameters in the conditional mean equation, we report their averages since they are allowed to vary over time. The significance of these coefficients ($_i^{(1)}$ in particular) in each time period is examined by using a standard t-test and shown in the graph of time-varying predictability (see, Figure 1). * and ** indicate that coefficients are respectively statistically significant at 5% and 1% level.

Table 3. Number and structural break dates in the time varying predictability indices

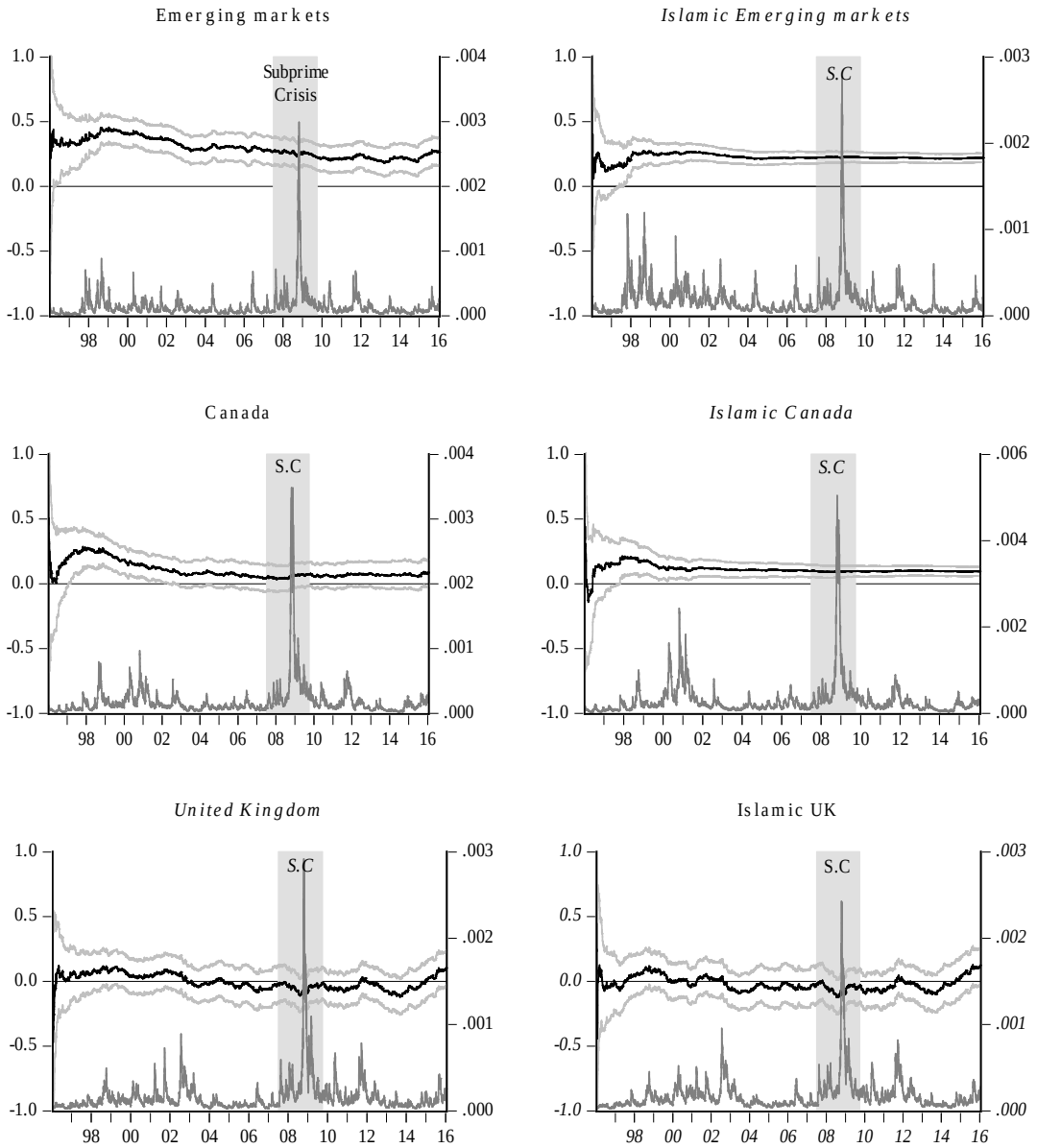
Conventional stock markets						
Emerging markets	Canada	UK	US	Europe	Asia pacific	
6	5	6	6	5	7	
02 Apr 2003	02 Apr 2003	21 Apr 2003	02 Apr 2003	23 Jun 2003	01 Mar 2004	
20 Apr 2007	05 Jul 2006	23 Jan 2006	21 Jul 2005	15 Dec 2005	08 Nov 2006	
17 Jul 2007	12 Nov 2007	01 May 2008	25 Sep 2007	14 Jan 2008	12 Nov 2007	
21 Sep 2007	16 Jul 2008	23 Oct 2009	22 Jun 2009	22 Jan 2009	21 Jan 2008	
18 Feb 2009	22 Sep 2011	10 Mar 2011	22 Jan 2010	18 Jun 2010	09 Feb 2009	
16 Oct 2013		16 Oct 2013	01 Feb 2012		18 Sep 2012	
					18 Feb 2013	
Islamic stock markets						
Islamic Emerging markets	Islamic markets (G)	Islamic Canada	Islamic UK	Islamic US	Islamic Europe	Islamic Asia pacific
4	3	5	6	5	5	6
02 Apr 2003	02 Apr 2003	02 Apr 2003	02 Apr 2003	02 Apr 2003	02 Apr 2003	02 Apr 2003
16 Jul 2007	31 Jul 2007	12 Sep 2005	09 Aug 2005	20 Jul 2005	24 Mar 2006	19 Jan 2006
17 Nov 2009	08 Dec 2009	13 Dec 2007	23 Jul 2007	21 Sep 2007	30 Jul 2007	01 Aug 2007
15 Aug 2012		15 Jul 20011	04 Jan 2008	08 Apr 2009	27 Oct 2009	22 Apr 2008
		17 Aug 2012	09 Mar 2011	27 Jan 2012	09 Mar 2012	27 Oct 2009
			16 Aug 2012			18 Mar 2013

Notes: This table reports the structural breaks identified in the time varying predictability indices of various conventional and Islamic stock markets generated from the Space-Space model.

Table 4. Results of Granger non-causality test before, during and after Subprime Financial Crisis (SFC)

Independent variables	Sub-periods	Dependent variables							$\overline{R^2}$
		Islamic Emerging markets	Islamic markets (G)	Islamic Canada	Islamic UK	Islamic US	Islamic Europe	Islamic Asia pacific	
Islamic Emerging markets	Before SFC	-	1.616	1.488	**2.055****	0.895	**2.386*****	1.133	0.998
	During SFC	-	1.271	0.983	0.853	0.678	1.029	**3.028*****	0.973
	After SFC	-	1.401	**1.787***	1.276	0.714	1.301	**2.116****	0.974
Islamic markets (G)	Before SFC	**4.179*****	-	**1.994****	**1.785***	1.091	**2.545*****	**6.786*****	0.972
	During SFC	**1.664***	-	**1.864****	**2.340***	1.414	1.507	**5.001*****	0.976
	After SFC	**1.942****	-	1.213	1.472	1.248	**1.882****	**9.824*****	0.990
Islamic Canada	Before SFC	**2.695*****	**3.142*****	-	0.803	1.146	1.257	**3.469*****	0.989
	During SFC	1.222	0.492	-	0.872	0.556	0.822	1.514	0.975
	After SFC	**4.178*****	**2.772*****	-	**3.043*****	**1.844****	**2.828*****	**7.579*****	0.996
Islamic UK	Before SFC	1.262	**2.215****	**2.242****	-	1.196	0.788	**1.626***	0.992
	During SFC	1.125	1.595	0.566	-	1.107	0.454	**2.315****	0.981
	After SFC	**1.627***	1.353	**2.035****	-	1.218	1.271	**3.841*****	0.982
Islamic US	Before SFC	**3.751*****	0.964	**1.697***	**2.782****	-	**4.015*****	**6.438*****	0.997
	During SFC	**1.670***	1.443	**1.949****	**2.037****	-	1.198	**2.772*****	0.994
	After SFC	**2.903*****	1.550	1.243	1.112	-	1.244	**12.861*****	0.992
Islamic Europe	Before SFC	**2.129***	**1.649***	**3.223*****	1.149	0.638	-	**2.556*****	0.996
	During SFC	**1.746***	1.567	0.491	1.345	0.667	-	**4.663*****	0.967
	After SFC	**1.789***	**1.603***	**2.001****	1.090	1.535	-	**5.947*****	0.988
Islamic Asia Pacific	Before SFC	1.477	**2.025***	1.506	**1.799***	1.012	**2.604*****	-	0.953
	During SFC	0.927	1.263	1.414	**2.001****	**1.685***	**2.199****	-	0.932
	After SFC	1.111	**1.611***	1.361	**2.164****	**1.747***	**1.394**	-	0.941

Notes: Results in this table are the Fisher statistics attached to the Granger non-causality test. *, ** and *** indicate that the coefficients are significant, respectively, at the 10%, 5% and 1%.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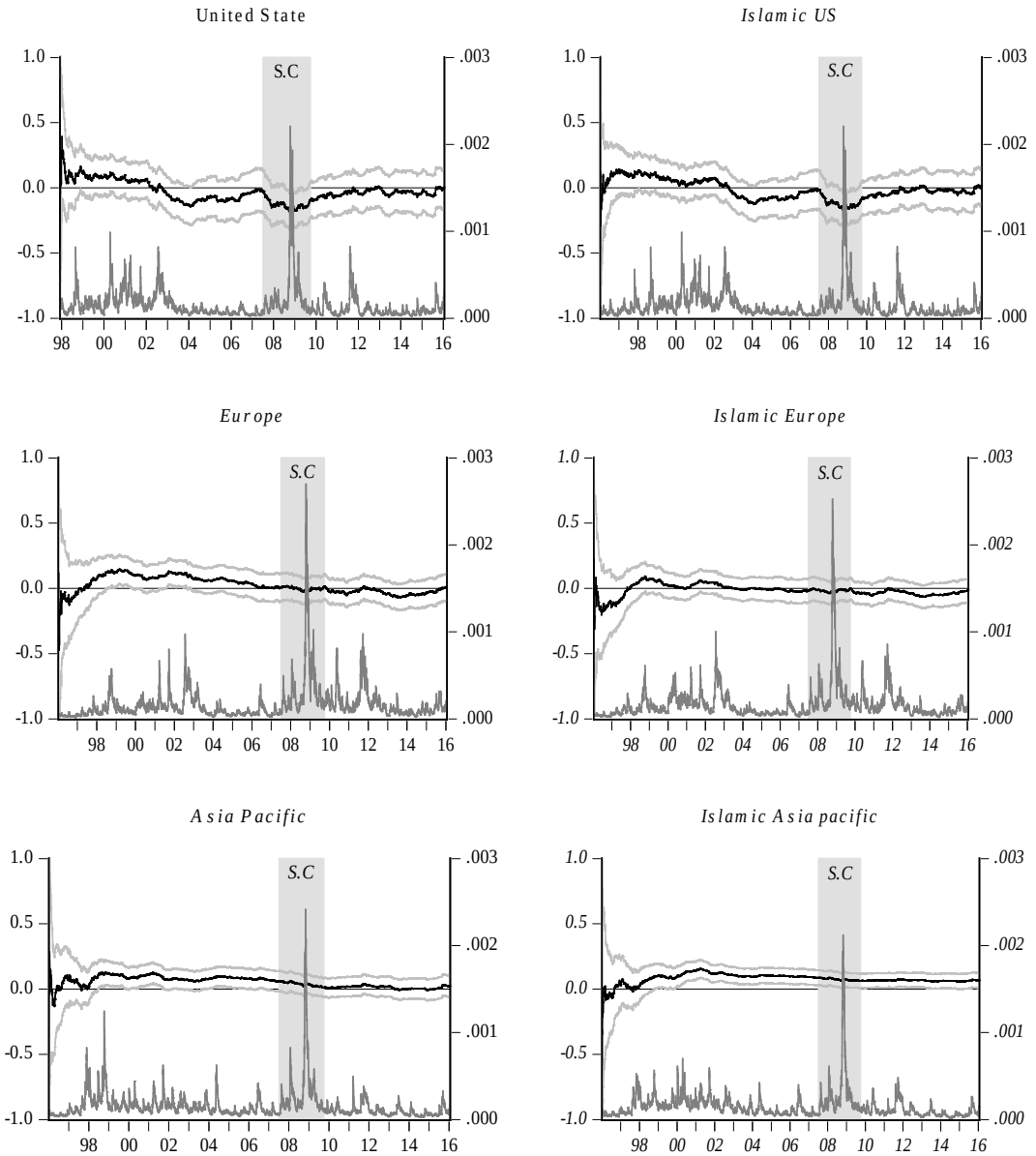
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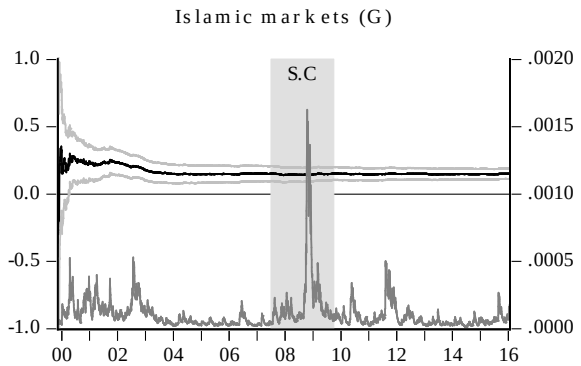

Left axis: Efficiency Evolution Right axis: Volatility Evolution

Fig 1. Evolving efficiency and volatility in conventional and Islamic stock markets, time-varying predictability index with 95% confidence intervals.