How is the European debt crisis affecting islamic equity? challenges in portfolio diversification within the eurozone: A markov switching and continuous wavelet transform analysis

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Abstract

The European Debt crisis hit hard on the Eurozone, where the market convergence, rigid exchange rates and the single currency based instruments create tight challenges for investors in terms of looking for safer investments and portfolio diversification. Islamic Equity markets in Eurozone provide safety compared to debt based highly volatile derivatives that caused the global financial collapse. Since it is critical to study areas with implications for the portfolio diversification issue for the investors and policy makers from the perspective of Islamic Equity markets, this paper makes the humble effort of filling in the gap in literature. The paper analyses how the Islamic Equity Markets in the Eurozone change in periods of crisis analyzing their regime shift probabilities and durations using Markov- Switching techniques. Overall, the time-variations in market indices suggest that the Islamic Equity markets in Eurozone are not immune to external shocks and they tend to fluctuate with the economic and financial shocks. The study also shows how Islamic Market investors, from Germany's perspective could find any optimal diversification opportunities inside the Eurozone and shows if there is a need for investing outside the Eurozone to maximize diversification benefits by empirically testing the time-varying and scale dependent volatilities and correlations using the method of Continuous Wavelet Transform. The period covered is from 12 June 2008 till 21 April 2016, with spans of weekly data of S&P Europe 350 Shariah – (S&P Dow Jones Indices) stock index prices changed into returns using logarithmic equations. The results of the study shed light into the area pf portfolio diversification between the studied countries within the Eurozone, showing very little diversification opportunities between the member countries. Overall there is little room for diversification in the highly correlated markets across heterogeneous investment horizons.

Keywords*:* International Portfolio Diversification, Eurozone Islamic Equity Markets Stock, Islamic Stock, Markov Switching Auto-Regressive (MS-AR), Continuous Wavelet Transform (CWT)

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Introduction

The whole world is still being affected by the European debt crisis which started around October 2009 rooting from the U.S led global financial meltdown of 2008-2009. Many countries in the Eurozone, which comprises of 17 European countries united with a common currency "the euro" and common economic policies, lost control of their debts which were high but manageable with prospects of economic growth prior to the financial crisis (Stracca, 2013). The unsustainable financial policies, with rigid exchange rate regimes, coupled with the slow global economic growth are reasons contributing to this crisis. The ongoing refugee migration crisis affecting the Europe most, cannot be ignored in this sense too which leads governments to increase their overwhelming debts to help accommodate the immigrants into their economies which call for reforms of many economic policies as well (Aiyar et al., 2016). The debt crisis is in a stage where the whole Eurozone might end up in a regional recession.

The investors saw Eurozone as a safer investment zone because of the backing the countries had from each other in the zone. However, things changed after investors of Greek bonds started selling their bonds after being pessimistic about the skyrocketing debt ratio of the country. There was no clear and quick strategy to deal with the negative turn of events since the countries didn't have a fiscal union (Huang, 2013). Markets started panicking when European Central Bank *(*ECB*)* denied to intervene to be the lender of the last resort. Overall, the Eurozone became uncompetitive with high inflation, loss of demand for exports, a growing current account deficit lowering economic growth throughout the region.

Germany is the economic engine for the Eurozone, however its slowing economy is hindering its ability to carry the region by providing supports and funds to the struggling countries within the Eurozone. Germany's investment banking profit decreased due to the Europe's debt crisis and they had to decrease their banking costs by reducing risk-weighted assets and cutting jobs. If the debt crisis continues to become worse, Germany's economic condition will only have a small chance of survival since it continues to help out the countries in need. (Huang, 2013). Since the impact of the Debt Crisis would be huge on Germany because of the position it holds, it will affect the investor's confidence and they will look for diversification areas within or outside the Eurozone.

The common monetary policy and government bills and bonds denominated in euro makes forming market integration, makes it more restrictive for investors to achieve portfolio diversification within the region (EUN and Lee, 2010; Beine et al., 2010). Some have studied the impact on the stock market of portfolio diversification within the Eurozone after the 17 Eurozone countries were bound by a single currency and fixed exchange rates. Some studies have been conducted studying the effects of the global financial crisis on the Eurozone (Smimou, 2011). Finane. Although there are studies studying the effects of financial crisis on global portfolio diversification, rare are studies done on a combining of financial crisis on portfolio diversification specially for the investors in the Islamic Equity Markets in the Eurozone.

Since Islamic Finance has been fast growing internationally in the global financial system, Europe has also embraced the popular alternative to conventional finance despite still being at a young stage, due to the government incentives to compete globally to make the finance industry thrive internationally, to cater to the demands of the growing Muslim population in Europe and most importantly as a safer alternative to combat the ongoing European financial crisis as compared to the conventional highly volatile debt based financing (Mauro et al. 2013). Equity markets are safer than deb based instruments and emphasis on the Islamic stock markets should not be neglected in light of the crisis.

Dow Jones Islamic Market Index launched in 1999 is an Islamic Market Index created for investors seeking equity investments in compliance with the unique principles of the Shari'ah. The index comprises of investment principles with the transparency and rules-based methodology of the traditional Dow Jones Index. It covers thousands of blue chips, fixed income investments and indices arranged along thematic lines. (Mauro et al. 2013) Companies who meet the required criteria can qualify for inclusion in the indices. The screening criteria have industry and sectoral screens such as screening for are riba (interest), gharar (uncertainty), maysir (gambling), prohibited commodities (liquour, pork,etc.) and fulfilment of contractual requirements as required in the Islamic Law of Contracts (Rosly, 2005) and also financial screens that look at the leverage of the company. The fast and huge growth of the Islamic financial sector with an average annual growth rate ranging from 15% to 20% per annum over the past decade (IIFM, 2010) encourages policy makers to look into Islamic finance solutions and investors to study the volatilities and co-movements of asset returns compared to conventional finance and risk and benefits of potential international portfolio diversification benefits with Islamic equity.

Since literature on the effects of the European Debt Crisis on Islamic equity markets in Eurozone is lacking, the paper is a humble attempt to fill in this gap by answering the following research questions crucial to investors, fund managers and policy makers. The aim of the paper is

(1) to understand how the Islamic Equity markets in the Eurozone performed during the periods of crisis such as the ongoing European Debt Crisis (using regime – shifting Markov Switching methodology)
(2) to find if there are any portfolio diversification benefits within the Eurozone at different holding periods and different frequencies.

The paper will analyze the Islamic equity markets of Germany, Belgium, Denmark, France and Italy since they are the most developed financial markets in the regions and the largest in terms of GDP and since the required data was available for these markets without any structural breaks for the period analyzed.

The data is analysed from the perspective of Germany 's Islamic equity market. Germany was selected based on the fact that it was the first Western country to tap the Islamic capital market with the issuance of their first sukuk in 2004, and Germany being the largest European economy featuring the largest Muslim population with more than 4 million people. Also German exporters could use institutions offering Islamic financing solutions as alternative sources of funding to increase their profit and loss sharing based businesses. They can open up trading with countries investing in Islamic finance to increase their inflow of funds and build the economy which would reflect positively on the Eurozone. The prospect for growth of Islamic finance in Germany looks good since German financial institutions also actively participate in the Islamic finance industry via their subsidiaries in London, Dubai and Kuala Lumpur (Mauro et al. 2013).

The paper's main contribution is to analyze the probability of regime shift during the studied period in light of the European Debt crisis and the duration of each regime by utilizing modern econometric method of Markov switching which is vital in dividing into different regimes in the absence of a known regime shifting variable. The study also attempts to give light to the existing literature on Islamic equity portfolio diversification by analyzing the sample within the Eurozone with emphasis on correlation and volatility depending on time-scale and investment horizon varying perspective using Continuous Wavelet Transform (CWT).

The results from the study could help the policy makers , investors in the Eurozone especially from the perspective of Germany's Islamic Equity Market in helping them in policy making integrating Islamic equity finance and portfolio diversification benefits and challenges and to identify unique portfolio diversification opportunities for the different sets of investors bearing different investment horizons or holding periods of stock (e.g. weekly, monthly, quarterly and so on) particularly for the Eurozone Islamic equity investors.

The paper first reviews the relevant literature related to international portfolio diversification; time varying and scale dependence of international stock market correlations; and Islamic stock markets theory and performance. It follows a brief look at the theoretical underpinnings. The next sections describe the data and methodology used to analyse the research objectives of the paper. The next section shows the results based on the methods used. After the explanation of the results, the paper outline the limitations of the research with regard to its scope and data giving suggestions for future improvements. The last section concludes the findings of the paper and suggests policy implications based on the results.

Literature Review

Most of the past research focuses on constant correlations and the benefits of diversification to US investors, hence other characteristics of international stock portfolios and the diversification benefits to foreign investors have been ignored. The literature review is adopted from Ilhan & Masih (2013).The first prominent studies on the international stock market diversification issue started in the 1970s. some of the prominent ones as such Levy and Sarnat (1970), Solnik (1974, 1982), Black and Litterman 1992 and Jankus 1998, since globalization and international investing topics became very vital. The reason behind those studies was simply to determine the constant correlations in regard to the creation of international portfolios to gain diversification benefits. While Levy and Sarnat (1970), for instance, show how the correlations between the developed and developing countries provide a significant risk reduction benefit, Solnik (1974) provides evidence that combining stocks from US and European countries generates portfolios that are only half as risky as domestically well diversified portfolios of US stocks.

International stock market connections are of crucial importance to international investors to identify a mix of international stocks that creates optimally diversified portfolios with the lowest possible risks (Dajcman et al, 2012). As the fact, the essence of lower risks from international diversification is critically dependent upon low correlations across markets (Grubel and Fadner, 1971). Thus, an increase in co-movements between asset returns of internationalstock markets can diminish the advantage of internationally diversified investment portfolios (Ling and Dhesi, 2010). On the other hand, Dwyer and Hafer (1988), Longin and Solnik (1995),Errunza et al. (1999), Driessen and Laeven (2007), Eun and Shim (1989), Von Furstenberg and Jeon (1989), Bertera and Mayer (1990) examined various stock price indicesaround at the time of stock market crash of 1987 and found a substantial amount of interdependence among national stock markets as contradictory to the previous studies.

It has been further studied in the literature that correlations amongst markets are evolving through time due to changes in interdependence across markets (Engle, 2002). Therefore, market returns are not only time varying, but may also be dependent on time scales highlighting the importance of investments horizons (Gencay et al, 2001). The stock markets crash of 1987, however, provided new insights into the literature of international financial markets interdependence, which contradicted past theories and empirical results. Dwyer and Hafer (1988), using daily data for seven months before and after the October 1987 crash report statistical evidence that changes in the stock price indices in Germany, Japan, US and USA are generally related. In addition, other studies such as Longin and Solnik (1995), Errunza et al. (1999), Driessen and Laeven (2007) Eun and Shim (1989),Von Furstenberg and Jeon (1989), Bertera and Mayer (1990) also examined various stock price indices around the stock market crash of 1987 and found a substantial amount of interdependence among national stock markets. The appeared inconsistencies in the literature continued to be seen after then. More recently, the studies such as Becker et al. (1990), Hamao et al. (1990), and Kasa (1992) studies the possible linkages between US and Japanese markets finding strong correlation between them with an asymmetric spill-over effects from the US to Japanese market. Briefly, the literature studying stock market linkages and its resulting impact for international portfolio diversification strategies has remained inconclusive with the results reporting contradictory evidence. Hence this subject needs further investigation

Most recently, Dacjman et al (2012) find that co-movement dynamics between the developed European stock markets ofthe United Kingdom, Germany, France and Austria are not constant and returns are time varying. Hence, when modeling volatilities and correlations, it is more appropriate to use time varying conditional correlations models as compared to constant correlations model Similarly, studies have also found that investment holding periods (for e.g. 2 days, 6 days, 30 days, etc.) also have an impact on the volatilities and correlations dynamics of stock market returns. This type of research is relatively new and there are only a few empirical papers that incorporate time scaling in examining volatilities and correlations. Gencay et al (2001) were one of the earliest proponents of the time scaled dependence of returns and correlations in financial markets. In and Kim (2013) have combined a cluster of their papers using wavelet time-scaling in finance to produce a book just published called „An introduction to Wavelet nTheory in Finance‟. Dacjman et al (2012), in their recent study on co-movement dynamics between the developed European stock markets of the United Kingdom, Germany, France and Austria also find evidence in favor of scale dependence for stock market returns. Hence, future studies are recommended to consider the time scale properties in modeling volatilities and correlations.

Smimou, K. (2011) studied the impact on the stock market of portfolio diversification within the Eurozone after the 17 Eurozone countries were bound by a single currency and fixed exchange rates. Although the Euro market integration has increased inter-country correlations, it does not preclude gains from international diversification, which partially rely on the non-Eurozone countries for an optimal portfolio in a mean-variance framework. Furthermore, the empirical evidence supports that there is a significant stationarity of average correlations over time between pre-Euro and post-Euro periods, and it has improved since the introduction of the Euro. Also, their results show that the Euro produced a change in volatility with a different pace within the Eurozone vis-à-vis non-Eurozone countries, to support a direct and opposite relationship between volatility and correlation.

Literature on Islamic stock portfolio diversification is limited. As a fact that Islamic stock markets are quite recent, studies on stock market integration among Islamic stock markets worldwide are still relatively scarce (Moeljadi, 2012). Hakim and Rashidian (2004), for instance, attempt to examine the returns performances of the Dow Jones Islamic Market Index (DJIM), Dow Jones World Index (DJW) and Dow Jones Sustainability World Index (DJS) by using the capital asset pricing model (CAPM) framework. The study finds that DJIM has done relatively well compared to the DJW, but has underperformed the DJS. Hussein (2005), as another study, analyses the DJIM returns for the period 1996 to 2003 and posits that Islamic indexes provide investors with positive abnormal returns throughout the entire bull period, but they under-perform their non-Islamic index counterparts during the bear market period. The study held by Abderrezak (2008) scrutinizes 46 Islamic Equity funds (IEFs) during January 1997 to August 2002 by using Fama‟s 3 factor model. He finds that Islamic funds performed poorly against their respective indices. As the results of the study, the co-movement of IEFs returns with the market, measured by the betas, is low, poor evidence for selectivity does exist, small-cap firms and growth preference stocks significantly affect iEFs, and finally IEFs do suffer from lower diversification.

Achsani et al. (2007) finds that the interdependence of the Islamic stock markets tends to be asymmetric across a wide geographical area. While there are strong correlations between the Islamic stock indices of Indonesia and Malaysia, the US and Canada, and Japan and Asia Pacific, this is not true for across region basis. Besides, the study finds that while the Islamic stock market in the US has a strong influence on the other Islamic stock markets, the reverse is not the case. On the other hand, Aziz and Kurniawan (2007) contest that there are potential diversification benefits for investors considering the Islamic stock markets in Indonesia and Malaysia. In particular, the Jakarta Islamic Index and the Kuala Lumpur Shari"ah Index have significant leverage and asymmetric effects. Other recent studies such as Majid and Kassim (2012), Kamil et al (2012) etc. also find mixed results in their analysis. As evident from the review above, there are inconsistencies in empirical literature analysing the portfolio diversification properties of the Islamic indices across the globe. While some studies find evidence of strong correlations across Islamic stock indices, others have found Islamic stocks to be weakly correlated allowing investors to gain international diversification opportunities. Due to the limited literature on Islamic stock market, it is vital to do empirical studies to find the stock movements, volatility, effects of financial crisis and regime shift behavior of the stock Islamic stock markets using relevant econometric models and techniques.

Methodology

The Markov switching model

According to Hamilton (1989), a time-series variable yt can be modeled by a Markov switching autoregressive of order p (MS-AR) with regime shifts in mean and variance as follows

$$y_t = \mu(s_t) + \left[\sum_{i=1}^{P} \phi\,(y_t = \mu(s_{t-i}))\right] + \sigma(s_t)\varepsilon_t$$

where ϕi are the autoregressive coefficients. μ and σ are the mean and standard deviation depending on the regime St at time t. yt , represents the Islamic Shariah equity indices in Eurozone.

$$e_t = \beta_1 + \sum_{k=1}^{l} \beta_{2j}\,(s_t)e_{t-k} + \sum_{k=1}^{l} \beta_{3j}\,(s_t)r_{t-k} + v(s_t)u_{e,t}$$

and rt and et denote the stock market and exchange rate returns for each country, respectively. ut is the innovation process with a variance v(st) depending on regime St which is assumed to follow an irreducible ergodic two-state Markov process, defined by the transition probabilities pij between states as follows3:

$P_{ij} = P[S_t = \frac{j}{S_{t-1}} = i]$ with $P_{ij} = P[S_t = \frac{j}{S_{t-1}} = i]$

where

$$\begin{cases} P_{11} = P(S_t = 1|S_{t-1} = 1) \\ P_{12} = 1 - P_{11} = P(S_t = 1|S_{t-1} = 2) \\ P_{21} = 1 - P_{11} = P(S_t = 2|S_{t-1} = 1) \\ P_{22} = P(S_t = 2|S_{t-1} = 2) \end{cases}$$

The model MS-AR framework detects potential regime shifts in the stock market returns and can also show the impact of crises on the stock market volatility. The present study uses Markov Switching to determine the regime switch in the stock markets of Islamic Equity in Eurozone during the financial crisis periods. The results of MS-AR show the duration of each regime and the probability of shifting to the other regime while being in the current regime.

Continuous Wavelet Transformation (CWT)

The Wavelet analysis which combines a time domain and frequency domain analysis is a powerful mathematical tool for signal processing in the time-frequency domain that overcomes the main limitations of the Fourier transform (Kaiser, 2011). As agreed in Dewandaru et al. (2016), wavelet analysis is extensively used in disciplines such as geophysics, medicine, climatology or astronomy, although its application in economics and finance is a relatively new phenomenon due to its flexibility. The wavelet is classified in two groups, such as; discrete and continuous. The paper uses Continuous Wavelet Transform(CWT) borrowed from Yildirim & Masih (2014).

There has been a general practice to utilize Fourier analysis to expose relations at different frequencies between interest variables. However, the shortcomings of the use of Fourier transform for analysis has been well established. A big argument against the use of Fourier transform is the total loss of time information and thus making it difficult to discriminate ephemeral relations or to identify structural changes which is very much important for time series macro- economic variables for policy purposes. Another strong argument against the use of Fourier transform is the reliability of the results. It is strongly recommended (i.e., it is based on assumptions such as) that this technique is appropriate only when time series is stationary, which is not so usual as in the case with macro-economic variables. The time series of macro-economic variables are mostly noisy, complex and rarely stationary. To overcome such situation and have the time dimensions within Fourier transform, Gabor (1946) introduced a specific transformation of Fourier transform. It is known as the short time Fourier transformation. Within the short time Fourier transformation, a time series is bro- ken into smaller sub-samples and then the Fourier transform is applied to each sub-sample. However, the short time Fourier transformation approach was also criticized on the basis of its efficiency as it takes equal frequency resolution across all dissimilar frequencies (see, for details, Raihan et al., 2005). Hence, as solution to the above mentioned problems wavelet

transform took birth. It offers a major advantage in terms of its ability to perform "natural local analysis of a time-series in the sense that the length of wavelets varies endogenously: it stretches into a long wave- let function to measure the low-frequency movements; and it compresses into a short wavelet function to measure the high-frequency movements" (Aguiar- Conraria and Soares, 2011, p. 646). Wavelet possesses interesting features of conduction analysis of a time series variable in spectral framework but as function of time. In other words, it shows the evolution of change in the time series over time and at different periodic components i.e., frequency bands. However, it is worthy to mention that the application of wavelet analysis in the economics and finance is mostly limited to the use of one or other variants of discrete wavelet transformation. There are various things to consider while applying discrete wavelet analysis such as up to what level we should decompose. Further, it is also difficult to under- stand the discrete wavelet transformation results appropriately. The variation in the time series data, what we may get by utilizing any method of discrete wavelet transformation at each scale, can be obtained and more easily with continuous transformation. Even if wavelets possess very interesting features, it has not become much popular among economists because of two important reasons as pointed out by Aguiar-Conraria et al. (2008). Aguiar-Conraria et al. (2008, p. 2865) pointed out that "first, in most economic applications the (discrete) wavelet transform has mainly been used as a low and high pass filter, it being hard to convince an economist that the same could not be learned from the data using the more traditional, in economics, band pass-filtering methods. The second reason is related to the difficulty of analyzing simultaneously two (or more) time series. In economics, these techniques have either been applied to analyze individual time series or used to individually analyze several time series (one each time), whose decompositions are then studied using traditional time-domain methods, such as correlation analysis or Granger causality." A number of authors have recently begun to use the continuous wavelet transform (CWT) in economics and finance research (for e.g. see Vacha and Barunik (2012), Madaleno and Pinho (2012), Saiti (2012), etc.). The CWT maps the original time series, which is a function of just one variable time-separate into function of two different variables such as time and frequency. One major benefit CWT has over DWT/MODWT is that we need not define the number of wavelets (time-scales) in CWT which generates itself according to the length of data. Other than that, the CWT maps the series correlations in a two-dimensional figure that allows us to easily identify and interpret patterns or hidden information. For both MODWT and CWT, we use the Daubechies (1992) least asymmetric wavelet filter of length L=8 denoted by LA (8) based on eight non-zero coefficients. Previous studies on high-frequency data have shown that a moderate-length filter such as L=8 is adequate to deal with the characteristic features of time-series data (see Gencay et al., 2001, 2002, In and Kim 2013, etc.). In literature, it is argued that an LA (8) filter generates more smooth wavelet coefficients than other filters such as Haar wavelet filter.

The continuous wavelet transform (CWT) $W_X(u,s)$ is obtained by projecting a mother wavelet onto the examined time series $x(t) \in L^2(\mathbb{R})$, that is:

$$W_X(u,s) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{s}} \psi \left(\frac{t-u}{s}\right) dt$$

The position of the wavelet in the time domain is given by u, while its position in the frequency domain is given by s. Therefore, the wavelet transform, by mapping the original series into a function of u and s, gives us information simultaneously on time and frequency. To be able to study the interaction between two time-series, how closely X and Y are related by a linear transformation, we need to apply a bivariate framework which is called wavelet coherence. The wavelet coherence of two time-series is defined as:

$$R_n^2(s) = \frac{\left|S(s^{-1}W_n^{xy}(s))\right|^2}{S(s^{-1}|W_n^x(s)|^2 . S(s^{-1}\left|W_n^y(s)\right|^2}$$

Where S is a smoothing operator, s $W_n^x(s)$ is a wavelet scale, is the continuous wavelet transform of the time series X, $W_n^y(s)$ is the continuous wavelet transform of the time series Y, is a cross wavelet transform of the two time series X and Y (Madaleno and Pinho, 2012). For brevity, we omit further detailed mathematical equations and interested readers may refer to Gencay et al (2001; 2002) and In and Kim (2013) for full methodological models.

Despite, being useful in measuring the strength of the linkage between any two time-series in the time-frequency space, the wavelet coherence is unable to show the lead–lag relations between the two series or if it is a negative or positive relationship between the two variables. This problem The wavelet phase-difference gives a solution to this problem. It characterizes possible delays in the oscillations between the two series, providing information on lead–lag effects as well as the sign of the association.

Following Torrence & Webster (1999), the phase-difference is defined by

$$\phi_{xy}(u,s) = \tan^{-1}\left(\frac{\Im\left(S\left(s^{-1}W_{xy}(u,s)\right)\right)}{\Re\left(S\left(s^{-1}W_{xy}(u,s)\right)\right)}\right),$$

where $\Re$ and $\Im$ represent the real and imaginary parts, respectively.

The phase information is graphically shown by way of arrows displayed inside displayed on the wavelet coherence figure (in high coherence regions), where the direction of the arrows gives information about the relationship between the two variables. A phase-difference of zero indicates that the two time series move together at the specified frequency. When the two series are in phase, they move in the same direction, shown with arrows pointing to the right. when the two series are in phase and if they move. Arrows pointing to left shows that the two series move in the opposite direction (anti-phase). If the arrows are pointing up, it means that the first time series leads the second one, whereas the second leads the first series, in the case where arrows are pointing down (Dewandaru et al., 2016).

Data Analysis and Empirical Results

The data used in this research are the weekly closing of the selected stock market indices in the period of 12 June 2008 to 21 April 2016 to see the possible effects of the ongoing European Debt crisis. The total number of observations (after adjustment) is 411 observations. The data is sourced from Data Stream database. Five of the S&P Europe 350 Shariah - S&P Dow Jones Indices were selected for the study; S&P EUR 350 Shariah Belgium E Price Index, S&P EUR 350 Shariah Denmark E Price Index, S&P EUR 350 Shariah Germany E Price Index, S&P EUR 350 Shariah Italy E Price Index and S&P EUR 350 Shariah France E Price Index and are the stock indices used in the study as a proxy for Islamic Equity Markets in Eurozone.

The stock indices returns were calculated as differences of the logarithmic daily closing prices of indices $\{ln(pt) - ln(pt-1)\}$ where p is an index value. This conversion is necessary to achieve stationarity in variance Engle's (2002).

Selected Eurozone Islamic Stock Indices for Study

Belgium	S&P EUR 350 Shariah Belgium E - PRICE INDEX
Denmark	S&P EUR 350 Shariah Denmark E - PRICE INDEX
Germany	S&P EUR 350 Shariah Germany E - PRICE INDEX
Italy	S&P EUR 350 Shariah Italy E - PRICE INDEX
France	S&P EUR 350 Shariah France E - PRICE INDEX

Descriptive statistics

Column1	BELGIUM	DENMARK	FRANCE	GERMANY	ITALY
Mean	1250.997	3557.796	935.8704	1388.508	1065.369
Median	1280.93	3102.97	870.31	1307.43	1035.69
Maximum	1547.14	7536.65	1362.31	2118.46	1519.54
Minimum	817.18	1394.14	592.05	715.3	660.33
Std. Dev.	143.6714	1762.85	187.1503	342.8315	191.7947
Skewness	-0.89786	0.90511	0.386761	0.083269	0.13885
Kurtosis	3.442226	2.666819	2.151541	2.065164	1.964741
Jarque-Bera	58.57047	58.01784	22.57451	15.44082	19.67456
Probability	0	0	0.000013	0.000444	0.000053
Sum	514159.7	1462254	384642.7	570676.7	437866.5
Sum Sq. Dev.	8463006	1.27E+09	14360349	48188702	15081935
Observations	411	411	411	411	411

Results from Markov Switching

To examine the behaviour of the Islamic equity markets in the stock and exchange markets in a regime-switching environment, the first step in our empirical investigation consists of verifying whether stock returns of sample markets exhibit regime-switching behaviour. First we test the null hypothesis of no regime shifts (i.e., the dynamics of stock returns is better reproduced by a linear autoregressive model) against the alternative of regime switching model which corresponds to a MS-AR model. The likelihood ratio test (LR) is used for the purpose of identifying the correct model. This test developed by Garcia and Perron (1996) is computed as follows

$$LR = 2 \times |lnL_{MS-AR} - lnL_{AR}$$

where lnL is the log likelihood of the competing models. The best-suited model is selected on the basis of Davies (1987) critical values. The table below shows that the LR test statistics are significant in all cases at the 1% level. These results lead us to reject the null hypothesis of no regime shifts for the Islamic equity markets in the Eurozone, which means that the time-varying behaviour of these markets is better described by the nonlinear MS-AR model.

LR test statistic results

Variables	lnL-MSAR	lnL-AR	LR2
Belgium	884.72	872.92	23.60+
Denmark	845.13	820.65	48.97+
France	918.59	887.88	61.41+
Germany	863.50	823.36	80.28+
Italy	786.75	745.09	83.31+

Notes: + denote the null hypothesis of no regime shift is rejected at the 1% significance level.

The MS-AR models are then estimated for each of the sample stock markets and the estimation results are reported in Table *Estimation results for the MS-AR model*

The first regime, referred to as regime 1, is characterized by a high volatility level and the second regime (regime 2) displays a low volatility level.

The standard deviations show that all stock markets except Italy are highly significant for regime shifting and hence that their values signify the existence of two different regimes. In the table, P11 means the probability of staying in regime one when in regime one, and P22 means probability of staying in regime 2 when in regime 2. Being in Regime 1 more probable for each market except Italy where when in regime 2, the probability of remaining in regime 2 is higher.

The probabilities (P11 and P22) suggests that the high volatility (turmoil) regime is more persistent than the low volatility one in case of Islamic equity markets in Eurozone regime 1 than in regime 2. The duration denoted by d1(duration in regime 1) and d2(duration in regime 2) also confirms this finding.

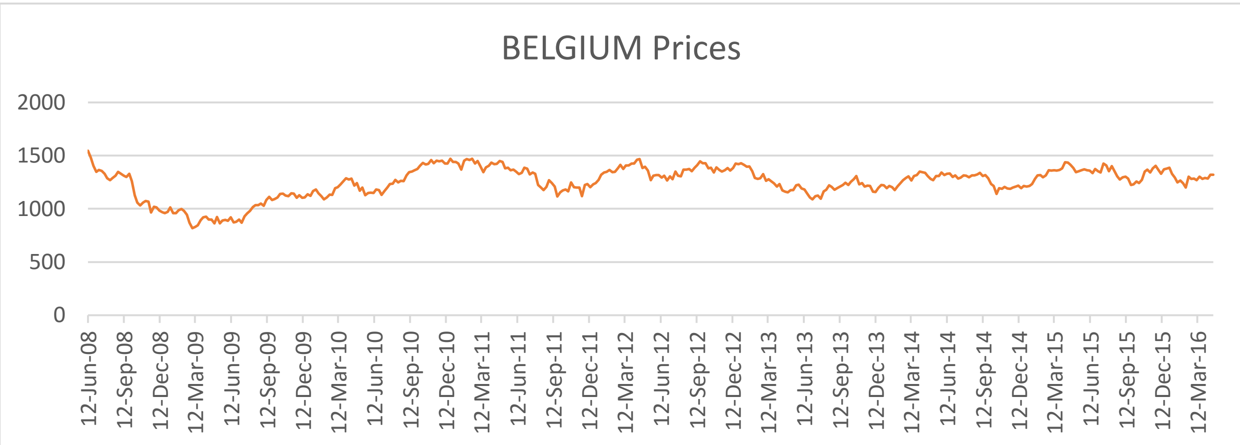
Estimation results for the MS-AR model

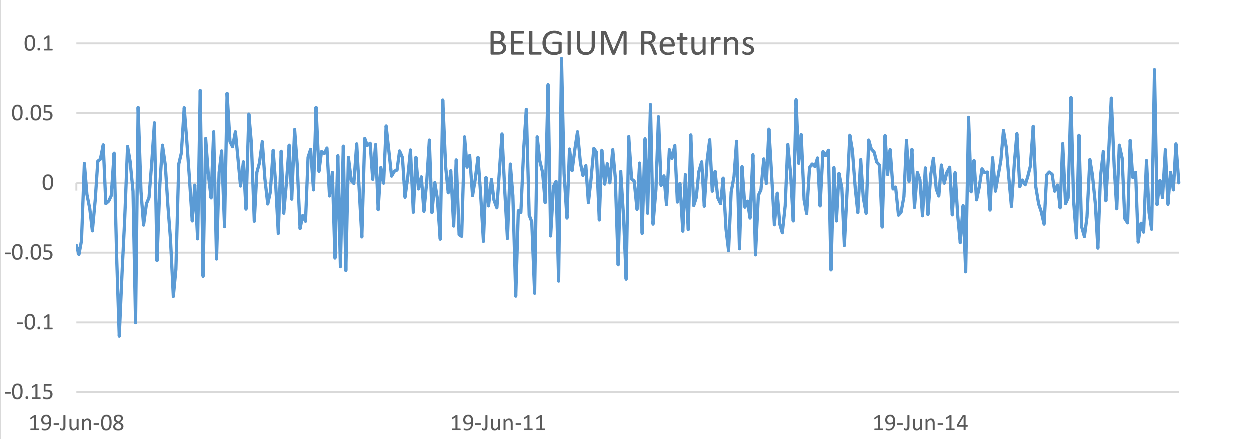
	BELGIUM	DENMARK	FRANCE	GERMANY	ITALY
Const (1)	0.004946 (0.002483) **	0.005166(0.001452) ***	0.003364(0.000951) ***	0.002935(0.001302) **	-0.008666(0.008157)
Const (2)	-0.008097 (00.006447)	-0.004293 (0.007858)	-0.005122 (0.003110) **	-0.011166 (0.008231)	0.001797 (0.001353)
AR(1)	-0.106536 (0.065982)	-0.060556 (0.052707)	-0.069254 (0.050874)	-0.068126 (0.050802)	-0.079091 (0.049812)
AR(2)	-0.025670 (0.067191)	-0.083715 (0.048856) *	-0.104295(0.050763) **	-0.003138 (0.017221)	-0.037080 (0.049759)
AR(3)	-0.036149 (0.054738)	0.044997 (0.048985)	-0.107904 (0.049911) **	-0.008875 (0.033023)	-0.080019 (0.051817)
AR(4)	-0.048847 (0.057600)	-0.060248 (0.048305)	-0.041581 (0.049798)	0.019914 (0.049553)	-0.044354(0.048358)
L(S1)	-3.867617(0.109821) ***	-3.754364 (0.082912) ***	-3.923220 (0.050206) ***	-3.689795 (0.042323) ***	--2.636192*(0.106460)** *
L(S2)	-3.343664 (0.109930) ***	-2.948215 (0.116376) ***	-3.234581 (0.078749) ***	-2.825373 (0.113769) ***	-3.530494 (0.044824) ***
P11	0.901832	0.933581	0.979972	0.992128	0.927303
P22	0.840753	0.747541	0.946201	0.943735	0.988265
d1	10.18664	15.05599	49.93118	127.0266	13.75568
d2	6.279567	3.961033	18.58787	17.77299	85.21246

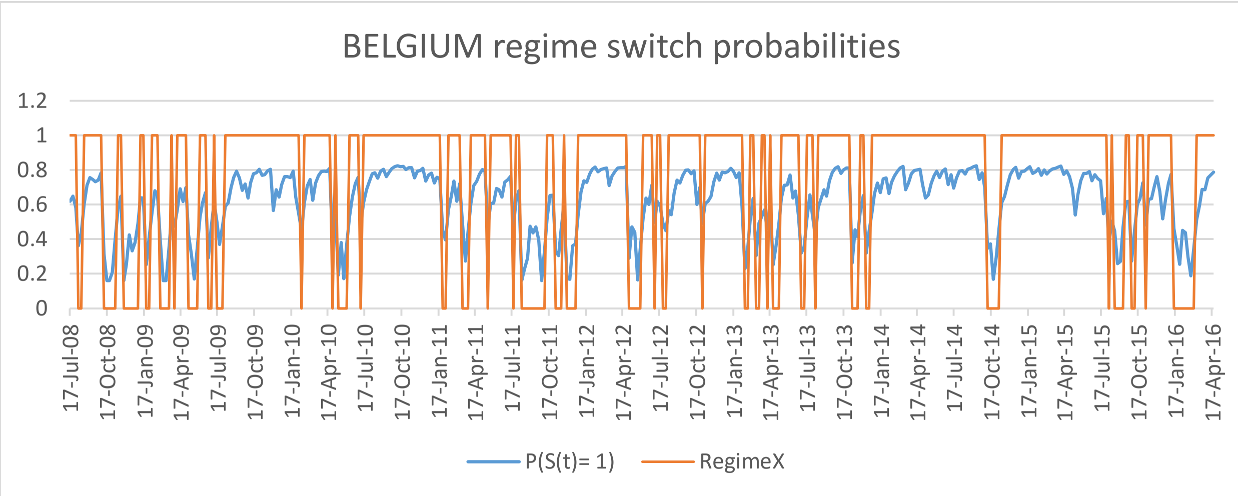
Notes: standard deviations are reported in parentheses. *d1* and *d2* are the average durations for the stock market to be in regime 1 and in regime 2, respectively. ***, **, * indicate that the estimated coefficients are significant at the 1%, 5% and 10% levels, respectively

The following charts show the stock market index, stock market returns and the smoothed probability of being in regime 2 for the five countries under consideration.

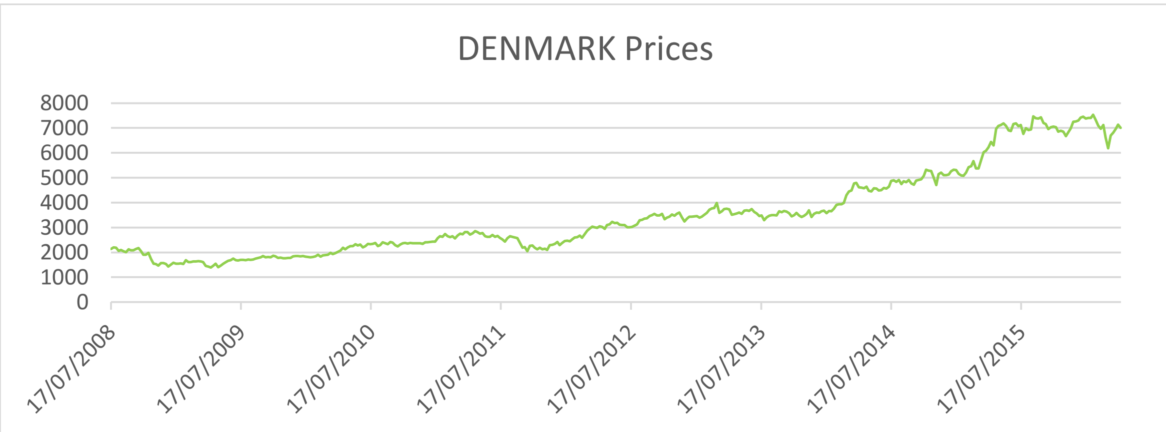
Belgium

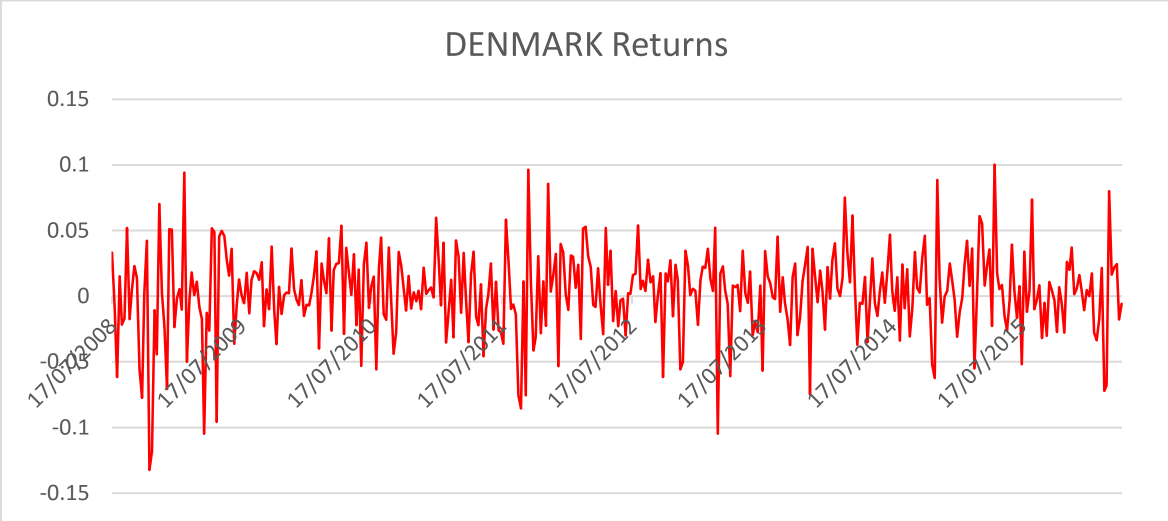


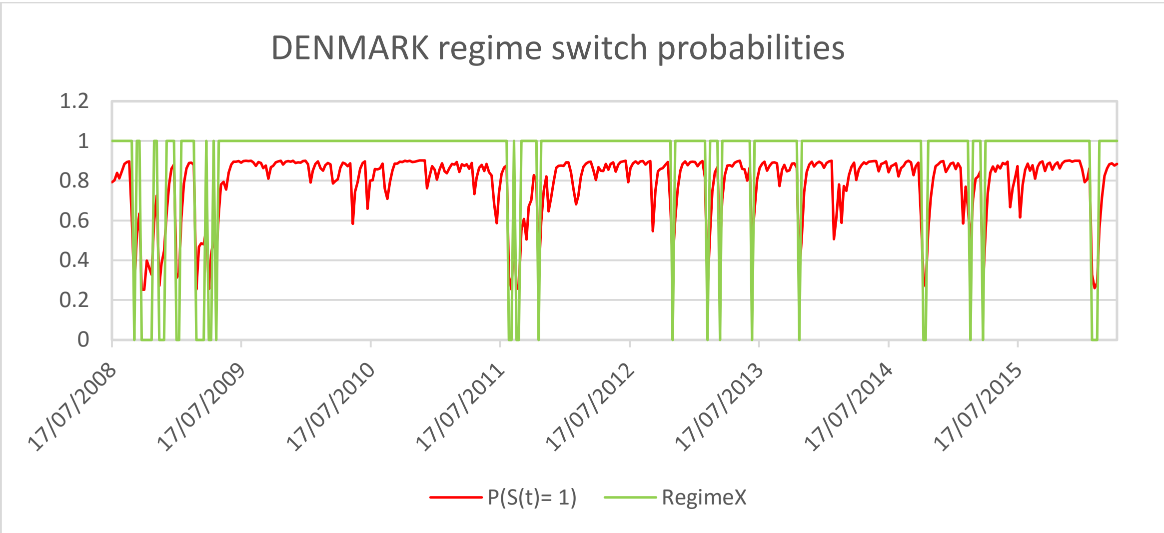

BELGIUM Returns
0.1
0.05
0
-0.05
-0.1
-0.15
19-Jun-08
19-Jun-11
19-Jun-14


BELGIUM regime switch probabilities
1.2
1
0.8
0.6
0.4
0.2
0
17-Jul-08
17-Oct-08
17-Jan-09
17-Apr-09
17-Jul-09
17-Oct-09
17-Jan-10
17-Apr-10
17-Jul-10
17-Oct-10
17-Jan-11
17-Apr-11
17-Jul-11
17-Oct-11
17-Jan-12
17-Apr-12
17-Jul-12
17-Oct-12
17-Jan-13
17-Apr-13
17-Jul-13
17-Oct-13
17-Jan-14
17-Apr-14
17-Jul-14
17-Oct-14
17-Jan-15
17-Apr-15
17-Jul-15
17-Oct-15
17-Jan-16
17-Apr-16
P(S(t)= 1)
RegimeX

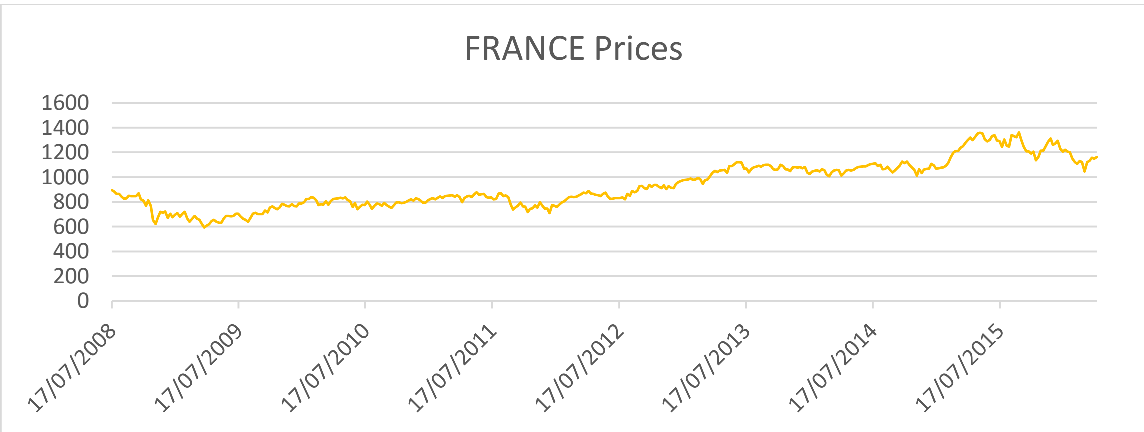
Denmark

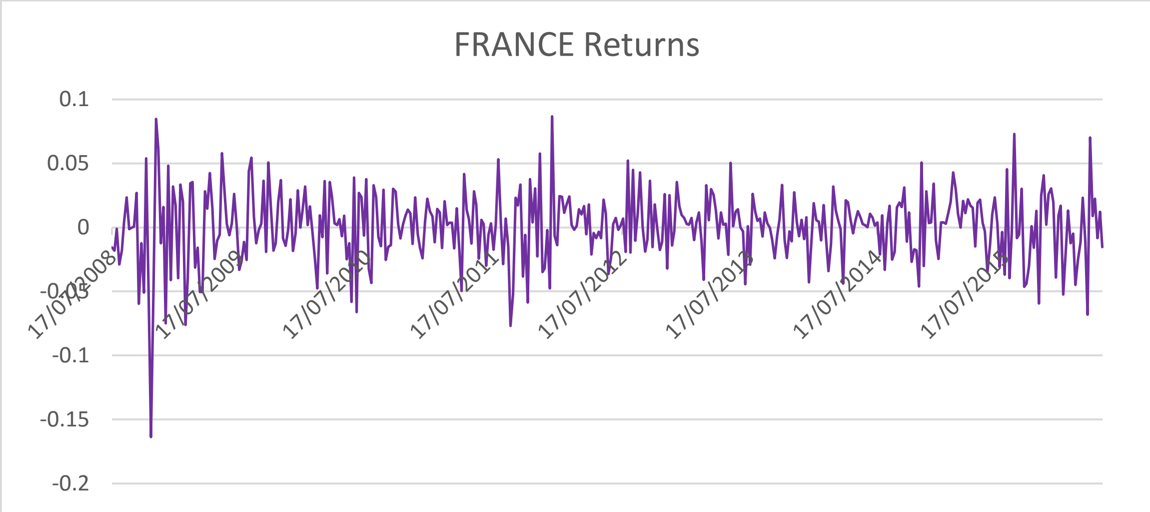

DENMARK Prices
8000
7000
6000
5000
4000
3000
2000
1000
0
17/07/2008
17/07/2009
17/07/2010
17/07/2011
17/07/2012
17/07/2013
17/07/2014
17/07/2015

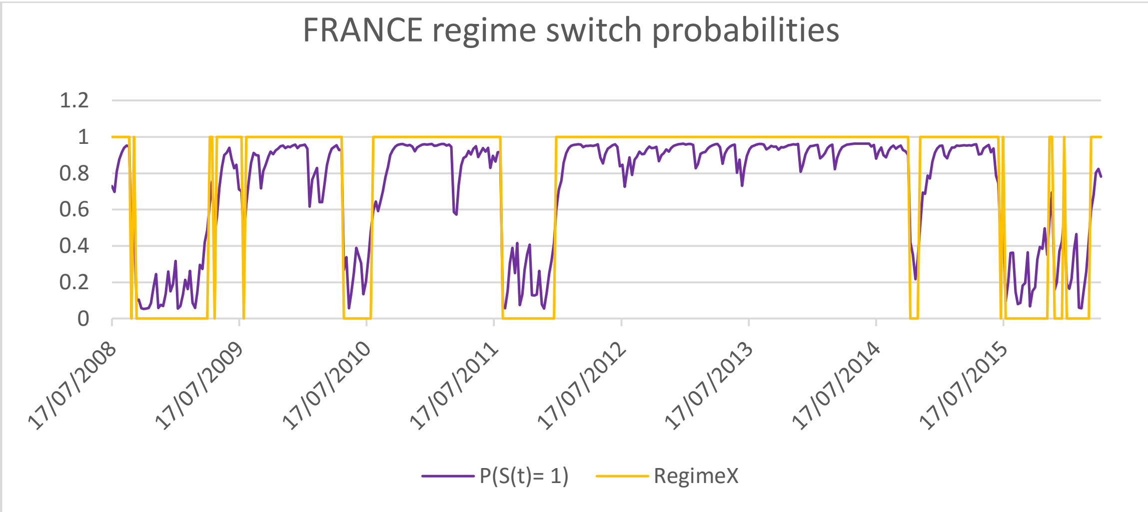

DENMARK Returns
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
17/07/2008
17/07/2009
17/07/2010
17/07/2011
17/07/2012
17/07/2013
17/07/2014
17/07/2015


DENMARK regime switch probabilities
1.2
1
0.8
0.6
0.4
0.2
0
17/07/2008
17/07/2009
17/07/2010
17/07/2011
17/07/2012
17/07/2013
17/07/2014
17/07/2015
P(S(t)= 1)
RegimeX

France

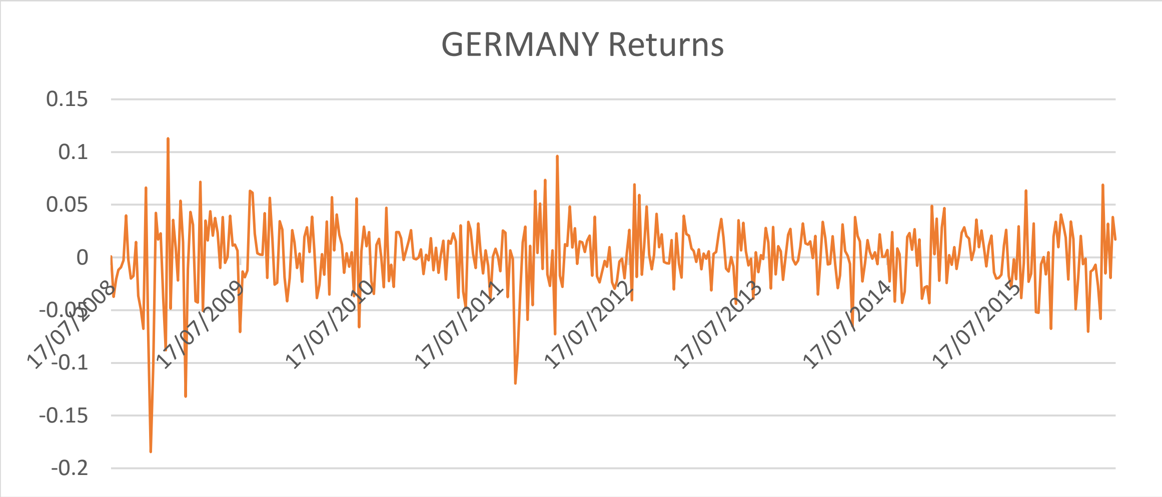

FRANCE Prices
1600
1400
1200
1000
800
600
400
200
0
17/07/2008
17/07/2009
17/07/2010
17/07/2011
17/07/2012
17/07/2013
17/07/2014
17/07/2015

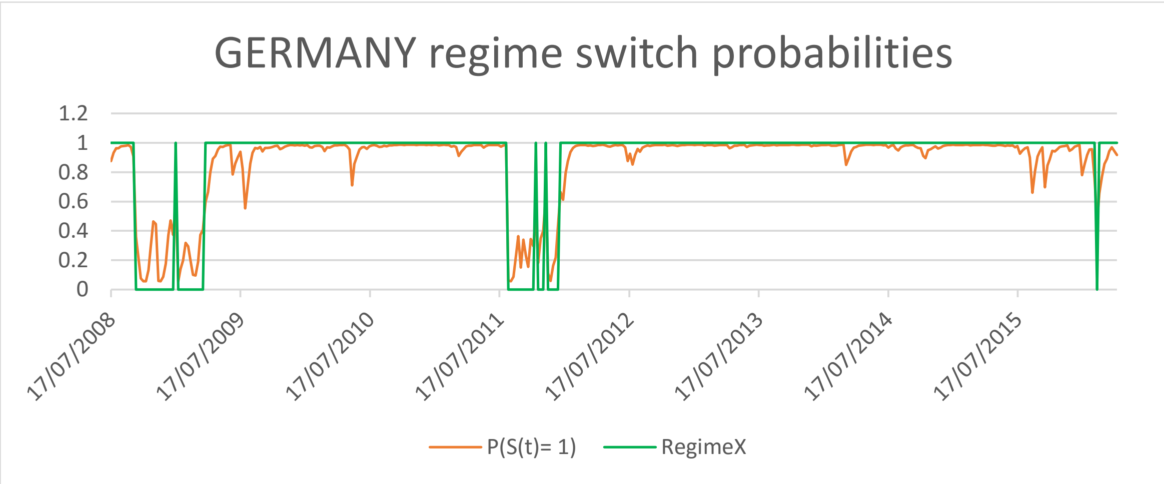

FRANCE Returns
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
17/07/2008
17/07/2009
17/07/2010
17/07/2011
17/07/2012
17/07/2013
17/07/2014
17/07/2015


FRANCE regime switch probabilities
1.2
1
0.8
0.6
0.4
0.2
0
17/07/2008
17/07/2009
17/07/2010
17/07/2011
17/07/2012
17/07/2013
17/07/2014
17/07/2015
P(S(t)= 1)
RegimeX

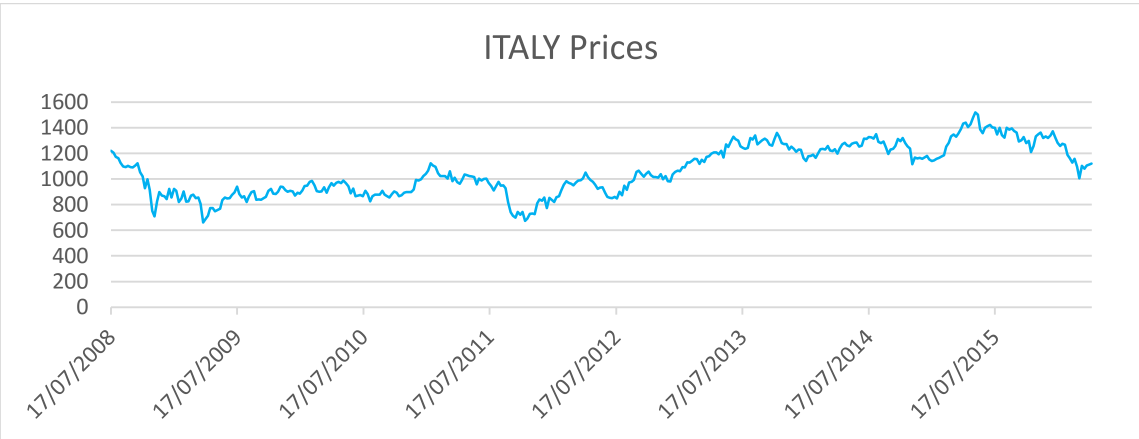
Germany

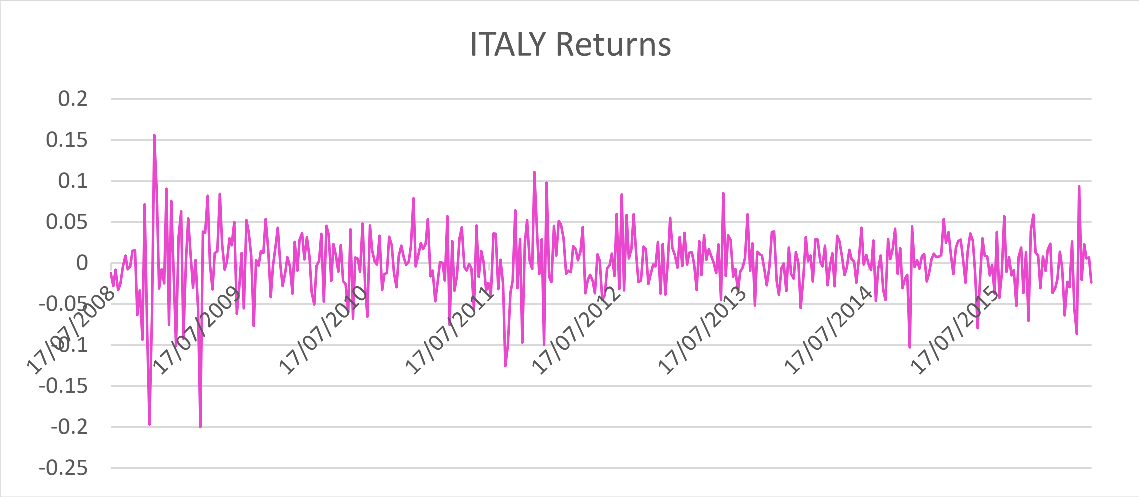

GERMANY Prices
2500
2000
1500
1000
500
0
17/07/2008
17/07/2009
17/07/2010
17/07/2011
17/07/2012
17/07/2013
17/07/2014
17/07/2015

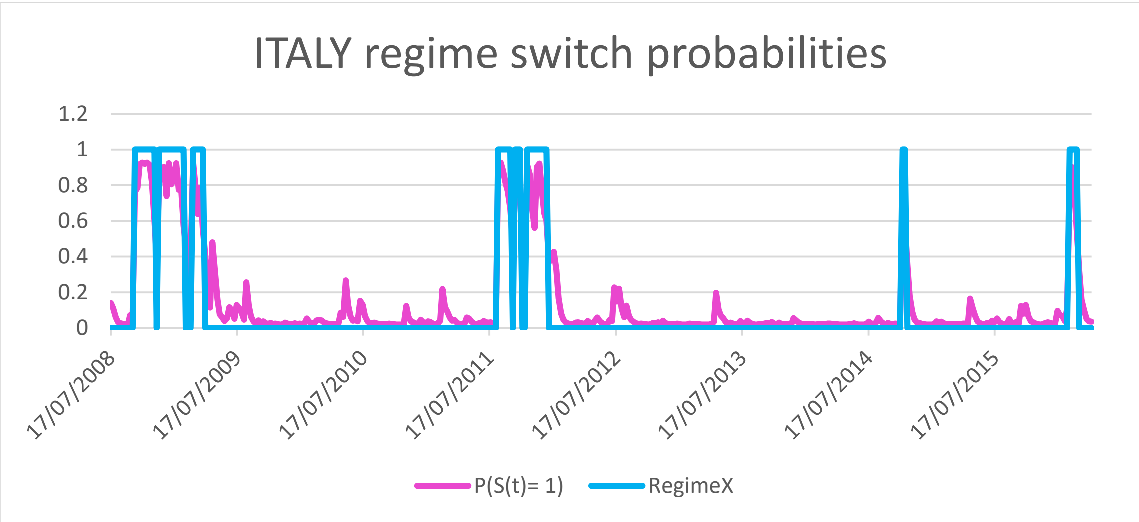

GERMANY Returns
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
17/07/2008
17/07/2009
17/07/2010
17/07/2011
17/07/2012
17/07/2013
17/07/2014
17/07/2015


GERMANY regime switch probabilities
1.2
1
0.8
0.6
0.4
0.2
0
17/07/2008
17/07/2009
17/07/2010
17/07/2011
17/07/2012
17/07/2013
17/07/2014
17/07/2015
P(S(t)= 1)
RegimeX

Italy


ITALY Prices
1600
1400
1200
1000
800
600
400
200
0
17/07/2008
17/07/2009
17/07/2010
17/07/2011
17/07/2012
17/07/2013
17/07/2014
17/07/2015





Belgium shows the prices are fairly stable yet showing an upward trend like the rest of the countries except. The returns look more volatile during the crisis periods of 2008-2009 Global financial crisis and then again in 2011-2012 the peak period of the European Debt Crisis, where this period is also known as the Greece Debt crisis.

Overall, the time-variations in market indices suggest that the Islamic Equity markets in Eurozone are not immune to external shocks and they tend to fluctuate with the economic and financial shocks. The smoothed probability of staying in regime 1 (high volatility state), which is displayed in the middle graphs, shows several high volatility periods that are common to all markets. These periods cover particularly the ongoing European Debt crisis which hiked in 2011-2012 and also the recent oil price crisis is also reflected.

Italy is the exception when showing regime shift, which is similar for all other countries where the probability of being in regime 1 is higher and in Italy's case the probability of being in regime 2 is higher as confirmed from the regime shift probabilities charts. The regime shifts also shows that during crisis periods, 2008-2009, 2011-2012, there is high volatility across all markets.

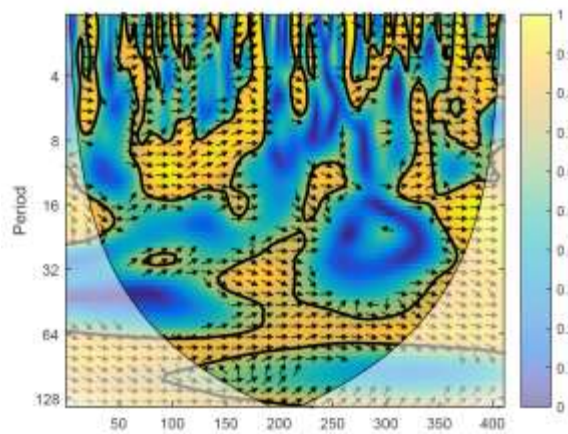
The results obtained by MS-AR is not surprising since all stock markets experienced turmoil during the crisis and this confirms that Islamic stock markets in the Eurozone was no exception.

Results from Continuous Wavelet Transform (CWT)

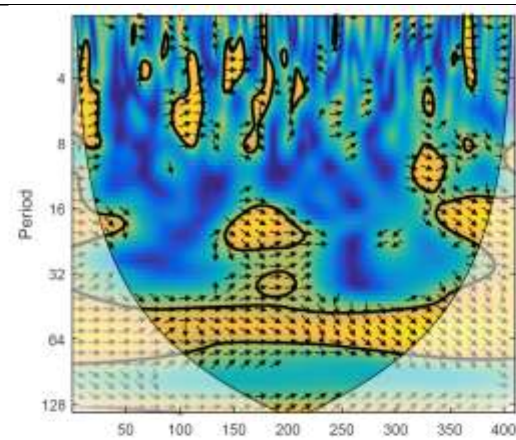
The graphs below present wavelet squared coherency and wavelet phase-difference between changes in Islamic stocks return of Germany for each of the country Belgium, France and Italy. The wavelet coherence shows three dimensions; frequency (by the vertical axis), time (by the horizontal axis) and wavelet coherence power. Since the data is weekly returns, the scales are interpreted as weeks of holding periods. The lowest scale being 4 weeks and the highest being 128 weeks as shown by the vertical axis. The horizontal axis show the time period. Our data starts from 12 June 2008 ends on 21 April 2016.The color range depicts the Wavelet coherence. Golden yellow being the high power and blue being low power. When the two series have high common power, it is shown by the gold yellow parts where as if they don't experience common power, it is represented by the blue regions.

The thick black borders enclose the 5% significant level (Monte Carlo simulations) shown by the gold yellow regions depicting significant wavelet coherence. The area below the thin black cone of influence is insignificant.

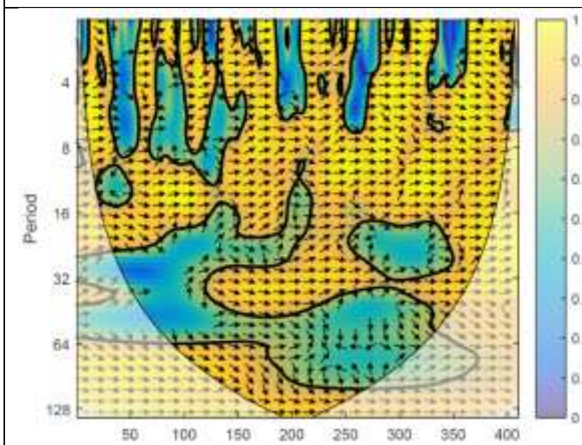
CWT representations



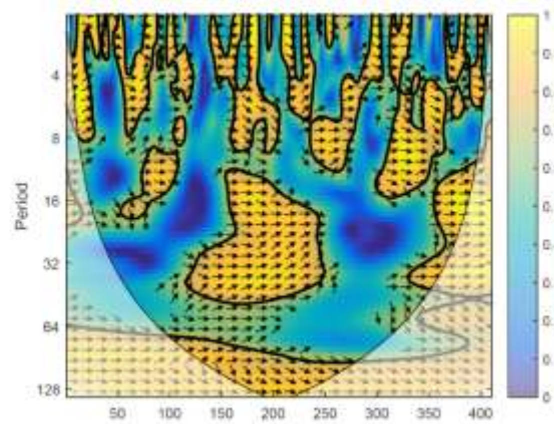
Germany vs Belgium



Germany vs Denmark



Germany vs France



Germany vs Italy

For easy interpretation we will use, Short scale as 2-8 weeks, Medium 8-64 weeks and Long 64-128 weeks.

Germany vs. Belgium

In short investment horizons of 2-8 weeks, Germany and Belgium Islamic stock markets shows less persistent coherence. During the middle time scales (8-64 weeks), the duration of the periods of coherence and no coherence becomes greater. Investors holding stocks for longer periods see that both markets are in continuous coherence around 64 weeks. Both stock indices are positively correlated since all the arrows in the significant gold yellow arrows are moving right. Germany seems to leading Belgium around 2011. This maybe because Germany market is more influential during the peak of the Debt Crisis. But judging from more arrows pointing down than up, it seems that Belgium leads Germany in the mid scales. While during the longer investment horizon both influence each other with similar strength implying that both Belgium and Germany are very influential markets.

Germany vs.Denmark

Overall during the short time scales, there was more coherence during the 2010-2012 period of Debt Crisis. and then very less significant coherence during the later periods. For investment horizons ranging from 8-16 weeks, there is almost no coherence until the last few years of observation around 2015-2016. This means that for investors holding Germany Islamic stocks can enjoy diversification benefits by investing in Denmark Islamic stocks for the same period. From 16-32 weeks, there was high coherence during the 2010-2012. In this case too, the longer investment period around 64 weeks show that both stock indices are in persistent coherence. An investor holding both stocks for a long investment horizon, their diversification benefits are nil if they have only stocks of these two markets. Germany leads Denmark in longer time scales while in shorter scales, sometimes Denmark was found to be leading Germany around 2010.

Germany vs. France

We see that there is a lot of coherence between Germany and France in all the time scales it is surprising to see a low coherence just before longer time scale of 64 weeks, which is very different from all the scenarios.

Germany vs. Italy

Short scale coherence is not persistent. Middle scale longer period of coherence. Deeper blue is seen during the Crisis periods. Longer coherence periods are seen below 64 while there was a period of non-coherence just above scale 64 (same case with Germany and France.)

The results of Wavelet analysis sheds light into the area pf portfolio diversification between the studied countries within the Eurozone, showing very little diversification opportunities between the member countries. Overall there is little room for diversification in the highly correlated markets across heterogeneous investment horizons.

Limitations

Of all the limitations of this study, the most obvious is that the study is based on only 5 selected Islamic markets in Europe which limits the scope the of the study. Hence readers should be aware that the results cannot be generalized to other regions or other markets. The results might vary with the choice of selected Shariah indices too. The selection for this study is based on the availability of data. However, for a more conclusive result, data from Shariah indices from all the Eurozone or European countries could be studied. A comparative analysis of the regime shift of Shariah equities and conventional equities would also be of use for researchers, investors and policy makers. The study could be extended to study the does not analyze the conditional and unconditional volatility and correlation of all stock indices in a matrix form which can be studied by MGARCH DCC, however, the results are time –invariant in MGARCH-DCC unlike CWT Like some studies have done, MODWT can also be used to check the robustness of results obtained by the CWT. CWT is however more robust since transformation is continuous and not discrete like MODWT

Conclusion and Policy Implications

Islamic Equity Markets in the Eurozone is studied in the paper using S&P Europe 350 Shariah – (S&P Dow Jones Indices) equity indices from Germany, Belgium, Denmark, France and Italy. The study humbly tries to fill in the literature gap of studies done on effects of European Debt crisis, and portfolio diversification benefits of Islamic equity markets. The study is done from the perspective of the investors in the German Islamic Equity market since it has the largest Muslim population in Europe. The Econometric methodologies of Markov Switching is used to see the regime shift behavior in these markets during the crisis periods, the results of which showed that the time-variations in market indices suggest that the Islamic Equity markets in Eurozone are not immune to external shocks and they tend to fluctuate with the economic and financial shocks. The regime shifts also shows that during crisis periods, 2008-2009, 2011-2012, there is high volatility across all markets. To see the correlation between the German market and each of the other four markets, the econometric method of Continuous Wavelet Transform was used which showed that Germany and the studied markets have high overall coherence. The least correlation was with Italy were diversification benefits can be sought depending on the chosen investment horizon. The highest correlation was with France, where both markets will be deprived of portfolio diversification benefits if they hold stock from only these two markets. Hence to create an optimal portfolio diversification, investors in the German Islamic equity market should look for investments outside the Eurozone due to the high correlation between the markets in the Eurozone.

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Appendix

Estimation Output: Belgium

Dependent Variable: BELGIUM
Method: Switching Regression (Markov Switching)
Date: 04/24/16 Time: 16:07
Sample (adjusted): 7/17/2008 4/21/2016
Included observations: 406 after adjustments
Number of states: 2
Initial probabilities obtained from ergodic solution
Ordinary standard errors & covariance using numeric Hessian
Random search: 25 starting values with 10 iterations using 1 standard deviation (rng=kn, seed=229367713)
Convergence achieved after 15 iterations

Variable	Coefficient	Std. Error	z-Statistic	Prob.
	Regime 1			
C	0.004946	0.002483	1.991804	0.0464
LOG(SIGMA)	-3.867617	0.109821	-35.21739	0.0000
	Regime 2			
C	-0.008097	0.006447	-1.255970	0.2091
LOG(SIGMA)	-3.343664	0.109930	-30.41627	0.0000
	Common			
AR(1)	-0.106536	0.065982	-1.614618	0.1064
AR(2)	-0.025670	0.067191	-0.382050	0.7024
AR(3)	-0.036149	0.054738	-0.660410	0.5090
AR(4)	-0.048847	0.057600	-0.848048	0.3964
	Transition Matrix Parameters			
P11-C	2.217750	1.030650	2.151797	0.0314
P21-C	-1.663844	1.502090	-1.107686	0.2680

Mean dependent var	-8.35E-05	S.D. dependent var	0.028321
S.E. of regression	0.028586	Sum squared resid	0.325236
Durbin-Watson stat	1.986501	Log likelihood	884.7209
Akaike info criterion	-4.308970	Schwarz criterion	-4.210291
Hannan-Quinn criter.	-4.269915		

Inverted AR Roots	.01-1.83i	.01+1.83i	-.02-.09i	-.02+.09i
	Estimated AR process is nonstationary			

Transition Results Summary: Belgium

Equation: EQ01_BELGIUM
Date: 04/24/16 Time: 16:13
Transition summary: Constant Markov transition probabilities and expected durations
Sample (adjusted): 7/17/2008 4/21/2016
Included observations: 406 after adjustments

Constant transition probabilities:
P(i, k) = P(s(t) = k | s(t-1) = i)
(row = i / column = j)

	1	2
1	0.901832	0.098168
2	0.159247	0.840753

Constant expected durations:

	1	2
	10.18664	6.279567

Estimation Output: Denmark

Dependent Variable: DENMARK
Method: Switching Regression (Markov Switching)
Date: 04/24/16 Time: 16:18
Sample (adjusted): 7/17/2008 4/21/2016
Included observations: 406 after adjustments
Number of states: 2
Initial probabilities obtained from ergodic solution
Ordinary standard errors & covariance using numeric Hessian
Random search: 25 starting values with 10 iterations using 1 standard deviation (rng=kn, seed=1907009790)
Convergence achieved after 11 iterations

Variable	Coefficient	Std. Error	z-Statistic	Prob.
		Regime 1		
C	0.005166	0.001452	3.557724	0.0004
LOG(SIGMA)	-3.754364	0.082912	-45.28139	0.0000
		Regime 2		
C	-0.004293	0.007858	-0.546343	0.5848
LOG(SIGMA)	-2.948215	0.116376	-25.33363	0.0000
		Common		
AR(1)	-0.060556	0.052707	-1.148912	0.2506
AR(2)	-0.083715	0.048856	-1.713519	0.0866
AR(3)	0.044997	0.048985	0.918575	0.3583
AR(4)	-0.060248	0.048305	-1.247253	0.2123
		Transition Matrix Parameters		
P11-C	2.643048	0.764196	3.458599	0.0005
P21-C	-1.085538	0.711785	-1.525093	0.1272

Mean dependent var	0.003034	S.D. dependent var	0.032280
S.E. of regression	0.032530	Sum squared resid	0.421154
Durbin-Watson stat	1.955317	Log likelihood	845.1326
Akaike info criterion	-4.113954	Schwarz criterion	-4.015275
Hannan-Quinn criter.	-4.074899		

Inverted AR Roots	.01+1.71i	.01-1.71i	-.01-.17i	-.01+.17i
	Estimated AR process is nonstationary			

Equation: EQ01_DENMARK
Date: 04/24/16 Time: 16:19
Transition summary: Constant Markov transition probabilities and expected durations
Sample (adjusted): 7/17/2008 4/21/2016
Included observations: 406 after adjustments

Constant transition probabilities:
P(i, k) = P(s(t) = k | s(t-1) = i)
(row = i / column = j)

	1	2
1	0.933581	0.066419
2	0.252459	0.747541

Constant expected durations:

	1	2
	15.05599	3.961033

Dependent Variable: FRANCE
Method: Switching Regression (Markov Switching)
Date: 04/24/16 Time: 16:22
Sample (adjusted): 7/17/2008 4/21/2016
Included observations: 406 after adjustments
Number of states: 2
Initial probabilities obtained from ergodic solution
Ordinary standard errors & covariance using numeric Hessian
Random search: 25 starting values with 10 iterations using 1 standard deviation (rng=kn, seed=419488313)
Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Regime 1				
C	0.003364	0.000951	3.535403	0.0004
LOG(SIGMA)	-3.923220	0.050206	-78.14302	0.0000
Regime 2				
C	-0.005122	0.003110	-1.647196	0.0995
LOG(SIGMA)	-3.234581	0.078749	-41.07436	0.0000
Common				
AR(1)	-0.069254	0.050874	-1.361270	0.1734
AR(2)	-0.104295	0.050763	-2.054550	0.0399
AR(3)	-0.107904	0.049911	-2.161914	0.0306
AR(4)	-0.041581	0.049798	-0.834990	0.4037
Transition Matrix Parameters				
P11-C	3.890415	0.584542	6.655492	0.0000
P21-C	-2.867209	0.579187	-4.950402	0.0000

Mean dependent var	0.000919	S.D. dependent var	0.027482
S.E. of regression	0.027474	Sum squared resid	0.300417
Durbin-Watson stat	2.015357	Log likelihood	918.5854
Akaike info criterion	-4.475790	Schwarz criterion	-4.377111
Hannan-Quinn criter.	-4.436735		

Inverted AR Roots	.01+1.79i	.01-1.79i	-.01-.18i	-.01+.18i
	Estimated AR process is nonstationary			

Equation: EQ01_FRANCE
Date: 04/24/16 Time: 16:28
Transition summary: Constant Markov transition probabilities and expected durations
Sample (adjusted): 7/17/2008 4/21/2016
Included observations: 406 after adjustments

Constant transition probabilities:
P(i, k) = P(s(t) = k | s(t-1) = i)
(row = i / column = j)

	1	2
1	0.979972	0.020028
2	0.053799	0.946201

Constant expected durations:

	1	2
	49.93118	18.58787

Dependent Variable: GERMANY
Method: Switching Regression (Markov Switching)
Date: 04/24/16 Time: 16:25
Sample (adjusted): 7/17/2008 4/21/2016
Included observations: 406 after adjustments
Number of states: 2
Initial probabilities obtained from ergodic solution
Ordinary standard errors & covariance using numeric Hessian
Random search: 25 starting values with 10 iterations using 1 standard deviation (rng=kn, seed=255042075)
Convergence achieved after 10 iterations

Variable	Coefficient	Std. Error	z-Statistic	Prob.
		Regime 1		
C	0.002935	0.001302	2.254743	0.0241
LOG(SIGMA)	-3.689795	0.042323	-87.18246	0.0000
		Regime 2		
C	-0.011166	0.008231	-1.356612	0.1749
LOG(SIGMA)	-2.825373	0.113769	-24.83429	0.0000
		Common		
AR(1)	-0.068126	0.050802	-1.341006	0.1799
AR(2)	-0.003138	0.017221	-0.182245	0.8554
AR(3)	-0.008875	0.033023	-0.268741	0.7881
AR(4)	0.019914	0.049553	0.401863	0.6878
		Transition Matrix Parameters		
P11-C	4.836493	0.793343	6.096348	0.0000
P21-C	-2.819770	0.742451	-3.797922	0.0001

Mean dependent var	0.001142	S.D. dependent var	0.031966
S.E. of regression	0.032310	Sum squared resid	0.415489
Durbin-Watson stat	1.946774	Log likelihood	863.4972
Akaike info criterion	-4.204420	Schwarz criterion	-4.105741
Hannan-Quinn criter.	-4.165365		

Inverted AR Roots	.01-1.68i	.01+1.68i	-.01+.03i	-.01-.03i

Estimated AR process is nonstationary

Equation: EQ01_GERMANY
Date: 04/24/16 Time: 16:29
Transition summary: Constant Markov transition probabilities and expected durations
Sample (adjusted): 7/17/2008 4/21/2016
Included observations: 406 after adjustments

Constant transition probabilities:
P(i, k) = P(s(t) = k | s(t-1) = i)
(row = i / column = j)

	1	2
1	0.992128	0.007872
2	0.056265	0.943735

Constant expected durations:

	1	2
	127.0266	17.77299

Dependent Variable: ITALY
Method: Switching Regression (Markov Switching)
Date: 04/24/16 Time: 16:31
Sample (adjusted): 7/17/2008 4/21/2016
Included observations: 406 after adjustments
Number of states: 2
Initial probabilities obtained from ergodic solution
Ordinary standard errors & covariance using numeric Hessian
Random search: 25 starting values with 10 iterations using 1 standard deviation (rng=kn, seed=502429955)
Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	z-Statistic	Prob.
		Regime 1		
C	-0.008666	0.008157	-1.062504	0.2880
LOG(SIGMA)	-2.636192	0.106460	-24.76221	0.0000
		Regime 2		
C	0.001797	0.001353	1.328082	0.1842
LOG(SIGMA)	-3.530494	0.044824	-78.76315	0.0000
		Common		
AR(1)	-0.079091	0.049812	-1.587803	0.1123
AR(2)	-0.037080	0.049759	-0.745196	0.4562
AR(3)	-0.080019	0.051817	-1.544256	0.1225
AR(4)	-0.044354	0.048358	-0.917200	0.3590
		Transition Matrix Parameters		
P11-C	2.545977	0.666009	3.822737	0.0001
P21-C	-4.433343	0.699259	-6.340055	0.0000

Mean dependent var	8.66E-05	S.D. dependent var	0.038863
S.E. of regression	0.039277	Sum squared resid	0.613996
Durbin-Watson stat	1.923460	Log likelihood	786.7453
Akaike info criterion	-3.826331	Schwarz criterion	-3.727653
Hannan-Quinn criter.	-3.787276		

Inverted AR Roots	.01-1.88i	.01+1.88i	-.01-.10i	-.01+.10i
	Estimated AR process is nonstationary			

Equation: EQ01_ITALY
Date: 04/24/16 Time: 16:32
Transition summary: Constant Markov transition probabilities and expected durations
Sample (adjusted): 7/17/2008 4/21/2016
Included observations: 406 after adjustments

Constant transition probabilities:
P(i, k) = P(s(t) = k | s(t-1) = i)
(row = i / column = j)

	1	2
1	0.927303	0.072697
2	0.011735	0.988265

Constant expected durations:

	1	2
	13.75568	85.21246