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Abstract

The objective of this paper is to investigate the behavior of the time varying volatility in eleven MENA countries' stock market using a three-state Markov regime-switching model over the period from October 30, 2006 to October 21, 2011. We find that MENA stock market volatility can be characterized by three regimes: tranquil period with low volatility of volatility, turmoil regime with high volatility of volatility and crisis regime with extremely high volatility of volatility. Besides, the Granger causation effects from the MSCI World index to MENA stock markets are stronger and statistically significant especially in crisis regime.

JEL Classification: F30, G01, G15.

Keywords: Time varying volatility; MENA countries' stock market; three-state Markov regime switching model; Granger causality test.

ملخص

الهدف من هذه الورقة هو دراسة سلوك التذبذب في 11 سوق للأسهم في بلدان الشرق الأوسط وشمال أفريقيا باستخدام نموذج ماركوف لتباديل نظام الثلاث الحالات خلال الفترة من 30 أكتوبر 2006 إلى 21 أكتوبر 2011 .نجد أنه يمكن وصف تقلبات أسواق الأوراق المالية فى بلدان الشرق الأوسط وشمال أفريقيا من قبل ثلاثة أنظمة: فترة هدوء مع تقلب منخفض من نظام الاضطراب، ارتفاع في معدل التذبذب من التقلب وأخيرا نظام أزمة مع تقلبات عالية للغاية. الى جانب ذلك، فان آثار السببية جرانجر من المؤشر العالمي MSCI لأسواق الأوراق المالية في بلدان الشرق الأوسط وشمال أفريقيا هي الأقوى وذات دلالة إحصائية خاصة في نظام الأزمات.

1. Introduction

Over the last two decades, most of the MENA (Middle East and North Africa) countries have experienced a number of economic reforms, financial liberalization, and global integration process. These countries experienced a noticeable growth in market capitalization, the number of listed companies, the value and the shares traded (Zaher, 2007). These new characteristics of these markets may lead to changes in their volatility generating process.

Understanding the behavior of volatility is important for pricing financial assets, implementing hedging strategies and for evaluating regulatory proposals to restrict international capital flows. Hammoudeh and Li (2008) examine the sudden changes in volatility for five Gulf area Arab stock markets (Bahrain, Kuwait, Oman, Saudi Arabia and UAE) over the period 1994-2001 and find that most of these stock markets are more sensitive to major global events than to local regional factors. Neaime (2006) studies the dynamic relationships in the volatilities of the stock market return within the MENA region1 and the more developed financial markets of the US and UK over the period 1995-2002. He shows that the group of countries having the stronger causal relationships in variance include the US, UK, Egypt, Jordan, Morocco, and Turkey. Maghyereh and Al-Zoubi (2004) examine the dynamic interdependence among four emerging MENA stock markets, namely Egypt, Jordan, Morocco and Turkey over the period 1998 - 2003 and show that there are strong linkages among these markets at the volatility level. Yu and Hassan (2008) investigate the Granger causality test between seven MENA markets of Bahrain, Oman, Saudi Arabia, Jordan, Egypt, Morocco, and Turkey and three developed countries (the US, the UK and France) over the period from January 1, 1999 through December 31, 2005. Empirical results from tests for unidirectional Granger causality between developed and MENA equity markets show with minor exception, a non-significant evidence of causality. Alkulaib, Najand and Mashayekh (2009) investigate the lead-lag relationship between the MENA countries and regions and found that there is more interaction and linkage in the Gulf Cooperation Council (GCC) region than in the North Africa and Levant regions.

This paper studies the regime-switching behavior in the conditional volatility of MENA stock market returns using a Markov regime switching volatility model with three distinct states: tranquil period with low volatility, turmoil regime with high volatility and crisis regime with extremely high volatility. The conditional volatility has been modeled by using an autoregressive GARCH (1, 1) model. Moreover, using the tests for Granger-causality, we investigate whether the strength of spillovers from the MSCI World index to MENA stock markets change scientifically as the World market moves from one regime to another2. The study is conducted using daily data for eleven MENA stock market returns (Bahrain, Egypt, Jordan, Kuwait Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia and UAE) over the period from October 30, 2006 to October 21, 2011

Results show that MENA stock market volatility can be characterized by three regimes: tranquil period with low volatility, turmoil regime with high volatility and crisis regime with extremely high volatility. For example, for Lebanon, the volatility in the crisis period is twenty times higher than that in the turmoil regime, which is seventy eight times higher than that in the calm period. Granger causality test results show significant evidence of causality in variance between the World market index and MENA markets in the turmoil regime for six MENA markets (Bahrain, Egypt, Morocco, Oman, Qatar and UAE) and for eight MENA markets (Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Tunisia, and UAE) during financial crisis. In the calm period, no significant causal relationship has been proved for all

[1] Seven MENA markets have been considered: Bahrain, Egypt, Jordan, Morocco, Kuwait, Saudi Arabia, and Turkey)

[2] The MSCI World index consists of the following 24 developed market country indices: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

MENA markets. This result suggests that information from the World market is transmitted to the MENA stock markets, albeit mostly in turbulent periods.

The paper is organized as follows: Section 1 introduces and motivates the importance of the study of the behavior of MENA stock market volatility. Section two describes the data and the methodology. Section four presents and analyses the results. Section five concludes and gives important recommendations to policy makers.

2. Data and Methodology

2.1. Data

Our dataset concerns daily stock market price index in local currency of eleven MENA countries, namely, Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia and UAE and the MSCI World index in US dollar[3]. The sample period is from October 30, 2006 through October 21, 2011 (October 29, 2010 for Saudi Arabia). Data are from Morgan Stanley Capital International[4]. Daily returns in each market are represented as the natural logarithmic differences in prices as follows:

$$R_{it} = Ln\left(\frac{P_{it}}{P_{it-1}}\right) \qquad (1)$$

where P_{it} is the closing price for each country's index at time *t*.

Descriptive statistics for each series' daily returns include mean, standard deviation, maximum, minimum, skewness, Kurtosis, Jarque-Bera test, Augmented Dickey Fuller (ADF) test and Ljung-Box test statistics applied to the return and squared return series are reported in table 1. Except for Morocco, Oman, Qatar and Tunisia, all other markets present a negative mean return. Tunisian market appears to have, on average, the highest return over the sample period (0.029%). The UAE has the highest risk as approximated by standard deviation of 2%. Skewness values are negative for all series excluding Jordan, Lebanon and Tunisia; which indicates that data are skewed left. Furthermore Kurtosis values are larger than 3 for all indices showing that these series have fat tails compared to the normal distribution. The Jarque-Bera test shows that the null hypothesis of normality is rejected for all markets. The ADF test with drift and trend was conducted to check for unit root in the return series. All indices returns are stationary and the null hypothesis of unit root is rejected. The Ljung-Box Q-statistic, up to the eighth order in level and squares of returns, clearly indicates that there is serial correlation in levels and squared returns for all indices, suggesting the existence of the volatility-clustering phenomenon.

2.2. Methodology

2.2.1. Regime-switching behavior in the volatility generating processes

To investigate the regime switching behavior in the volatility generating process we need to determinate the conditional volatility. The most popular approach for modeling conditional volatility is the GARCH family models as introduced by Engle (1982) and generalized by Bollerslev (1986) and Nelson (1991). For capturing volatility of stock market returns, an AR (P) GARCH (1, 1) model is specified as follows:

$$r_t = a_0 + \sum_{s=1}^{p} a_s r_{t-s} + \varepsilon_t \; ; \qquad (2)$$

$$\varepsilon_t / \Omega_{t-1} \sim N(0, h_t) \; ; \qquad (3)$$

[3] Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and UAE constitute the Gulf Cooperation Council (GCC).

[4] http://www.mscibarra.com/

$$h_t = \omega_0 + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1} \quad (4)$$

where r_t is the daily stock market return at time (t), h_t is the conditional variance of the residuals from the mean equation and ε_t is the error term that follows a normal distribution with mean zero and time-varying variance.

Once the conditional volatility series have been determined, we use a Markov regime-switching model. This model was introduced by Hamilton (1989) and largely applied to different developed and emerging stock market returns (Abid and Bahloul, 2011; Moore and Wang, 2007; Wang and Theobald, 2008). The selected model allows the variance to switch across different states, and the regime at any given date is supposed to be the outcome of a Markov chain whose realizations are unobservable. Three regimes of volatility have been defined: tranquil period with low volatility, turmoil regime with high volatility and crisis regime with extremely high volatility Baba and Sakurai (2011) find that there are three distinct regimes in the VIX index during the period 1990 - 2010: tranquil regime, turmoil regime and crisis regime. Moore and Wang (2007) and Wang and Theobald (2008) show the existence of three volatility regimes (low, medium and high) for two new European Union states namely Poland and Slovakia and for three East Asian emerging stock markets (Indonesia, Korea and Thailand), respectively.

The proposed model is given as follows:

$$h_t = \mu + \varepsilon_t \quad \text{with} \quad \varepsilon_t \sim N\left(0, \sigma_{S_t}^2\right) \quad (5)$$

where h_t represents daily conditional volatility, ε_t follows a normal distribution with zero mean and variance given by $\sigma_{S_t}^2$. S_t is assumed to be a three-state first order Markov process with transition probability matrix represented as:

$$P = \begin{bmatrix} p_{11} & p_{21} & p_{31} \\ p_{12} & p_{22} & p_{32} \\ p_{13} & p_{23} & p_{33} \end{bmatrix} \quad (6)$$

where $p_{ij} = \Pr\left(S_t = j \middle| S_{t-1} = i\right)$ and $\sum_{j=1}^{3} p_{ij} = 1$, for j = 1,2,3, and for all i. These probabilities are specified as constant coefficients that are independent of time t.

From equation (6), the expected duration d of regime j is given by

$$E(d) = \frac{1}{1 - p_{jj}} \quad (7)$$

Using Hamilton's filter and iterative algorithms Equation (5) and the transition probability matrix can be estimated by maximum likelihood (Hamilton, 1994; Kim and Nelson, 1999).

2.2.2. Granger causality test within regimes

In addition to the study of the regime switching behavior in the volatility of MENA stock market returns, we perform Granger causality tests (Granger, 1969) to investigate the effects of unidirectional causality between the World market index and MENA stock market volatilities across regimes. The sample has been divided into three sub-sample periods (calm, turmoil and crisis) using the smoothed states probabilities for the World market index. According to Hamilton (1989) a stock market is in regime *i* if the associated smoothed probability is higher than 0.5.

The pair-wise Granger causality tests are represented empirically as follows:

$$VMENA_t = c_1 + \sum_{j=1}^{m} a_j VMENA_{t-j} + \sum_{j=1}^{m} b_j VW_{t-j} + \varepsilon_t \quad (8)$$

where VW, $VMENA$ and ε_t represent stock market volatility of the MSCI World index and eleven MENA countries, and vectors of the random error term, respectively. M is the order of the respective lag variable. The VW is said to Granger cause $VMENA$ if lagged coefficients of VW are significantly different from zero. Since results of causality test are sensitive to the lag imposed, we use the Bayesian information criterion to select the optimal lag length.

3. Results and Analysis

3.1 Results of the autoregressive GARCH model

The preliminary analysis was conducted on AR (P) specifications. For all our indices, we obtain that a first-order autoregressive process is sufficient to describe the expected fluctuation in mean return. The estimation results of the AR (1)-GARCH (1, 1) are reported in table 2. The autoregressive coefficient in the conditional mean (a_1) is positive and significant for all MENA markets and the MSCI World index. This coefficient varies from 0.0602 for Jordan to 0.1679 for Morocco.

The time-varying pattern of the market index price variability was confirmed for all series. In fact the coefficients of the GARCH effects (α and β) are significant at the 1% level in all cases. The sum of α and β was close but less than one, implying persistent volatility effects. These values vary from 0.7686 for Morocco to 0.9990 for Oman. Lamoureux and Lastrapes (1990) stipulate that the high persistence may reflect regime switch in the variance process. Figure 1, which displays time series of the conditional variance, shows different states of volatility for all markets. This volatility is low, medium or high during several periods.

The Ljung-Box Q statistic tests show that autocorrelation of standardized residuals are statistically insignificant at 10% level for all indices. The Lagrange Multiplier test of Engle (1982) at four lags for heteroscedasticity on standardized residual are insignificant at 1% level for all series except Egypt, Saudi Arabia and the World market index showing that standardized residual does not exhibit additional ARCH effect.

3.2 Results of the Markov regime-switching model

Table 3 reports parameter estimates of the regime switching model in which stock market conditional volatility are assumed to be drawn from three distributions which differ in the variance of the stock market volatility5. We apply the mat lab package for Markov regime switching provided by Perlin (2011). Conditional volatility appears to be characterized by three regimes: tranquil period with low volatility, turmoil regime with high volatility and crisis regime with extremely high volatility. In fact, the volatility values are significant at 1% level for all markets.

In the first regime, the variance of the volatility varies from 0.0001% for Jordan and Morocco to 0.03% for Egypt. In the second regime, the volatility is more important than that in the first regime. This importance varies from eleven times for the World market index to seventy eight times for Lebanon. In the third regime, the variance of the volatility is extremely important. It varies from 0.04 % for Morocco to 1.2% for Lebanon. For example, for Oman, the volatility during crisis period is sixty nine times higher than that in the turmoil regime.

The probability of being in the same regime the following period is greater than 0.5 for all series, which indicates that regimes are persistent. Except for Bahrain and Egypt, the

[5] 100 have multiplied conditional volatility estimated by the GARCH model.

transition probabilities p_{12}, p_{21}, p_{23} and p_{32} are all significant showing that the transition between tranquil, turmoil, and crisis regimes is easy and justifying the use of the three-state Markov regime switching model.

Table 3 reports also the expected duration of the tranquil, turmoil and crisis regimes. This duration varies from 13 days for Morocco to 141 days for Saudi Arabia in the first regime. The expected duration of the second regime is ranged between 5 days for Morocco to 44 days for Saudi Arabia. The third regime shows an expected duration varying from 6 days for Morocco to 89 days for the World market index.

Figure 2 displays time series of smoothed states' probabilities for the World market index and the eleven MENA countries. The same figure shows different degrees of clearly defined states. For example, for Saudi Arabia, regimes are obvious, while for Morocco; the estimated state probabilities do not provide clear separation between the states. Regimes are very instable as we observe a frequent shift between tranquil, turmoil and crisis periods. Figure 2 shows some common patterns in the switching dates among all series especially around May 2008 when there is an increase in the probability of crisis regime. Also it shows individual patterns in the switching dates for countries that witnessed a revolution during the last period, such as Tunisia and Egypt.

3.3 Results of the Granger causality test

Empirical results of the unidirectional causality between the World market index and MENA countries across regimes based on volatility series are presented in panel A of table 4. Note that for the state 3, we use the first difference of VW and $VMENA$ while these series are not stationary in level. Cross-market volatility dependency varies in magnitude across regimes. Significant evidence of causality is not observed during the tranquil period. Causality in turmoil period is observed between the World market index and six MENA markets (Bahrain, Egypt, Morocco, Oman, Qatar and UAE). During the crisis period, the World market index leads eight MENA markets (Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Tunisia, and UAE). Thus, information transfer between financial markets seems to be more important during financial crisis. The choc(?) in financial market volatility from World market index in financial crisis is transmitted to MENA market.

Panel B of table 4 reports correlation coefficients between the World market index and MENA stock market volatilities in different world market regimes: calm, turmoil and crisis. In the first regime, correlation coefficients are very low or negative for some markets such as Egypt, Jordan and Lebanon. The most important correlation coefficient is for Saudi Arabia with a value of 0.30. In the second regime, except for Tunisia, and Saudi Arabia, correlation coefficients are more important and are higher than 0.5 for Egypt and UAE. In the third regime, correlation coefficients are extremely important for all markets except those of Kuwait, Morocco, Oman and Tunisia. The most important coefficient is for Jordan with a value of 0.87. Thus, during periods of financial crisis correlations between the volatilities of various stock markets tend to increase significantly, implying limited benefits from international portfolio diversification in highly volatile market regime.

4. Conclusion and Policy Implications

This paper investigates the time varying volatility and the volatility behavior in MENA region with three distinct states of nature: tranquil period with low volatility, turmoil regime with high volatility and crisis regime with extremely high volatility. The conditional volatility is modeled by using an autoregressive GARCH (1, 1) specification and the spillovers from the MSCI World index to MENA stock markets across different regimes are studied based on the Granger causality test.

Results over the period from October 30, 2006 to October 21, 2011 show that MENA stock market volatility can be characterized by three regimes: tranquil, turmoil and crisis. Also, significant evidence of causality in variance from the World market index to MENA markets has been proved in the turmoil regime and especially during financial crisis.

Although regimes were instable, we observed some common patterns in the switching dates among all series especially around May 2008 when there is an increase in the probability of crisis regime. Individual patterns in the switching dates are observed for countries that went through a revolution during the last period, such as Tunisia and Egypt.

Policy makers can benefit from the results of this paper: First, while transition from calm to turbulent markets is sudden and coincides with a higher volatility period, estimation of regime switching is crucial for policy makers as it allows them to predict financial crises and to estimate their duration in order to determine how they should be managed. Second, seeing the statistical significance of the presence of regime shifting in financial market volatilities, it is interesting for policy makers to predict risk in light of regime switching models.

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Figure1: Conditional variance of stock market returns

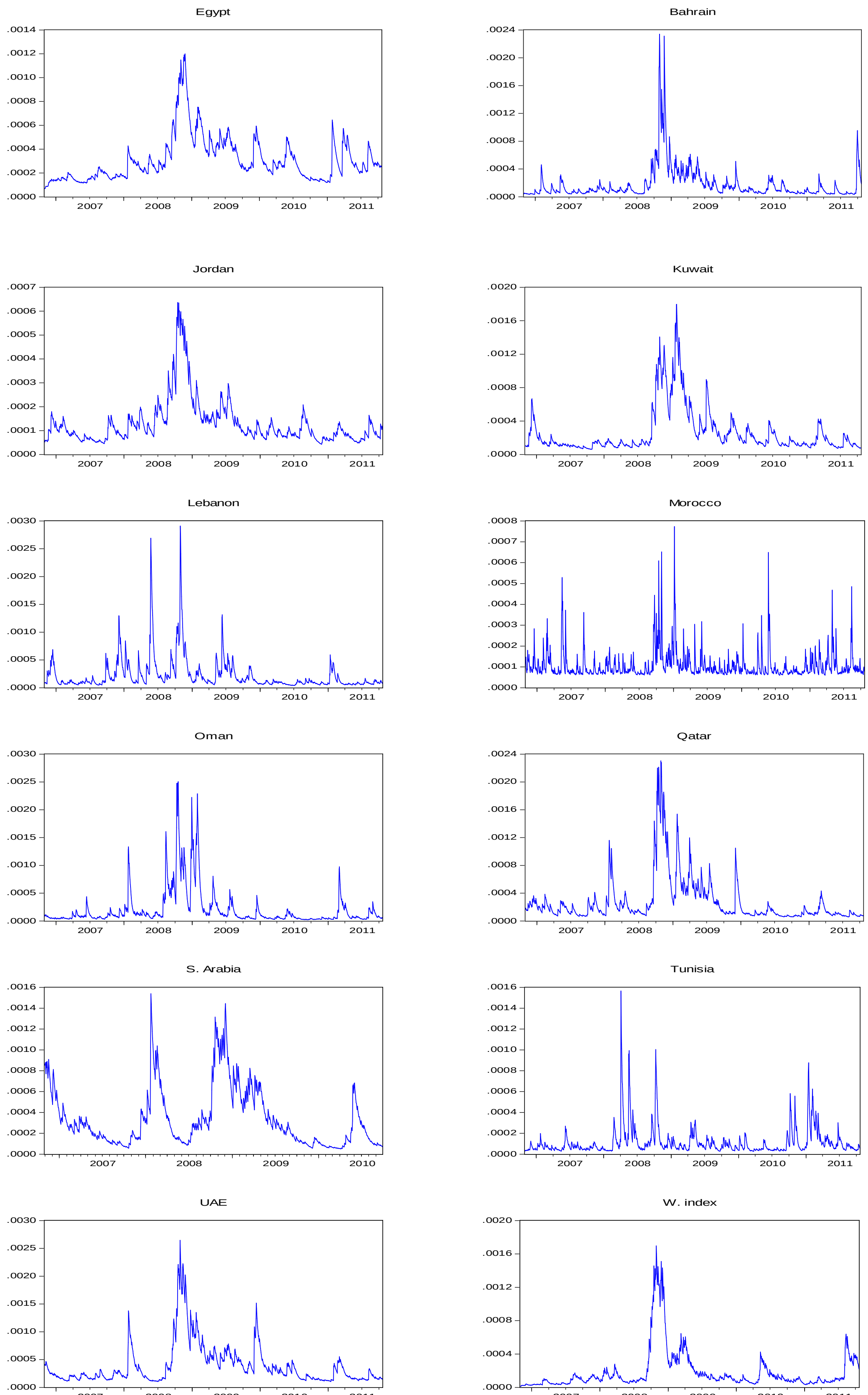

Figure 2: Smoothed States' Probabilities

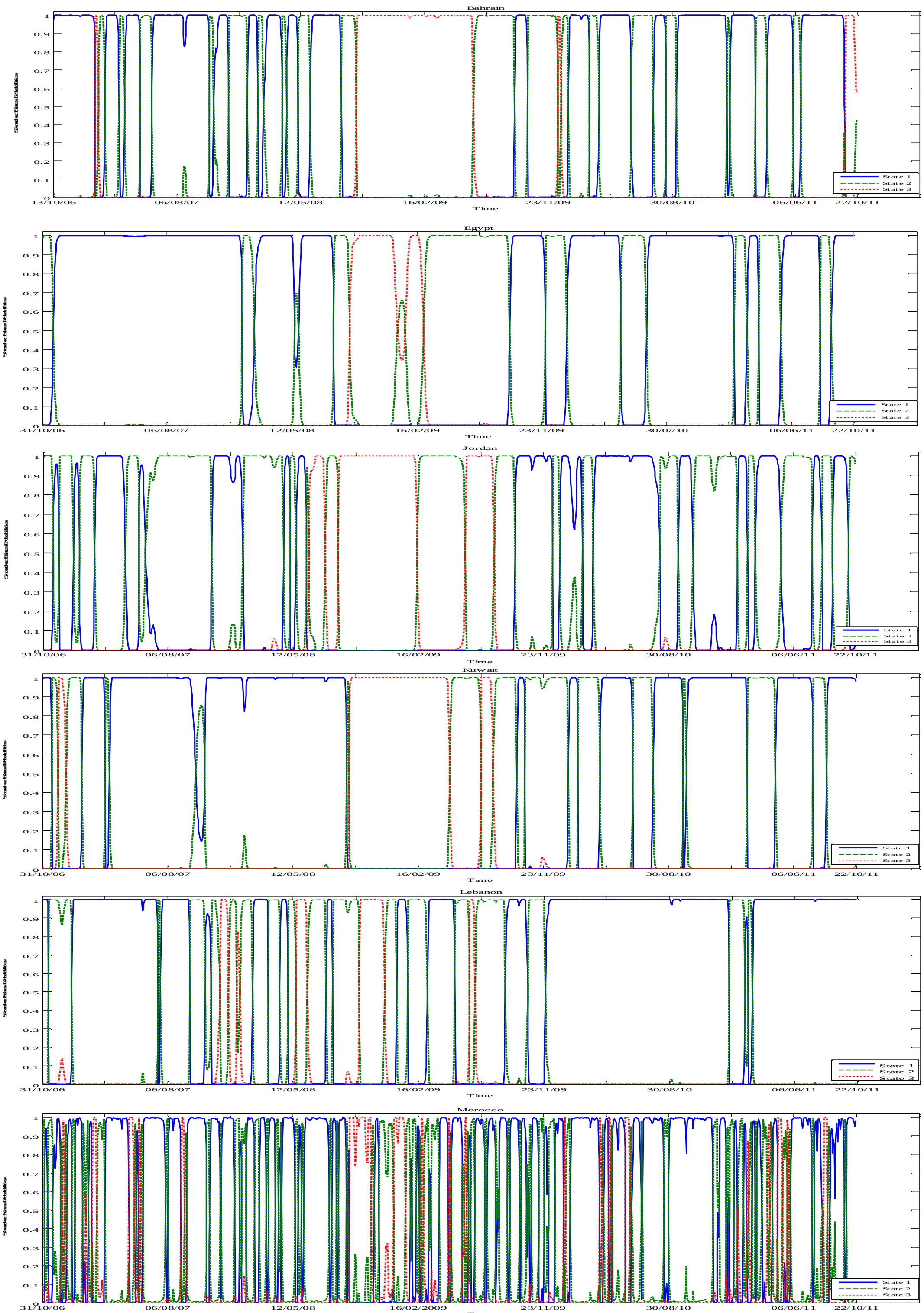

Figure 2: Continued

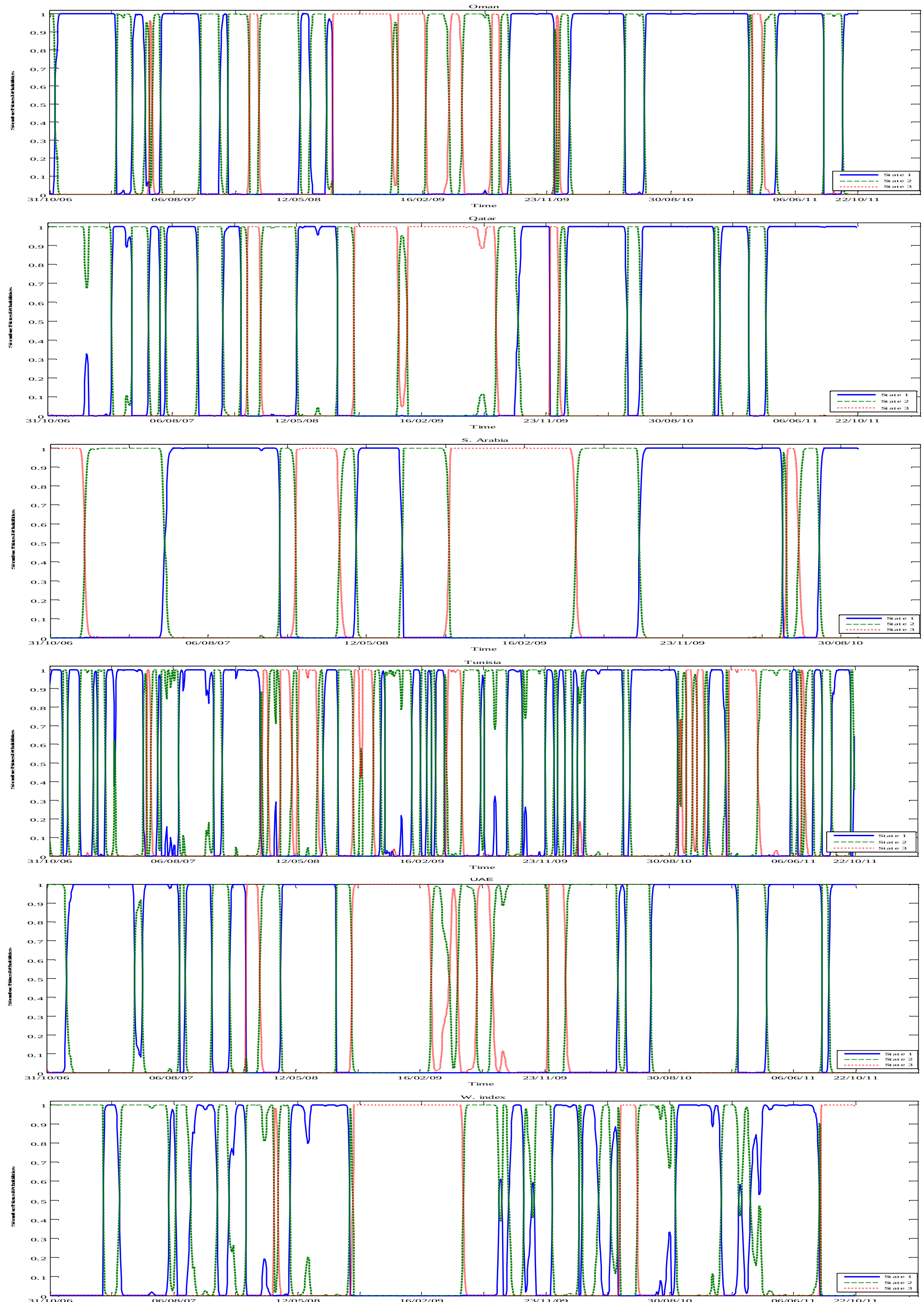

Table 1: Descriptive statistics for return series

	Bahrain	**Egypt**	**Jordan**	**Kuwait**	**Lebanon**	**Morocco**	**Oman**	**Qatar**	**S. Arabia**	**Tunisia**	**UAE**	**W. Index**
Mean	-0.00120	-0.00017	-0.00043	-0.00024	-0.00006	0.00013	0.00009	0.00019	-0.00010	0.00029	-0.00093	-0.00019
Std. Dev.	0.01291	0.01762	0.01155	0.01623	0.01455	0.01066	0.01391	0.01677	0.01797	0.01025	0.02002	0.01352
Maximum	0.07169	0.08295	0.05577	0.09200	0.10328	0.05011	0.09648	0.09180	0.09068	0.09468	0.10981	0.06740
Minimum	-0.11602	-0.10453	-0.05321	-0.10518	-0.10180	-0.05884	-0.09109	-0.11764	-0.10286	-0.06997	-0.13245	-0.07325
Skewness	-1.522	-0.820	0.040	-0.899	0.963	-0.237	-0.362	-0.731	-0.524	0.132	-0.895	-0.648
Kurtosis	16.989	8.296	7.149	11.220	13.802	6.520	14.909	12.954	10.108	13.458	10.389	8.304
Jarque-Bera	11101**	1665**	933**	3835**	6522**	684**	7711**	5483**	2201**	5928**	3131**	1615**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ADF test statistic	-32.43**	-31.93**	-32.51**	-32.99**	-26.92**	-29.50**	-32.04**	-31.61**	-29.20**	-30.96**	-30.86**	-32.11**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Q(8)$	19.644**	29.527**	26.938**	21.906**	32.967**	69.384**	34.248**	42.297**	20.379**	44.282**	40.461**	27.392**
	(0.012)	(0.000)	(0.001)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)	(0.009)	(0.000)	(0.000)	(0.001)
$Q^2(8)$	144.88**	117.36**	232.47**	236.88**	331.72**	178.20**	436.90**	196.88**	152.42**	95.676**	213.39**	844.00**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Note: The sample period is October 30, 2006 through October 21, 2011 (September 29, 2010 for Saudi Arabia). The ADF test for unit roots is based on the regression with constant and trend. $Q(8)$ and $Q^2(8)$ are the eighth-lag Ljung-Box test statistics applied to the return and squared return series, respectively. p-values are in parentheses. .** and * indicate significance at the 5% and 10% levels, respectively.

Table 2: Estimation Results of the AR (1)-GARCH (1, 1) Model

	Bahrain	Egypt	Jordan	Kuwait	Lebanon	Morocco	Oman	Qatar	S. Arabia	Tunisia	UAE	W. Index
Panel A: Mean equation												
a_0	-0.0005*	0.0003	-0.0002	0.0002	-0.0004	0.0002	0.0005**	0.0005	0.0007	0.0005**	-0.0001	0.0004
	(0.087)	(0.531)	(0.424)	(0.607)	(0.154)	(0.457)	(0.036)	(0.133)	(0.107)	(0.043	(0.761)	(0.144)
a_1	0.0821**	0.0818**	0.0602**	0.0661**	0.0628**	0.1679**	0.1249**	0.1423**	0.0659*	0.1014**	0.1305**	0.1169**
	(0.030)	(0.002)	(0.042)	(0.038)	(0.014)	(0.000)	(0.000)	(0.000)	(0.054)	(0.000)	(0.000)	(0.000)
Panel B: Conditional variance equation												
ω_0	0.000004**	0.000004**	0.000002**	0.000004**	0.000005**	0.000025**	0.000002**	0.000005**	0.000002**	0.000004**	0.000005**	0.000002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
α	0.1224**	0.0352**	0.0489**	0.0648**	0.1234**	0.1881**	0.1340**	0.0869**	0.0619**	0.1685**	0.0578**	0.0900**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.0000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
β	0.8591**	0.9534**	0.9332**	0.9206**	0.8597**	0.5805**	0.8650**	0.8945**	0.9334**	0.8100**	0.9284**	0.9032**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\alpha + \beta$	0.9815	0.9886	0.9821	0.9854	0.9831	0.7686	0.9990	0.9814	0.9953	0.9785	0.9862	0.9932
Panel C: Diagnostic tests												
$Log(L)$	4063	3507	4077	3724	3890	4158	4091	3745	2800	4269	3446	4052
$Q(8)$	6.834	6.896	4.654	9.110	10.382	8.843	11.710	10.912	7.527	6.152	9.517	5.931
	(0.555)	(0.548)	(0.794)	(0.333)	(0.239)	(0.356)	(0.165)	(0.207)	(0.481)	(0.630)	(0.301)	(0.655)
ARCH-LM (4)	1.406	3.353	1.932	0.979	0.533	0.389	0.552	0.686	4.251	0.992	1.612	3.037
	(0.229)	(0.010)	(0.103)	(0.418)	(0.712)	(0.816)	(0.697)	(0.601)	(0.002)	(0.410)	(0.168)	(0.017)

Note: $Q(8)$ is the eighth-lag Ljung-Box test statistic applied to the standardized residual. ARCH-LM (4) is the Lagrange Multiplier test of Engle (1982) at four lags for heteroscedasticity on standardized residual. p-values are in parentheses. .** and * indicate significance at the 5% and 10% levels, respectively.

Table 3: Estimation results for the Markov regime-switching model

	Bahrain	Egypt	Jordan	Kuwait	Lebanon	Morocco	Oman	Qatar	S. Arabia	Tunisia	UAE	W. Index
μ	0.0065**	0.0210**	0.0088**	0.0121**	0.0091**	0.0078**	0.0053**	0.0103**	0.0002**	0.0048**	0.0169**	0.0085**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
σ_1^2	0.000003**	0.000030**	0.000001**	0.000007**	0.000008**	0.000001**	0.000003**	0.000006**	0.000018**	0.000001**	0.000012**	0.000003**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
σ_2^2	0.00013**	0.00049**	0.00002**	0.00026**	0.00062**	0.00003**	0.00012**	0.00021**	0.00032**	0.00004**	0.00051**	0.00003**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
σ_3^2	0.0039**	0.0035**	0.0006**	0.0058**	0.0122**	0.0004**	0.0082**	0.0072**	0.0042**	0.0014**	0.0100**	0.0033**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
p_{11}	0.9750**	0.9904**	0.9652	0.9862**	0.9850**	0.9246**	0.9842**	0.9852**	0.9929**	0.9548**	0.9868**	0.9698**
	(0.00)	(0.00)	(1.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
p_{12}	0.0227**	0.0096**	0.0348**	0.0138**	0.0150**	0.0589**	0.0141**	0.0133**	0.0071*	0.0452**	0.0117**	0.0302**
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.08)	(0.00)	(0.01)	(0.00)
p_{13}	0.0023	0.0000	0.0000	0.0000**	0.000	0.0165**	0.0017	0.0015	0.000	0.000	0.0015	0.000
	(0.28)	(1.00)	(1.00)	(0.00)	(1.00)	(0.01)	(0.37)	(0.33)	(1.00)	(1.00)	(0.34)	(1.00)
p_{21}	0.0444**	0.0239**	0.0263**	0.0287**	0.0303**	0.1775**	0.0262**	0.0269**	0.0130**	0.0510**	0.0193**	0.0279**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)
p_{22}	0.9488**	0.9714**	0.9686**	0.9626**	0.9564**	0.7894**	0.9575**	0.9651**	0.9772**	0.9254**	0.9715**	0.9646**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
p_{23}	0.0068	0.0047	0.0051*	0.0087**	0.0133*	0.0331*	0.0163**	0.0080*	0.0098*	0.0236**	0.0092**	0.0075**
	(0.15)	(0.18)	(0.09)	(0.00)	(0.06)	(0.06)	(0.01)	(0.09)	(0.09)	(0.00)	(0.04)	(0.04)
p_{31}	0.000	0.000	0.0000	0.0000**	0.000	0.0000	0.0000	0.000	0.000	0.000	0.000	0.000
	(1.00)	(1.00)	(1.00)	(0.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)
p_{32}	0.0163*	0.0165	0.0159*	0.0161**	0.0590*	0.1687**	0.0363**	0.0166**	0.0147**	0.0596**	0.0236**	0.0112*
	(0.08)	(0.18)	(0.09)	(0.00)	(0.06)	(0.02)	(0.01)	(0.05)	(0.05)	(0.00)	(0.02)	(0.08)
p_{33}	0.9837**	0.9835	0.9841**	0.9839**	0.9410**	0.8313**	0.9637**	0.9834**	0.9853**	0.9404**	0.9764	0.9888**
	(0.00)	(1.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(1.00)	(0.00)
$Log(L)$	4745.15	40550.6	5332.76	4487.79	4476.45	5780.67	4646.09	4249.92	2880.74	5214.10	3800.51	4711.62
$E(d_1)$	40	104	29	72	67	13	63	68	141	22	76	33
$E(d_2)$	20	35	32	27	23	5	24	29	44	13	35	28
$E(d_3)$	61	61	63	62	17	6	28	60	68	17	42	89

Note: $E(d_1)$, $E(d_2)$, and $E(d_3)$ are the expected durations of regime 1, regime 2 and regime 3, respectively. p-values are in parentheses.** and * indicate significance at the 5% and 10% levels, respectively.

Table 4: Granger Causality Test Results and Correlation Coefficients

	Bahrain	Egypt	Jordan	Kuwait	Lebanon	Morocco	Oman	Qatar	S. Arabia	Tunisia	UAE
Panel A: Granger causality tests											
The World index does not cause MENA in calm regime	0.0597	0.3755	0.2107	0.0975	0.0810	2.4131	0.5378	0.2105	2.5405	2.4347	1.7296
The World index does not cause MENA in turmoil regime	5.7837*	8.0580*	3.2370	3.0129	1.2531	3.8681*	5.4135*	6.1550*	1.0241	0.3249	11.5778*
The World index does not cause MENA in crisis regime	0.6776	0.4482	9.5292*	6.4736*	6.5729*	3.4084*	6.2009*	9.2715*	0.4994	3.6380*	6.9437*
Panel B: Correlation coefficients between the World market index and MENA stock market volatilities											
Calm regime	0.06	-0.11	-0.065	0.097	-0.16	-0.17	0.08	0.08	0.30	-0.23	0.057
Turmoil regime	0.40	0.63	0.43	0.24	0.22	-0.166	0.36	0.360	0.02	-0.01	0.55
Crisis regime	0.74	0.83	0.87	0.45	0.75	0.21	0.42	0.79	0.76	0.27	0.81

Note:* denotes rejection of the null hypothesis at the 5% level. The lag length selection is determined according to the Bayesian information criterion.