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Correlation and Volatility of the MENA Equity Markets in Turbulent Periods, and Portfolio Implications

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Abstract

This paper examines the conditional volatility and return linkages for the equity markets of Morocco, Tunisia, Egypt, Israel, Lebanon, Jordan, Kuwait, Bahrain, Qatar, UAE, Saudi Arabia, and Oman over the period 2005-2012. To this end, we employ a multivariate model with time varying conditional variances and correlations and with leptokurtic distribution which allows for both return asymmetry and fat tails. Particularly, we investigate the pre- and post-stress periods using the Israeli-Hezbollah war in July 2006 and the global financial crisis of 2008 as dating points for detecting the time varying variance and correlation behaviours across the twelve equity markets. We find strong evidence that a downward trend in return correlations estimates across a number of MENA equity markets is driven equally by both the war and the global financial crisis, implying that there still appear to be benefits from regional portfolio diversification even in stress periods when they are most necessary. Finally, we use the estimated results to compute the optimal weights in order to make the best portfolio allocations.

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1. Introduction

Given that the covariance matrix of financial asset returns is both time-varying and highly persistent (Harris and Nguyen, 2013), it is important to employ multivariate models that are capable of capturing these features (Boudt and Croux, 2010). Particularly, considering that volatility and correlation structures of national equity markets are time-varying, incorporating these features into the estimation of the conditional covariance matrix of equity returns can lead to better decisions on portfolio maximization (Pantaleo et *al.*, 2010).

However, diversification strategies can be undermined by adverse market conditions (Ciner, Gurdgiev, and Lucey, 2013). During crisis periods the relationships linking equity returns across national boundaries interrupt, implying severe challenges for portfolio management (Dungey and Martin, 2007; Baur, 2013). The global financial crisis emphasizes the non-linear and asymmetric linkage of assets and markets (Baur, 2013). Several authors also suggest that the linkages between stock markets become stronger in turbulent periods (Ang and Bekaert, 2002; Ang and Chen, 2002), reducing the benefits of diversification. While, the literature on the linkages of equity markets in developed and large emerging countries is well elaborated, the phenomenon of rising links among the equity markets remains ambiguous and debatable in the understudied emerging markets of the Middle East and North African (MENA) region. Particularly, a careful investigation of trembling events provides additional evidence of whether diversification opportunities remain in some of the MENA equity markets. Building on this background, we aim to investigate the linkages between the MENA equity markets with a special focus on the impact of two dramatic, but completely different, events on the conditional volatility and correlation across national borders. The first is a regional non-financial event, the Israeli-Hezbollah war of 2006. The second is the global financial crisis of 2008. We also seek to use estimated results to compute optimal weights for national indices in a portfolio that minimizes overall risk without lowering expected returns. To the best of our knowledge no previous studies have addressed all the above issues in one single paper.

Cross-market linkages in developed and large emerging stock markets have been the subject of a growing body of literature on financial integration and portfolio diversification. According to Forbes and Rigobon (2002), such studies were motivated by the globalization phenomenon and repeated turmoil in the financial markets (US stock market crash in 1987, the East Asian crisis in 1997, and the global financial crisis in 2008 among others). Forbes and Chinn (2004) indicate that economic ties, cross-border trade, and capital flows are among the main factors that can interlink national equity prices.

The notable interest in emerging markets in general has been recently reinforced by better relative growth prospects and abundant global liquidity (Institute of International Finance, 2011). Since the early 2000s the MENA region has witnessed a remarkable economic growth and has evolved into a vibrant and important economic and financial block consequent to the liberalization and globalization. In various MENA markets, foreign capital controls have been relaxed to a certain extent. The openness of these markets to local and foreign investments increased with the sale of governments' assets to private funds, and the number of companies going public also soared. As a result, the dynamics of equity returns volatilities and correlations are likely to be affected.

There are also several important features of the MENA countries. Especially they are characterized by relatively small and illiquid stock markets (Bley, 2011), high trading cost (Assaf, 2009), restrictive foreign ownership (Balcilar et al., 2013), and distinct industrial organization (Assaf, 2009). Several market and institutional issues such as weak-form efficiency (Lagoarde-Segot and Lucey, 2008) and common economic, regulatory, political and cultural links that often function differently than those of developed counterparts, resulting in different co-movement between the MENA equity returns. As such, regional factors may dominate global factors (Balcilar, 2013).

This study also involves not only a heterogeneous sample of equity markets of various sizes and liquidity, but also of different phases of economic development. Israel is a developed economy, while all the others MENA countries are considered as developing economies, with Saudi Arabia being a member of the G20. It is also interesting to investigate the MENA region given that the majority of Arab countries are boycotting economically and financially Israel. Such conditions may contribute to a different behaviour of volatility and correlation than observed in purely developed markets.

This paper contributes to the empirical literature on equity linkages by three aspects. Firstly, we estimate time-varying conditional variances and correlations across twelve MENA equity markets, including Israel, and show that variances and correlations change significantly within relatively short time periods. Secondly, we test the impact of two adverse events on equity return linkages and thus on regional portfolio diversification so as to enhance the reward-to-volatility ratio. Thirdly, we derive from the covariance matrix of MENA stock returns optimal portfolio weights which minimize the overall risk. Methodologically, we use a multivariate Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model with General Errors Distribution (GED) which allows for both asymmetry and leptokurtic distribution.

Such research contribution is especially important for practitioners given the growth in regional equity funds composed merely of companies that are listed on the MENA stock exchanges. Besides implications for portfolio management, the results of this study are crucial for regulators and policymakers seeking the stability of the financial markets, in this politically troubled and security unstable region of the world, through timely responses to cross borders shocks. One potential shock could result from a possible confrontation between Israel and the Lebanese Hezbollah in response to any military resolution of the Iranian Nuclear file.

Overall, our findings provide evidence that conditional volatility trended upwards following stress periods. However, unlike previous findings (e.g. Longin and Solnik, 2001; Ang and Chen, 2002; Khallouli and Sandretto, 2012; Demirer, 2013), we find that the correlation between equity market returns across several MENA countries decreased during worldwide and regional bearish markets alike, implying diversification benefits during periods of high volatility. Unlike previous finding (Balcilar, 2013), we also find that not only regional events affect the MENA markets, but also global events.

Section 2 presents the theoretical insights and reviews the literature. Section 3 displays the descriptive statistics of the data. Section 4 discusses the methodology, including model development. Sections 5 and 6 present different empirical results. Finally, Section 7 draws our conclusions.

2. Theoretical background and literature review

The issue of linkages between MENA national equity markets has significantly attracted the attention of scholars and practitioners. While voluminous research focuses on the linkages between stock markets in developed countries, there are only a handful of studies that examine this issue in the MENA region. Previous studies provide reveal several mechanisms through which stock markets of the MENA region are linked.

First, MENA countries in general are sensitive to oil prices and consequently to oil revenues given the economic importance of the energy sector in this region of the world. Accordingly, Al Refai (2010) finds a positive relationship between increasing oil price and stock returns in several MENA countries. Using a Markov regime switching model, Naifar and Al Dohaiman (2013) also document evidence of a significant impact of oil price on stock market returns in the Arab Gulf countries. Awartani and Maghyereh (2013) argue that return and volatility transmissions between oil and some MENA equities are bi-directional and asymmetric. On

the other hand, Fayyad and Daly (2011) indicate that the overall stock market sensitivity to oil price shocks has increased since the beginning of the global financial crisis. Particularly, the authors find that Qatar and UAE have been more sensitive to oil shocks than other MENA markets. Arouri et al. (2011) show substantial return and volatility transmissions between crude oil prices and some MENA stock returns, suggesting that stock market sensitivity to changes in oil prices to differ according to whether a country is an oil importer or exporter. Mohanty et al. (2011) examine the link between changes in crude oil prices and industry-level stock returns in the Arab Gulf countries and find significant positive exposure in twelve out of twenty industries studied. Yet, using a four regime Markov-switching vector autoregressive model, Balcilar and Genc (2010) argue that there are no lead and lag relationships between crude oil prices and any of the Arab Gulf stock markets.

Second, a current strand of research examines the integration of MENA stock markets with the US and European stock markets. Recent important papers includes Khallouli and Sandretto (2012) study which uses the Markov-Switching exponential GARCH model to imply that there is evidence of mean and volatility linkages in MENA stock markets caused by the US stock market. Using the correlation index and return dispersion, Demirer (2013) also finds a strong link between market volatility and both diversification measures in most of the Arab Gulf equity markets, suggesting potential benefits of diversification with international equities. Similarly, Genc et al. (2010) find that some MENA stock markets are synchronized with US stock markets as a result of the growing influx of non Arab Gulf capital. Using the Markov-switching CAPM, Cheng et al. (2010) examine the degree of integration of MENA equity returns with international equity markets and indicate that some portfolio diversification opportunities exist. Graham et al. (2013) investigate the co-movement of selected MENA stock markets (Egypt, Jordan, Saudi Arabia, Kuwait, Qatar and the UAE) with the U.S. stock market from 2002-2010 using a wavelet squared coherency methodology. The authors indicate enhanced short term diversification gains from combining MENA market equities with global equities. On the other hand, based on five optimization models and two risk measures, Lagoarde-Segot and Lucey (2007) find that the main stock markets of the MENA region show weak levels of co-movement with world stock markets. Alkulaib et al. (2009) use the state space procedure to examine the linkages between stock markets in this region. The authors indicate that there is more interaction and linkage in the Arab Gulf region than in the remaining MENA regions. Conversely, employing the autoregressive distributed lag approach to co-integration, Marashdeh and Shrestha (2010) find that several MENA markets are not fully integrated with the US and European markets.

Using the error composition model, Ravichandran and Maloain (2010) provide new evidence that the relationship among Gulf equity markets strengthens, leading to more regional and global integration after a crisis than before it.

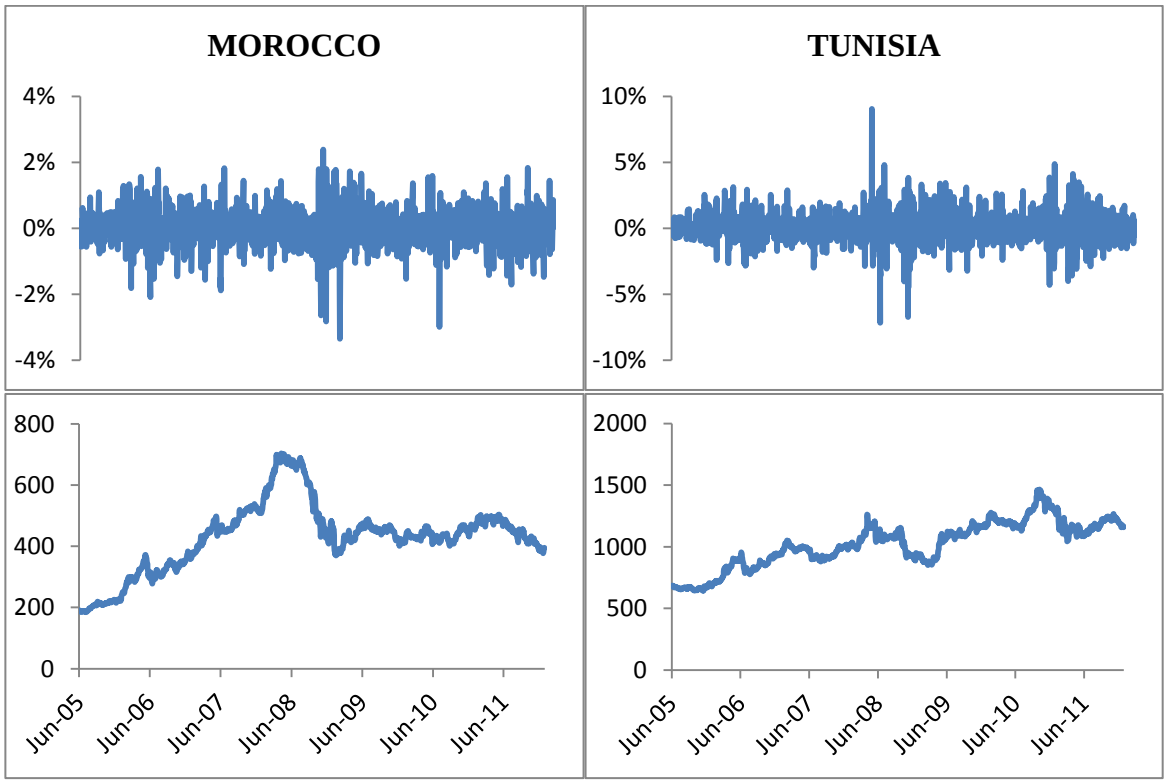
Third, the herding behaviour of institutional and individual investors may explain the increased correlation in stock returns across several MENA countries (Balcilar et al., 2013). Typically, investors may copy the behaviour of other investors leading them to trade in the same direction. As a result, they push asset prices away from their fundamental values, driving up market volatility.

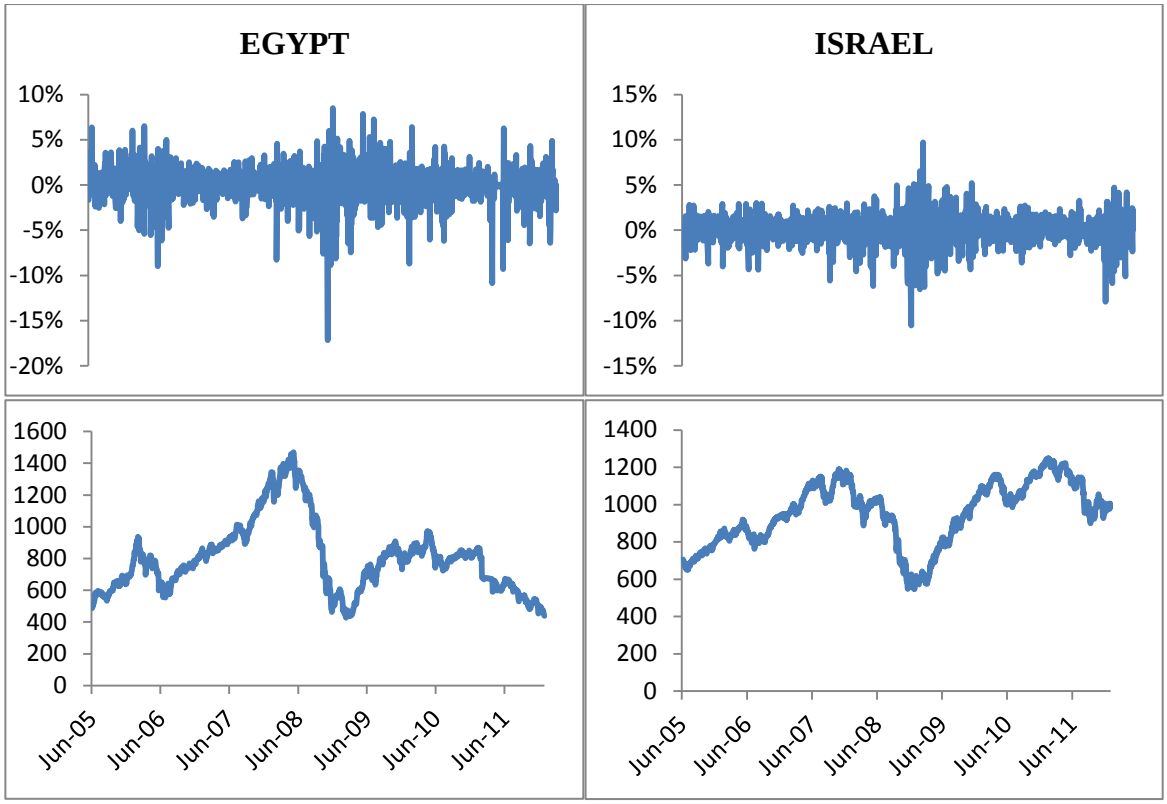
We extend the above analyses by including more recent observations (2005-2012), adding new Middle East countries (including Israel), and differentiating between global and regional shocks affecting cross-market linkages. Therefore, our paper importantly complements the existing evidence of interdependencies in MENA equity markets and provides new and additional insights for pertinent portfolio management.

3. Data and descriptive statistics

We use daily data from Data Stream covering the period 01 June 2005 and 2 January 2012 for the closing prices of MSCI (Morgan Stanley Capital International) equity indices in Morocco, Tunisia, Egypt, Israel, Lebanon, Jordan, Kuwait, Bahrain, Qatar, UAE and Oman. For the Saudi equity market, we use instead the Standard and Poor's Saudi Arabia BMI (Broad Market Index), because the MSCI ceased to cover the Saudi equity market. All indices are value weighted and measure the price performance of equity markets without including dividends. Although all MENA markets do not share the same week-end and public holidays, we thus select a total of 1 310 observations per index from common trading days. As such, the length of series is equal across countries. The return series are calculated as the difference of the logarithms of the price index, scaled by 100.

Figure 1. First differences (upper panel) and levels (lower panel) of MENA stock indices

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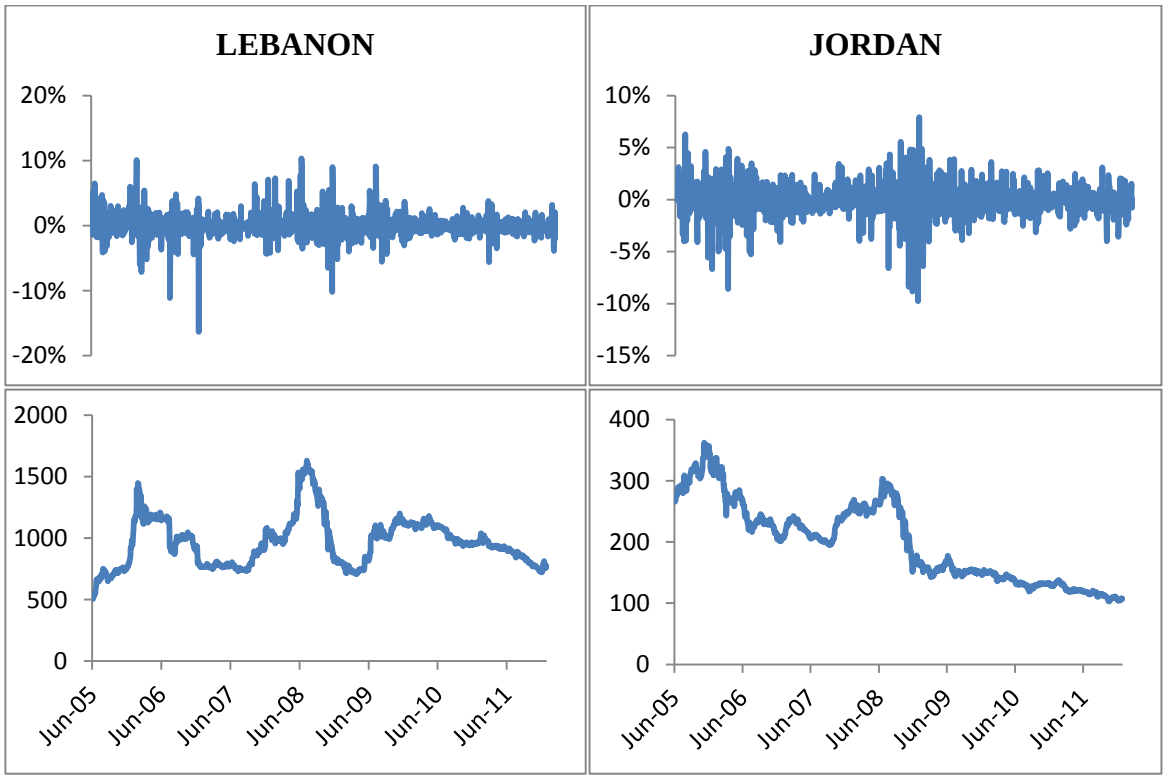
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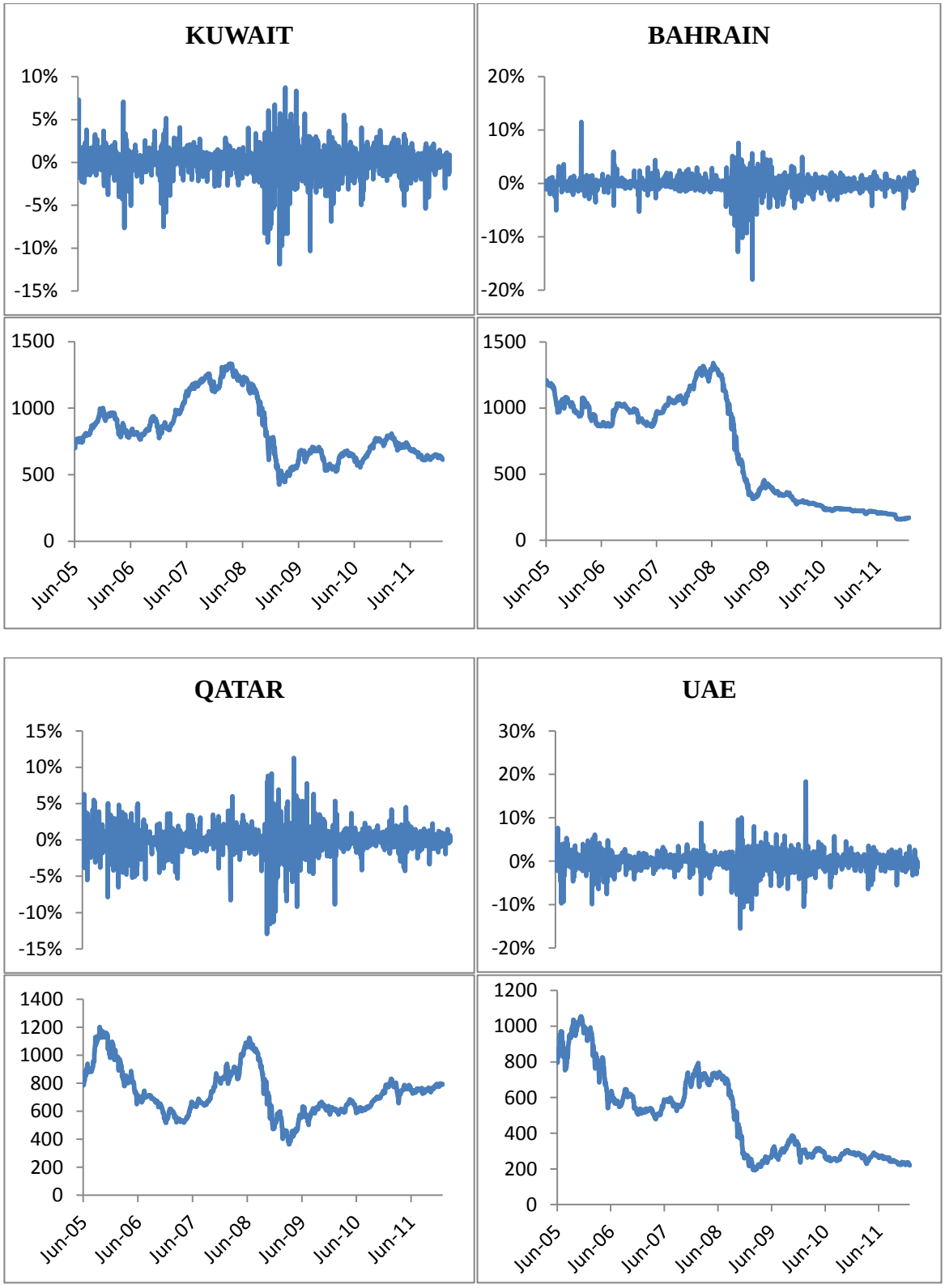
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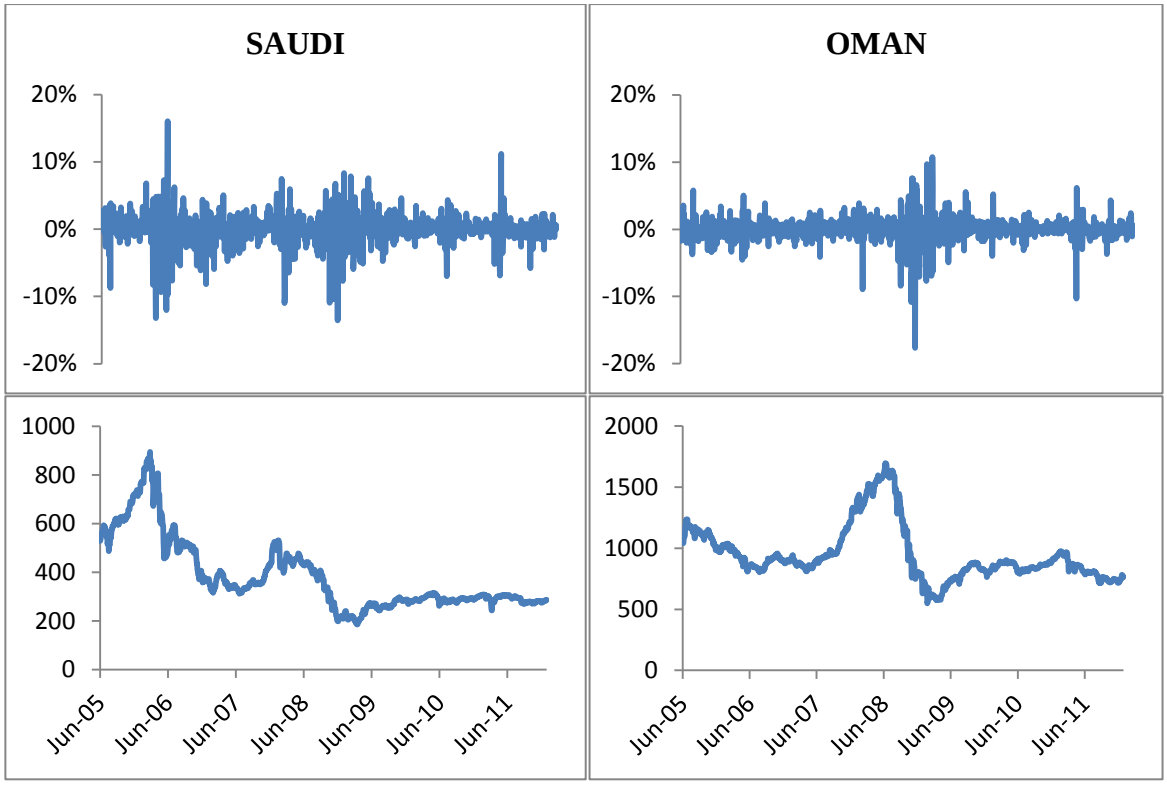

Figure 1 present first differences and levels of the series. We notice that volatility clustering is omnipresent in the return series, indicating that periods of high volatility are followed by periods of relatively low volatility. During the Israeli-Hezbollah war (July-August 2006), and the global financial crisis (July 2008-February 2009), we particularly observe significant unsteady patterns of returns.

Table 1. Descriptive statistics

	Mean return %	SD	CV	Skewness	Kurtosis	LB-Q (10)	ARCH-LM (10)	MC/GDP %
MOROCCO	4.21812	1.24229	0.29452	-0.34632	6.29561	109.18901[a]	147.64535[a]	75.81247
TUNISIA	3.15423	1.07581	0.34107	0.11654	9.43349	52.65897[a]	91.50797[a]	24.12092
EGYPT	-0.73805	1.84617	-0.25014	-1.15858	11.47941	41.25815[a]	85.01901[a]	37.73405
ISRAEL	3.30721	1.50903	0.45627	-0.49898	7.99348	35.18214[a]	219.02195[a]	100.30117
LEBANON	2.42805	1.62107	0.66763	-0.03091	17.00118	34.07792[a]	104.51707[a]	32.11728
JORDAN	-5.30522	1.35205	-0.25484	-0.6993	10.92041	15.19257[a]	254.01738[a]	111.91801
KUWAIT	-0.81418	1.58918	-1.95188	-1.00193	12.34981	32.85015[a]	341.91312[a]	87.79159
BAHRAIN	-11.43534	1.39551	-0.12203	-2.03681	31.90331	22.46405[a]	83.09541[a]	82.29074
QATAR	0.01298	1.73846	133.93375	-0.77292	13.03834	25.42387[a]	230.01514[a]	89.39705
UAE	-7.51975	1.94652	-0.25885	-0.60579	15.54756	42.08101[a]	224.23955[a]	47.71125
SAUDI	-3.62995	1.89902	-0.52314	-1.02128	16.28325	19.08903[b]	282.56913[a]	81.32219
OMAN	-1.94599	1.44586	-0.74298	-1.47248	27.59244	29.57484[a]	125.20357[a]	36.91293

Notes: SD (standard deviation); CV (coefficient of variation); LB-Q (Ljung and Box *Q*-statistics) measures the serial autocorrelation in the returns up to 10 lags; ARCH-LM (Engle Lagrange multiplier) tests the null hypothesis that there is no presence of an ARCH process in the residuals up to 10 lags; MC/GDP (market capitalization of listed companies as a percent of Gross Domestic Product). For Engle LM tests, [a], [b], [c] indicate statistical significance at 1%, 5% and 10% levels respectively.

As shown in Table 1, return volatility is the highest in UAE and the lowest in Tunisia. In terms of the relationship between return and risk, as measured by the coefficient of variation, Egypt offers by far the least advantageous with a coefficient of 133.93375. The Tunisian stock market is positively skewed, while those of others counties are negatively skewed. Since the kurtosis in all series exceeds by far three, a leptokurtic distribution is indicated. The

latest statistics point to non-normal distributional of the MENA return series. Furthermore, the autocorrelations in the returns as well as the heteroskedasticity in the residuals of the returns are omnipresent in all series. Such data characteristics justify the appropriateness of using a GARCH type model that has the capability of presenting time-varying conditional volatility and eliminating the autocorrelations and heteroskedasticity presence in the returns. The market capitalization of listed companies as a percent of Gross Domestic Product is the highest in Jordan and the lowest in Tunisia.

On the other hand, we examine cross-market unconditional correlations of stock returns as a simple way to gauge the degree of using intra-regional diversification. Results in Table 2 indicate that the MENA region is suitable for diversification gains potential.

Table 2. Unconditional correlations across market returns

	MOROCCO	TUNISIA	EGYPT	ISRAEL	LEBANON	JORDAN	KUWAIT	BAHRAIN	QATAR	UAE	SAUDI
TUNISIA	0.23641										
EGYPT	0.18360	0.08670									
ISRAEL	0.00898	0.02154	0.01388								
LEBANON	0.06771	0.06306	0.15967	0.01098							
JORDAN	0.11428	0.10549	0.27677	-0.01263	0.17047						
KUWAIT	0.09606	0.11728	0.18385	-0.01580	0.11825	0.24436					
BAHRAIN	0.07133	0.08103	0.13226	0.00790	0.13217	0.23857	0.38250				
QATAR	0.12591	0.09313	0.30314	0.01114	0.10699	0.33067	0.31826	0.29030			
UAE	0.12401	0.10861	0.37924	0.01774	0.13481	0.33756	0.30835	0.30120	0.50300		
SAUDI	0.13041	0.08749	0.29964	-0.00641	0.13655	0.29776	0.26419	0.19216	0.31168	0.39456	
OMAN	0.11086	0.13097	0.28033	0.02872	0.15538	0.30409	0.25525	0.29866	0.46245	0.47081	0.31793

Market returns among the Gulf countries (Kuwait, Bahrain, Qatar, UAE, Saudi Arabia, and Oman) are highly correlated which may reflect strong cross-border trade and capital flows across these countries. Also, policy coordination among policy makers and existing similarities between major industries underlying those markets may contribute to strong correlations. Conversely, correlations are very weak between Israel and each of the remaining MENA countries.

4. Modeling volatility and correlation

It is widely recognized that multivariate models are appropriate for studying the transmission mechanism and correlation dynamics (Harris and Nguyen, 2013). In particular, the application of a multivariate GARCH process can model several return series simultaneously and allows the conditional variances and co-variances of series to influence each other (Bala and Premaratne, 2004). With the development of several multivariate GARCH models such as the diagonal VECH model of Bollerslev et *al*. (1988), the constant correlation model of Bollerslev (1990), the factor ARCH model of Engle et *al*. (1990), we select the Baba-Engle-Kraft-Kroner (BEKK) model defined in Engle and Kroner (1995) and documented in various studies (Kroner and Ng, 1998; Lee, 2009) to seize the conditional variance and correlation of equity returns. Particularly, the diagonal BEKK model is preferred because it not only seizes the asymmetric volatility effects in variances and co-variances, or produces positive definite conditional covariance matrices, but also economizes on parameters relative to other multivariate GARCH models. The model can be expressed in the following way:

$$\theta_t = \varphi + Q\theta_{t-1} + \varepsilon_t \quad (1)$$

$$\varepsilon_t \sim GED(0, H_t)$$

where θ_t is a 12×1 vector of daily returns at time t for each index, φ is a 12×1 vector that denotes the constants, Q is a 12×12 matrix of parameters q_{ij} that measures the effects of own

lagged and cross mean transmission from market *i* to market *j* between the two markets, and the error ε_t is a 12×1 vector of the innovation for each market at time *t* and has a 12×12 conditional variance-covariance matrix, H_t . The conditional variance is specified as follows:

$$H_t = C'C + A'(\varepsilon_{t-1}\varepsilon'_{t-1})A + G'H_{t-1}G + D'(\varepsilon_{t-1}\varepsilon'_{t-1}d_{t-1})D \quad (2)$$

where C_t is a lower triangular matrix of constants with 12×12 symmetric elements c_{ij}, *A* is a diagonal matrix with a 12×12 symmetric elements *a* that measure lagged innovations (squared residuals) effects, *G* is a diagonal matrix with a 12×12 symmetric elements *g* that measure the persistence of conditional volatility, d_{t-1} is a dummy variable equal to 1 if $\varepsilon_{t-1} <0$ and 0 otherwise, and *D* is a diagonal matrix with a 12×12 symmetric elements *d* that measure lagged asymmetric effects. The simple form of equation (2) for market *i* can be written as:

$$h_{ii,t} = c_{i,i}^2 + a_{i,i}^2\varepsilon_{i,t-1}^2 + g_{i,i}^2 h_{i,i,t-1} + d_{i,i}^2\varepsilon_{i,t-1}^2 d_{i,t-1} \quad (3)$$

Equation (2) allows of temporal interactions between innovations in the two markets by means of the estimation of the conditional covariance. This allows the assessment of time-varying correlations between conditional variances and past innovations. For a pair of markets *i* and *j* we calculate the conditional correlation ρ_{ij} at time *t* as follows:

$$\rho_{ij,t} = \frac{h_{ij,t}}{(\sqrt{h_{ii,t}}\sqrt{h_{jj,t}})} \quad (4)$$

5. Estimation results

5.1 Conditional variance process

Using the Berndt-Hall-Hall-Hausman (1974) algorithm, we estimate our model via the maximum likelihood method with GED functions. The latest fits well our data characteristics which violate the assumption of normality (Table 1). We present in Table 3 the parameter estimates of the conditional variance process. Most of elements in the matrices *A* and *G* are statistically significant at the 1% level, implying that strong GARCH and ARCH effects are present for all return series. In addition, the estimates satisfy the stationarity conditions for all the variance and covariance processes ($a + g < 1$). The asymmetric volatility parameter *d* is significant in all return series, with the exception of Lebanon. This suggests that the asymmetric volatility also plays a key role in the dynamic of conditional variance process.

As a diagnostic check of the goodness of fit of our model, the Ljung-Box (1979) statistics for all series indicate that the serial autocorrelation in squared residuals is insignificant up to 10 lags. Similarly, the same statistics point toward a random behavior of the multivariate squared residuals.

Table 3. Estimates of the multivariate GARCH model

	MOROCCO	TUNISIA	EGYPT	ISRAEL	LEBANON	JORDAN	KUWAIT	BAHRAIN	QATAR	UAE	SAUDI	OMAN
	-0.25390[a]	-0.26744[a]	0.05537	-0.23592[a]	0.17173[a]	0.08651[a]	0.01315[a]	0.00984[a]	0.03799[a]	0.05914[a]	-0.15037[a]	0.09141[a]
a	**0.03971**	**0.03398**	**0.03382**	**0.08578**	**0.02752**	**0.03732**	**0.02472**	**0.02108**	**0.03308**	**0.02759**	**0.02252**	**0.03916**
	0.98141[a]	0.98771[a]	0.93090[a]	0.94863[a]	0.77280[a]	0.90511[a]	0.97797[a]	0.98578[a]	0.94259[a]	0.93129[a]	0.96313[a]	0.89578[a]
g	**0.00379**	**0.00138**	**0.00825**	**0.00674**	**0.01701**	**0.01270**	**0.00298**	**0.00139**	**0.00539**	**0.00659**	**0.00275**	**0.00912**
	0.17694[a]	0.19363	0.51809[a]	0.86789[a]	-0.16576	0.51837[a]	0.26012[a]	0.20584[a]	0.35832[a]	0.46431[a]	0.39665[a]	0.46834[a]
d	**0.05859**	**0.05612**	**0.05157**	**0.09187**	**0.14426**	**0.05622**	**0.03005**	**0.02275**	**0.04163**	**0.04593**	**0.03659**	**0.05178**
LB-Q^2 (10)	9.81397	12.01934	16.72310	12.01821	14.93023	8.64373	9.09384	11.75201	14.59081	14.70212	17.91034	5.83763
MLB-Q^2 (10)	1195.31098											

Note: [a], [b], [c] indicate statistical significance at 1%, 5% and 10% levels respectively. Standard errors are reported in bold. LB-Q^2 (Ljung and Box *Q*-statistics on the squared residuals). M LB-Q^2 (Multivariate Ljung and Box *Q*-statistics on the squared residuals).

Instead of focusing on the variance-covariance equations estimates, we will focus on the conditional variances and correlations across crisis periods.

5.2 Conditional correlation

The conditional correlations reported in Table 4 appear to be similar to the static correlations of Table 2. An interesting pattern, however, appears in the downward trend in the degree of the conditional correlation across all the markets compared to the results reported in Table 2. The lowest correlation is observed between Tunisia and Qatar (-0.00239), while the highest correlation is shown between Qatar and the UAE (0.40309).

Table 4. Average conditional correlations across market returns

	MOROCCO	TUNISIA	EGYPT	ISRAEL	LEBANON	JORDAN	KUWAIT	BAHRAIN	QATAR	UAE	SAUDI
TUNISIA	0.25644										
EGYPT	0.11768	0.05117									
ISRAEL	0.01755	0.00400	0.02558								
LEBANON	0.01386	0.01602	0.04352	0.00726							
JORDAN	0.08064	0.04753	0.16866	0.02809	0.06113						
KUWAIT	0.05716	0.05582	0.09966	0.02355	0.05178	0.10639					
BAHRAIN	0.03711	0.01649	0.08104	0.01280	0.02812	0.10316	0.17070				
QATAR	0.05750	-0.00239	0.25068	0.01859	0.03916	0.16910	0.17128	0.15258			
UAE	0.07834	0.05781	0.30512	0.03679	0.05176	0.19691	0.22228	0.18868	0.40309		
SAUDI	0.08671	0.05878	0.19745	0.04348	0.00733	0.13872	0.14547	0.05880	0.17916	0.25771	
OMAN	0.03570	0.07112	0.18644	0.03716	0.01476	0.17893	0.12499	0.13220	0.28807	0.28725	0.18573

6. Additional exploration

6.1 Sensitivity analysis

Having established strong evidence in favour of strong GARCH and ARCH effects and weak conditional correlations, here we consider two regression models for measuring changes in conditional variances and correlations. To this end, the two models which test whether stock market linkages have strengthened or weakened during stress periods and afterwards are specified as:

$$Conditional\ Variance_{j,t} = f_0 + f_1 war/financial\ crisis\ dummy_{j,t} + f_2\ post\ war/financial\ crisis\ dummy_{j,t} + u_{j,t} \quad (5)$$

$$Conditional\ Correlation_{j,t} = f_0 + f_1 war/financial\ crisis\ dummy_{j,t} + f_2\ post\ war/financial\ crisis\ dummy_{j,t} + v_{j,t} \quad (6)$$

where war dummy is a dichotomous variable equals one from July 12, 2006 to August, 14 2006 and zero otherwise; post-war is a dichotomous variable equals one after August, 14 2006 and zero otherwise; financial crisis dummy is a dichotomous variable equals one from July 2008 to February 2009 and zero otherwise; post-financial crisis is a dichotomous variable equals one after February 2009 and zero otherwise; u_t and v_t are assumed as uncorrelated disturbances series.

Table 5 reports the estimates of equation (5). Panel A reports the estimates of war- and post-war dummy coefficients. Only 4 out of 12 estimated war dummy coefficients (F_1) are statistically significant at the 1% level. The war increased the conditional volatility in Morocco, Tunisia, and Lebanon, and decreased it in the UAE. On the other hand, the results of the slope coefficient estimates for the post-war dummy variable (F_2) are mixed. After the war, the conditional volatility increased in Morocco, Tunisia, Israel, Kuwait, and Bahrain, while it decreased in Lebanon, Jordan, UAE, and Saudi Arabia.

Table 5. Impact of Israeli-Hezbollah war and financial crisis on conditional variances

Panel A: Israeli-Hezbollah war of 2006	**Panel B**: Financial crisis of 2008

	F_0	F_1	F_2	F_0	F_1	F_2
MOROCCO	8.63759[a]	2.70178[a]	1.33834[a]	9.00213[a]	5.44653[a]	0.48817[a]
	55.48581	**4.79818**	**7.81799**	**117.00289**	**29.85907**	**4.36428**
TUNISIA	4.91527[a]	3.64421[a]	3.03703[a]	6.16578[a]	5.60662[a]	1.65564[a]
	28.94816	**5.93390**	**16.26547**	**66.42885**	**25.47858**	**12.26949**
EGYPT	10.22068[a]	0.55916	0.24707	8.79295[a]	11.53276[a]	1.07521[a]
	23.93357	**0.36200**	**0.52614**	**38.72486**	**21.42365**	**3.25718**
ISRAEL	9.34395[a]	-1.35970	8.59481[a]	11.12275[a]	11.11288[a]	9.56724[a]
	10.27370	**-0.41330**	**8.58408**	**20.94364**	**8.82616**	**12.39133**
LEBANON	16.50207[a]	23.79752[a]	-4.83250[a]	15.80793[a]	4.10514[a]	-7.87740[a]
	13.19789	**5.21318**	**-3.51814**	**21.19788**	**2.32194**	**-7.26593**
JORDAN	6.33552[a]	-1.34590[b]	-1.59334[a]	4.94972[a]	4.34484[a]	-0.78853[a]
	33.70252	**-1.98689**	**-7.54879**	**48.21739**	**17.85260**	**-5.28363**
KUWAIT	5.61389[a]	-1.29759	1.46364[a]	4.98129[a]	11.53019[a]	1.46364[a]
	18.73521	**-1.19401**	**4.39730**	**36.16817**	**35.31232**	**7.30987**
BAHRAIN	2.72702[a]	-0.23995	1.82163[a]	2.59839[a]	9.46295[a]	1.50568[a]
	11.37063	**-0.27898**	**6.91320**	**23.77052**	**36.51465**	**9.47463**
QATAR	8.44343[a]	-1.90395[b]	1.10831[b]	6.41993[a]	13.26239[a]	-0.64400[b]
	19.77903	**-1.23822**	**2.36318**	**30.38048**	**26.47228**	**-2.09623**
UAE	10.70552[a]	-4.16889[a]	-1.50232[a]	8.18121[a]	11.87294[a]	0.05955[a]
	25.00377	**-2.70021**	**-3.19108**	**36.36776**	**22.26192**	**0.18207**
SAUDI	13.75021[a]	-0.60979	-6.59018[a]	9.66887[a]	7.29990[a]	-5.20640[a]
	25.12752	**-0.31275**	**-10.93812**	**31.69948**	**10.09481**	**-11.74099**
OMAN	3.91721[a]	-1.05093	1.09268[b]	3.43858[a]	13.69885[a]	-0.11172
	0.07823	**-0.67932**	**2.30281**	**16.07070**	**27.00509**	**-0.35914**

Note: [a], [b], [c] indicate statistical significance at 1%, 5% and 10% levels respectively; Robust *T*-statistics are reported in bold.

Panel B reports the results of regressions of the conditional variances. The estimated dummy parameters of the financial crisis (F_1) are all positive and statistically significant at the 1% level, suggesting a positive impact of the financial crisis on the conditional variance. Conversely, the results of the slope coefficient estimates for the post-crisis dummy variable (F_2) are mixed. The estimated coefficients are statistically significant at the 1% level for all markets, except for Qatar and Oman. However, conditional variances for Tunisia, Egypt, Israel, Kuwait, Bahrain, and UAE increased after the crisis compared to their pre-crisis levels. Whereas, the slope coefficient (F_2) is negative in the cases of Lebanon, Jordan, and Saudi Arabia, suggesting that in post-crisis the conditional variance has diminished in these three markets. Although there are major differences between highly accessible Lebanese and Jordanian markets and less accessible Saudi market, they all exhibit mixed volatility behavior in response to the financial crisis. One possible explanation for the increase in volatility could be the herding behavior of investors (Balcilar et al., 2013).

Table 6. Impact of the Israeli-Hezbollah war on conditional correlations

	TUNISIA	EGYPT	ISRAEL	LEBANON	JORDAN	KUWAIT	BAHRAIN	QATAR	UAE	SAUDI	OMAN	Coefficient
	0.25136[a]	0.11973[a]	-0.00190	0.01808[a]	0.07578[a]	0.05558[a]	0.02565[a]	0.06976[a]	0.08032[a]	0.06942[a]	0.04092[a]	f_0
	91.23949	**71.02290**	**-1.25026**	**4.35243**	**76.88203**	**48.81632**	**23.45388**	**30.15519**	**78.44407**	**21.80850**	**23.60369**	
	-0.00723[a]	0.01478[b]	-0.04034[a]	-0.03347[b]	0.00669[c]	0.01321[b]	0.01247[b]	-0.02539[b]	0.00523	0.09874[a]	-0.00100	f_1
	-0.72662	**2.42791**	**-7.34561**	**-2.23161**	**1.87988**	**3.21140**	**3.15747**	**-3.03868**	**1.41323**	**8.58954**	**-0.16007**	
	-0.02930[a]	-0.01077[a]	0.01035[a]	0.00199	0.00273[b]	-0.00413[b]	0.00210	-0.00065	-0.01019[a]	-0.01870[a]	-0.00124	f_2
MOROCCO	**-8.57057**	**-5.14585**	**5.48493**	**0.28840**	**2.23451**	**-2.92250**	**1.54948**	**-0.22583**	**-8.01901**	**-4.73262**	**-0.57573**	
		0.03821[a]	-0.02018[a]	0.01981[a]	0.05833[a]	0.06926[a]	0.02025[a]	0.01511[a]	0.06128[a]	0.01372[a]	0.09576[a]	f_0
		22.47316	**-9.07460**	**4.58572**	**53.14822**	**41.75616**	**16.13700**	**5.65933**	**44.72498**	**4.15595**	**48.46862**	
		0.04834[a]	0.03058[a]	-0.03815[b]	0.00692[c]	-0.01278[b]	0.00982[b]	0.00424	0.00373	0.16597[a]	-0.02506[a]	f_1
		7.87231	**3.80864**	**-2.44598**	**1.74606**	**-2.13404**	**2.16743**	**0.43973**	**0.75450**	**13.92435**	**-3.51209**	
		0.00480[b]	0.01320[a]	0.00788	-0.01956[a]	-0.01393[a]	-0.02221[a]	-0.00971[a]	-0.01173[a]	0.02329[a]	-0.02089[a]	f_2
TUNISIA		**2.27571**	**4.78226**	**1.47010**	**-14.36447**	**-6.76571**	**-14.26079**	**-2.92879**	**-6.89892**	**5.68499**	**-8.51968**	
			-0.01946[a]	0.03660[a]	0.17756[a]	0.09057[a]	0.05108[a]	0.21845[a]	0.29169[a]	0.19110[a]	0.19812[a]	f_0
			-4.06044	**24.88937**	**36.00954**	**20.20594**	**16.18088**	**53.63338**	**50.45889**	**27.21356**	**51.54373**	
			-0.03261[c]	-0.03264[a]	0.09426[a]	0.03791[b]	0.03834[a]	0.12700[a]	-0.01242	0.06125[b]	0.00971	f_1
			-1.88415	**-6.14541**	**5.29323**	**2.34208**	**3.36324**	**8.63423**	**-0.59473**	**2.41505**	**0.69919**	
			0.04206[a]	0.01381[a]	-0.05034[a]	-0.02063[a]	-0.00361	0.01944[a]	-0.01028	-0.02572[b]	-0.04147[a]	f_2
EGYPT			**7.07149**	**7.56929**	**-8.22580**	**-3.70895**	**-0.92251**	**3.84596**	**-1.43319**	**-2.95107**	**-8.69351**	
				0.00777[a]	0.02678[a]	0.00749[b]	-0.01323[a]	0.02289[a]	0.02580[a]	0.03372[a]	0.04735[a]	f_0
				2.60330	**7.33831**	**2.21398**	**-4.75771**	**7.58069**	**6.45871**	**7.04489**	**12.77945**	
ISRAEL				0.06387[a]	-0.05012[a]	-0.04202[a]	-0.04343[a]	-0.02372[b]	-0.05414[a]	-0.03343[c]	-0.04242[a]	f_1

		5.92464	**-3.80279**	**-3.43971**	**-4.32524**	**-2.17531**	**-3.75201**	**-1.93351**	**-3.17001**	
		0.00091	-0.00902[b]	-0.00082	0.00061	-0.02574[a]	-0.01305[a]	0.00998[c]	-0.02328[a]	f_2
		0.24631	**-1.99109**	**-0.19546**	**0.17562**	**-6.86742**	**-2.63249**	**1.67932**	**-5.06390**	
			0.04499[a]	0.03840[a]	0.02592[a]	-0.01498[a]	0.02195[a]	-0.00822	0.02119[a]	f_0
			15.92786	**13.37500**	**14.94289**	**-2.16994**	**9.07195**	**-1.63615**	**3.38399**	
			0.01605	0.00392	-0.02710[a]	0.11009[a]	0.00998	-0.02758	0.03881[c]	f_1
			1.57377	**0.37773**	**-4.32656**	**4.41481**	**1.14255**	**-1.52064**	**1.71632**	
			0.01686[a]	0.01894[a]	-0.00220	0.05281[a]	0.03263[a]	0.01865[a]	-0.03504[a]	f_2
LEBANON			**4.81059**	**5.31502**	**-1.02359**	**6.16225**	**10.86564**	**2.99111**	**-4.51001**	
				0.11170[a]	0.09819[a]	0.13432[a]	0.20316[a]	0.12856[a]	0.20375[a]	f_0
				19.62565	**34.04675**	**22.06419**	**32.73124**	**22.85661**	**38.65559**	
				0.00761	0.01461	0.10128[a]	-0.01350	0.06138[a]	-0.01217	f_1
				0.37033	**1.40262**	**4.60679**	**-0.60208**	**3.02191**	**-0.63914**	
				-0.03613[a]	-0.02980[a]	0.00560	-0.05068[a]	0.00162	-0.06520[a]	f_2
JORDAN				**-5.11523**	**-8.32568**	**0.74136**	**-6.57985**	**0.23264**	**-9.96777**	
					0.08270[a]	0.14072[a]	0.23411[a]	0.14134[a]	0.14004[a]	f_0
					16.46679	**20.99471**	**50.81353**	**28.29050**	**28.34016**	
					0.08358[a]	0.07261[a]	-0.02502	0.01565	-0.00706	f_1
					4.60812	**2.99985**	**-1.50400**	**0.86761**	**-0.39564**	
					0.00315	-0.01761[b]	-0.04738[a]	-0.00693	-0.04840[a]	f_2
KUWAIT					**0.50496**	**-2.11746**	**-8.28549**	**-1.11783**	**-7.89300**	
						0.08960[a]	0.15703[a]	0.01311[a]	0.11671[a]	f_0
						18.83628	**36.11718**	**2.66013**	**33.40015**	
						0.09695[a]	0.01618	0.05532[a]	0.02749[b]	f_1
						5.64369	**1.03081**	**3.10907**	**2.17820**	
						0.03686[a]	-0.00088	0.02653[a]	-0.00769[c]	f_2
BAHRAIN						**6.24390**	**-0.16299**	**4.33833**	**-1.77355**	
							0.34665[a]	0.16956[a]	0.27192[a]	f_0
							62.30345	**39.10097**	**33.34999**	
							0.00173	0.03834[b]	0.00844	f_1
							0.08590	**2.44847**	**0.28665**	
							0.03073[a]	0.00967[c]	-0.03450[a]	f_2
QATAR							**4.45060**	**1.79663**	**-3.40924**	
								0.25642[a]	0.26700[a]	f_0
								39.17700	**48.47086**	
								-0.07899[a]	-0.03245	f_1
								-3.34195	**-1.62141**	
								-0.02182[a]	-0.01347[b]	f_2
UAE								**-2.68673**	**-1.97104**	
									0.18926[a]	f_0
									49.66770	
									0.00928	f_1
									0.67463	
SAUDI									-0.01568[a]	f_2

Note: [a], [b], [c] indicate statistical significance at 1%, 5% and 10% levels respectively; Robust *T*-statistics are reported in bold.

On the other hand, equation (6) estimates are reported in tables 6 and 7.

As shown in the regression reported in Table 6, the estimated war dummy parameter (F_1) is statistically significant at the 1% level in only 39% (26 out of 66) of the cases. Remarkably during the war, the conditional correlation diminished in 42% (11 out of 26) and increased in 58% (15 out of 26) of the significant cases. Conversely, the estimates of the slope coefficient (M_2) are mixed. In evidence, it is significant at the 1% level in 61% (40 out of 66) of the cases, suggesting an impact of the war on the post-war conditional correlations. The conditional correlation increased in 14 cases and decreased in 26 cases compared to the pre-war levels. These results imply that numerous markets offer the needed benefits of portfolio diversification during stress periods, when they are the most needed.

On the other hand, equation (6) estimates reported in table 7 show the impact of the financial crisis on conditional correlations across all markets. The estimated financial crisis dummy parameter (F_1) is statistically significant at the 1% level in all cases except in Tunisia/Kuwait. In particular during the financial crisis, the conditional correlation decreased in 15% (10 out of 66) of the cases, implying some benefits of portfolio diversification during periods of high volatility. However, the estimates of the slope coefficient (F_2) are mixed, with 67% (44 out of 66) of the cases being significant at the 1% level. The overall positive trend in the conditional correlation during the financial crisis extended into the post-crisis period of 40 out of the 44 cases, as indicated by the significance of the positive dummy parameter (F_2),

except in the cases of Tunisia/Oman, Tunisia/Qatar, Tunisia/Kuwait, Morocco/Oman, Morocco/Qatar, Jordan/Saudi Arabia, and Kuwait/Saudi Arabia where the conditional correlation decreased after the crisis compared to the pre-crisis levels.

Table 7. Impact of the global financial crisis on conditional correlations

	TUNISIA	EGYPT	ISRAEL	LEBANON	JORDAN	KUWAIT	BAHRAIN	QATAR	UAE	SAUDI	OMAN	Coefficient
	0.23251[a]	0.11260[a]	0.00209[a]	0.01712[a]	0.07656[a]	0.05232[a]	0.02701[a]	0.06752[a]	0.07368[a]	0.06232[a]	0.03915[a]	f_0
	118.03333	**115.21397**	**1.66518**	**6.72740**	**122.36061**	**74.80972**	**39.52276**	**48.65319**	**107.60884**	**25.84221**	**35.65939**	
	0.11385[a]	0.02632[a]	0.02417[a]	-0.04286[a]	0.02131[a]	0.02768[a]	0.04829[a]	-0.04398[a]	0.03026[a]	0.09061[a]	-0.00518[a]	f_1
	24.39012	**11.36439**	**8.12377**	**-7.10850**	**14.37173**	**16.68993**	**29.81412**	**-13.37408**	**18.65264**	**15.86565**	**-1.98693**	
	0.02887[a]	0.00561[a]	0.03052[a]	0.00265	0.00446[a]	0.00472[a]	0.01218[a]	-0.01297[a]	0.00368[a]	0.03553[a]	-0.00688[a]	f_2
MOROCCO	**10.08743**	**3.95302**	**16.73255**	**0.71799**	**4.90856**	**4.64614**	**12.19598**	**-6.43402**	**3.70312**	**10.14192**	**-4.31540**	
		0.04209[a]	-0.01205[a]	0.02442[a]	0.04658[a]	0.06068[a]	0.00675[a]	0.00912[a]	0.05434[a]	0.03547[a]	0.08203[a]	f_0
		38.85356	**-7.55689**	**9.52133**	**54.19836**	**64.14905**	**8.33462**	**6.23405**	**56.43762**	**15.80427**	**56.35029**	
		0.05190[a]	0.03310[a]	-0.05804[a]	0.01827[a]	0.00534[b]	0.04702[a]	-0.02574[a]	0.03435[a]	0.09508[a]	-0.04154[a]	f_1
		20.21782	**8.75684**	**-9.54943**	**8.96947**	**2.38439**	**24.82280**	**-7.42350**	**15.05658**	**17.87832**	**-12.01293**	
		0.00887[a]	0.02979[a]	-0.00579	-0.00216[c]	-0.01271[a]	0.01178[a]	-0.02086[a]	-0.00011	0.03193[a]	-0.01568[a]	f_2
TUNISIA		**5.63678**	**12.85396**	**-1.55437**	**-1.73202**	**-9.24832**	**10.14747**	**-9.81510**	**-0.08043**	**9.79008**	**-7.41905**	
			-0.00274	0.04507[a]	0.14722[a]	0.07350[a]	0.04530[a]	0.23035[a]	0.28079[a]	0.17501[a]	0.17047[a]	f_0
			-0.98953	**48.21940**	**41.42502**	**26.74687**	**19.99254**	**86.22293**	**72.15309**	**40.45098**	**59.99108**	
			0.12064[a]	-0.03765[a]	0.19234[a]	0.18202[a]	0.20597[a]	0.11295[a]	0.16089[a]	0.15704[a]	0.11392[a]	f_1
			18.35812	**-16.99855**	**22.84088**	**27.95393**	**38.36239**	**17.84029**	**17.44281**	**15.31836**	**16.91881**	
			0.03757[a]	0.00543[a]	0.00412	0.01771[a]	0.03446[a]	0.02063[a]	0.01852[a]	0.01497[b]	0.01012[b]	f_2
EGYPT			**9.32400**	**3.99999**	**0.79797**	**4.43574**	**10.46801**	**5.31514**	**3.27241**	**2.38188**	**2.45208**	
				0.01120[a]	0.01689[a]	0.00145	-0.01701[a]	0.00226	0.01078[a]	0.03832[a]	0.02900[a]	f_0
				6.06135	**7.77877**	**0.86481**	**-9.78529**	**1.12988**	**4.24280**	**14.23526**	**13.64426**	
				-0.01973[a]	0.06501[a]	0.09963[a]	0.11208[a]	0.09174[a]	0.10645[a]	0.04483[a]	0.05995[a]	f_1
				-4.50777	**12.63929**	**24.99483**	**27.21863**	**19.38323**	**17.68348**	**7.02845**	**11.90055**	
				-0.00452[c]	0.01070[a]	0.02797[a]	0.04311[a]	0.01632[a]	0.03555[a]	0.00133	0.00474	f_2
ISRAEL				**-1.68416**	**3.39130**	**11.44454**	**17.07503**	**5.62446**	**9.63262**	**0.33980**	**1.53411**	
					0.05625[a]	0.05160[a]	0.02319[a]	0.02212[a]	0.04270[a]	0.00264	-0.00065	f_0
					36.68658	**27.05645**	**23.25920**	**5.77917**	**31.07705**	**0.96629**	**-0.16644**	
					0.01240[a]	-0.00109[a]	0.02616[a]	0.06575[a]	0.01549[a]	-0.05698[a]	0.09695[a]	f_1
					3.41365	**-0.24142**	**11.06923**	**7.24790**	**4.75716**	**-8.80549**	**10.40894**	
					0.00859[a]	0.00069[a]	0.00529	0.02422[a]	0.01757[a]	0.02474[a]	0.01292[b]	f_2
LEBANON					**3.81100**	**0.24806**	**3.65464**	**4.35513**	**8.79924**	**6.23633**	**2.26177**	
						0.09014[a]	0.07703[a]	0.14170[a]	0.17208[a]	0.13228[a]	0.16654[a]	f_0
						24.00637	**27.81363**	**35.19958**	**38.95511**	**37.96661**	**41.49003**	
						0.19487[a]	0.23255[a]	0.19629[a]	0.23548[a]	0.14289[a]	0.14464[a]	f_1
						21.90341	**35.43524**	**20.57791**	**22.49665**	**17.25971**	**15.20652**	
						-0.00879	0.00548	0.01718[a]	0.00172	-0.01914[a]	-0.00568	f_2
JORDAN						**-1.59260**	**1.36118**	**2.93797**	**0.26776**	**-3.78116**	**-0.97409**	
							0.08176[a]	0.12871[a]	0.20099[a]	0.13554[a]	0.10700[a]	f_0
							19.61962	**31.47431**	**61.99025**	**44.60160**	**31.61298**	
							0.39931[a]	0.26999[a]	0.19745[a]	0.17319[a]	0.17844[a]	f_1
							40.43719	**27.86260**	**25.70400**	**24.05635**	**22.24813**	
							0.11304[a]	0.03512[a]	0.00261	-0.01826[a]	-0.00065	f_2
KUWAIT							**18.67055**	**5.91110**	**0.55455**	**-4.13622**	**-0.13177**	
								0.11184[a]	0.15187[a]	0.02608[a]	0.10968[a]	f_0
								32.94350	**49.35245**	**8.44646**	**37.79029**	
								0.27121[a]	0.26839[a]	0.31217[a]	0.20463[a]	f_1
								33.71254	**36.80699**	**42.66351**	**29.75205**	
								0.03052[a]	0.02195[a]	0.00180	0.00368	f_2
BAHRAIN								**6.18731**	**4.91173**	**0.40099**	**0.87376**	
									0.35979[a]	0.17584[a]	0.24447[a]	f_0
									101.30418	**70.07309**	**50.22594**	
									0.17411	0.05736[a]	0.25652[a]	f_1
									20.68846	**9.64578**	**22.24041**	
									0.05992[a]	-0.00599	0.04077[a]	f_2
QATAR									**11.61325**	**-1.64523**	**5.76546**	
										0.23947[a]	0.25320[a]	f_0
										61.99764	**69.07744**	
										0.12330[a]	0.20793[a]	f_1
										13.47139	**23.93942**	
										0.01321[b]	0.03004[a]	f_2
UAE										**2.35376**	**5.64058**	
											0.17640[a]	f_0
											70.75952	
											0.03459[a]	f_1
											5.84208	
											0.01365[a]	f_2
SAUDI											**3.76793**	

Note: [a], [b], [c] indicate statistical significance at 1%, 5% and 10% levels respectively; Robust *T*-statistics are reported in bold.

6.2 Portfolio implications

To illustrate the implications of our empirical findings for concrete portfolio management, we follow the applications drawn by Kroner and Ng (1998) and construct an optimal portfolio which minimizes risk without lowering expected returns as follows:

$$\omega_{ij,t} = \frac{h_{jj,t} - h_{ij,t}}{h_{ii,t} - 2h_{ij,t} + h_{jj,t}} \tag{7}$$

$$\omega_{ij,t} = 0 \; if \; \omega_{ij,t} < 0; \; \omega_{ij,t} = \omega_{ij,t} \; if \; 0 \leq \omega_{ij,t} \leq 1; \; \omega_{ij,t} = 1 \; if \; \omega_{ij,t} > 1 \tag{8}$$

where $\omega_{ij,t}$ is the portfolio weight for index *i* at time *t*, $h_{ii,t}$ denotes the conditional variance of index *i*, $h_{jj,t}$ denotes the conditional variance of index *j*, and $h_{ij,t}$ denotes the conditional covariance between index *i* and index *j*. The weight of the second index *j* in the portfolio would therefore be 1- $\omega_{ij,t.}$

Table 8 reports the portfolio weights derived from the multivariate GARCH models. For example, the average weight for the Tunisia/Morocco portfolio indicates that for a $1000000 portfolio, $728350 must be invested in the Tunisian equity index and $271650 must be invested in the Moroccan equity index.

Table 8. Optimal portfolio weights

	MOROCCO	TUNISIA	EGYPT	ISRAEL	LEBANON	JORDAN	KUWAIT	BAHRAIN	QATAR	UAE	SAUDI
TUNISIA	0.72835										
EGYPT	0.68011	0.33295									
ISRAEL	0.30859	0.25077	0.57003								
LEBANON	0.38001	0.28603	0.54707	0.21099							
JORDAN	0.35995	0.31759	0.68932	0.38012	0.39023						
KUWAIT	0.40105	0.30833	0.61034	0.25997	0.35790	0.57218					
BAHRAIN	0.34189	0.27930	0.57898	0.39270	0.37089	0.55752	0.62059				
QATAR	0.38023	0.17239	0.75331	0.30154	0.30218	0.62950	0.63972	0.67093			
UAE	0.35598	0.52093	0.80072	0.32881	0.32711	0.70884	0.70319	0.68231	0.79301		
SAUDI	0.40310	0.43981	0.72859	0.50779	0.28895	0.61302	0.60598	0.40801	0.67095	0.75930	
OMAN	0.39810	0.50939	0.75207	0.59007	0.29821	0.67310	0.62799	0.59034	0.75089	0.73935	0.68823

7. Conclusions

The global financial crisis of 2008, the Israeli-Hezbollah war of 2006, and large fluctuations in equity prices have renewed interest on the dynamic relationship across the MENA stock markets. Besides, searching for reliable degrees of time-varying return volatility and correlation linkages among these recently emerging stock markets, beyond the unrealistic and too restrictive assumption of constant volatility and correlation, has been the motivation for much research by scholars and practitioners. To deal with this defy, not only we propose a model which provides time-varying volatility and pair-wise correlation processes as key inputs for asset allocation, hedging, and risk assessment, but also investigate the effect of global and regional stress periods on the behavior of MENA equity linkages. Construction of an optimal portfolio entails a time-varying covariance matrix of all the assets in the portfolio. As such, we incorporate the dynamic conditional correlations between MENA equity returns which varied significantly over bearish periods, suggesting substantial diversification benefits.

The main focus of this study is to examine the dynamic behavior of time-varying conditional volatility and correlation across the stock markets of Morocco, Tunisia, Egypt, Israel, Lebanon, Jordan, Kuwait, Bahrain, Qatar, UAE, Saudi Arabia, and Oman. We apply a multivariate GARCH model not only to capture the asymmetric impact of information on returns volatility and allow for non-normal distribution, but also to derive the pair wise conditional correlations of the return series.

The coefficients for the variance-covariance equations are generally significant for own-innovations and for volatility persistence in the individual price, indicating the presence of strong ARCH and GARCH effects. The positive and statistically significant coefficients of the leverage effects across most of the series suggest that higher amount of good news is needed to compensate the negative effects of bad news on conditional volatility. In addition, the overall conditional correlations between pair-wise countries are low, especially between Morocco, Tunisia, Israel, Lebanon, and the rest of the MENA countries. This finding is plausible especially given weak economic and financial ties between these groups of countries (Valadkhani and Chancharat, 2008), implying possibilities of diversification.

Apart from examining only the dynamic of the conditional variance process, we focus on the impact of some special events such as the Israeli-Hezbollah war of 2006, and the global financial crisis of 2008 on the conditional variances and correlations.

Regarding conditional volatilities, they all show a sudden increase during the financial crisis, compared to only 3 upsurges and 1 drop during the war period. In particular, the conditional volatility in Lebanon had spiked during the war but then decayed, with the magnitude impact of the war volatility being 7 times higher than that of the financial crisis. In Israel, the behaviour of the conditional volatility was the opposite, suggesting a slower response to the war compared to Lebanon but with a long-lived phenomenon. Yet in Israel, the magnitude of the impact of the war and financial crisis on the slope of the conditional volatility in the pre-stress periods is quite the same, 8.59 and 9.56 respectively. On the contrary in Lebanon, during the war, the magnitude of the war on the conditional volatility is more than 7 times the magnitude of the financial crisis.

Regarding conditional correlations, on the contrary, they increase in 85% of the cases during the financial crisis, compared to only 50% during the war period. However, the war and financial crisis periods cause a decrease in the conditional correlation in 10 and 11 cases respectively, suggesting the same appreciated benefits of diversification during stress periods. After the stress periods, on the other hand, the volatility of returns increases significantly in 7 markets after the financial crisis, compared to only in 5 after the war. Accordingly, after the two stress periods, the power of diversification relatively diminishes, given an uptrend in the conditional correlation of 40 cases compared to only 14 cases in the post-war period.

The relatively even impact of both events on the equity market linkages contradicts with some of the finding of Balcilar et al. (2013) who indicate that regional events affect more the MENA markets than global events. Furthermore, our key results contradict earlier studies that find correlations between stock market returns in different countries tend to increase during worldwide bearish markets (Longin and Solnik, 2001; Ang and Chen, 2002; Khallouli and Sandretto, 2012; Demirer, 2013). Given that the conditional covariance matrix typically outperforms the unconditional covariance matrix (Harris and Nguyen, 2013), we use our empirical results to construct the minimum variance portfolios of equities in the MENA region. Besides equity allocations and risk management, our results make a difference to financial regulators and monetary authorities equally. Bearish equity markets reduce the wealth of market participants and thus consumption, entailing serious implications for the prospects of both the real economy and financial institutions.

Finally, time series are not stable and consequently correlations and volatilities. Thus, one limitation of the current study is that results may be driven by the relatively short sample period of data series. Further examination of return linkages accounting for the effects of world equity indices and oil prices, among other factors, is recommended.

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