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Abstract

This paper examines the left and right tail dependence-switching structure between twelve MENA stock markets, and oil and other major global factors. We compare the MENA–oil tail dependence with that of Bitcoin, gold, and VIX. Using a recent combined wavelet and dependence-switching copula approach, we show evidence of significant tail dependence between MENA stock markets and oil and the other global factors. The dependence structure varies across the associated different regimes and under both the short- and long-term horizons. Moreover, the safe haven role of gold is more apparent in the long term than in the short term for all MENA markets, and this result is similar for Bitcoin but is less evident for VIX. We conclude by providing policy implications.

Keywords: Oil; MENA stock markets; global factors; wavelet; dependence-switching copula approach.

JEL Classifications:

1. Introduction

Since the 1980's, Middle East and North Africa (MENA) countries, have followed a series of financial liberalization reforms that lessen capital controls and reduce restrictions on foreign portfolio investments to gradually open up their financial markets to the world. Those financial reforms aim to improve the efficiency and the development of their financial markets and decision-making. However, financial liberalisation would also increase the financial connectedness of the MENA stock markets with international risk factors, thereby making those market vulnerable to potential wild swings and risk contagions. Tran (2017) documents that the degree of equity market openness is the key factor that leads to the formation of speculative bubbles in the stock markets. Information transmission across international stock markets has a crucial impact on each open market, particularly following the contagions of the 2008-2009 global financial crisis (GFC) and the 2010-2012 European sovereign debt crisis (ESDC). In fact, dynamic cross-market information transmissions have important implications for each market participants in terms of asset allocation and portfolio risk assessment. On the other hand, the MENA stock markets have a different characteristic that brings in various speculative and investment assets, a feature that is generally shared by several commodities and equities, particularly gold, oil and VIX (the volatility index) products and more recently Bitcoin.

Oil is a strategic commodity for many MENA economies which can be used in different economic activities and domains including industrial production, transportation and agriculture, among other activities. Changes in oil prices have great effects not only on the dynamics of energy markets abut also on the financial markets of the world economy, particularly the stock markets, due to the financialization of commodities. More importantly, oil price shocks play a significant role in the functioning and the development of stock markets and have also become one of the important determinants of international stock markets' volatility (Mensi at al., 2017). The increasing integration of stock markets with oil markets has reduced diversification benefits and pushed investors to seek an alternative asset that reduces portfolio risk.

Gold is commonly considered as a diversification hedge and safe haven asset against extreme movements of stock indexes, particularly during turmoil periods (Baur and Lucey, 2010; Baur and McDermott, 2010). The yellow metal is also a refuge asset for oil markets and foreign exchange markets (Reboredo, 2013). Demand for this precious metal is strong in emerging markets such as those of China, India and the MENA countries. It is considered a haven asset class in the MENA countries amid the economic and political upheaval affecting this region. There is still an overt relationship between declines in oil prices and gold demand in the MENA countries. Moreover, a plunge in global stock markets drives current demand for gold in those countries. These relations may vary in the short and long run.

Pioneered by the pseudonym Satoshi Nakamoto in November 2008 during the GFC, Bitcoin (BTC) is the largest cryptocurrency market in terms of market capitalization.[5] MENA region is a host of a large number of expatriates who transfer significant amounts of their salaries to home countries. On the other hand, Bitcoin is a low cost money transfer option, compared to an average transfer fee of 8% for other money transfer methods, which thus helps expats save significant amounts of remittance fees and use the Bitcoin option more. It is also worth noting that the low levels of financial inclusion in the MENA countries has led to a limited access to financial services, while Bitcoin is not limited by national borders. The Middle East and Africa have the second largest mobile phone population in the world, and the recent success of mobile banking has offered alternative payment methods that enhance the demand for bitcoin. These channels have facilitated the use of this crypto currency as an alternative to stock markets in the MENA region and helped this region to address the problem of poor financial inclusion. It is also worth noting that Bahrain will establish the Middle East's first central bank-backed crypto exchange in 2019. Famous crypto veterans have also invested in this Bahrain-based startup. This development is expected to have an important connection with other financial markets in the region.

Bitcoin has garnered special attention from the world's investors and speculators, which in turn has led to ubiquitous financial and economic uncertainties that roiled the global financial systems including the stock markets in both developed and emerging countries. The extreme and sudden increase in Bitcoin's market value has attracted the attention of investors, traders and academics, despite the small size of this cryptocurrency compared to financial markets. It is worth exploring whether this crypto market acts as an underlying factor of contagion for stock markets, particularly in emerging markets. Biotin is connected to the stock market despite its small market capitalization. A bust in the bitcoin bubble can damage investor confidence since the same investor confidence that powers speculation and risk taking in the world's stock markets has also driven the ascent of this cryptocurrency. Also, more companies are hitching their struggling wagon to cryptocurrencies, which ties their share values to prices of Bitcoin. In contrast, Bouri et al. (2017) show that Bitcoin is a strong safe haven against extreme down movements in Asian stocks.

Next, the Chicago Board Options Exchange (CBOE) volatility index (VIX) is one among the most popular uncertainty indexes that is designed to measure the market's expectation of future volatility implied by options price.[6] VIX is a barometer for international investors and their decision making process is influenced by the level of VIX Connolly et al. (2005) and Chiang et al. (2015) conclude that stock market uncertainty increases the volatility in stock and bond markets. Therefore, bitcoin, VIX, gold and oil are connected with stock markets, particularly in oil-dependent economies such as those of MENA countries and their stock markets that are characterized by high volatility and uncertainty.

[5] BTC represents about 60% of the total market capitalization of cryptocurrencies.
[6]For further information, the reader may visit http://www.cboe.com/products/vix-index-volatility

Monitoring and modelling the extreme dependencies between the MENA stock markets and major global factors including Bitcoin, oil, gold, and VIX is an important task for investors, portfolio managers and policy makers. In addition, the global factors-stock market linkages are not constant in terms of time and can vary over time and under different market statuses (bearish and bullish). These linkages may also depend on the time investment horizons. These two properties should be accounted for when we model the relationship between global risk factors and stock markets, particularly for emerging markets such as those of the MENA countries.

There has been an increasing literature on the dependence structure between stock markets and global factors for the case of developed markets but the literaure is scarce and limited when it comes for the MENA equity markets. Neaime (2012), for example, analyses the correlations between global and regional financial linkages between MENA stock markets and the mature markets of the US and EU, and the intra-regional financial linkages between oil and financial markets of non-oil producing MENA countries. More recently, Neaime (2016) explores the contagion vulnerability and the international and regional financial linkages of the MENA stock markets due to this gap.

Our paper aims to analyze the extreme dependence switching between regimes for twelve MENA stock markets and oil and three global factors (i.e., Bitcoin, gold and VIX products). Susmel (2001) argues that tail dependences are extremely important for a safety-first investor's portfolio management. These linkages are further studied under short- and long-term investment horizons as these considerations may bring changes in the linkages.

This current study makes at least three main contributions to the related literature. First, it examines the dependence structure between twelve major MENA stock markets and both oil and major global factors (gold, and VIX), in addition to Bitcoin which is under-researched in the literature. Second, it investigates the dependence structure under different regimes and time horizons. More precisely, we consider four regimes (bear stock market-bull global factor, bull stock market-bear global factor, bear stock market-bear global factor, and bull stock market-bull global factor). Third, different time horizons are consider which are crucial for both the short term and long-term investors expectations.

Methodologically, we apply the dependence-switching copula approach which is very appropriate for examining bivariate dependence. The study mixes the Clayton copula with the Survival Clayton copula to allow for asymmetric instead of symmetric tail dependence. The model is flexible since it is capable of switching between a positive correlation regime (a bull market i with a bear market j and a bear market i with a bull market j, that is, increasing and decreasing markets in tandem), and a negative correlation regime (both markets i and j are together booming or crashing) during the sample period, (that is, a dependence switching). In contrast to the standard bivariate copula model, which assesses the average and tail dependence for the entire period, the present model allows for an asymmetric tail dependence

between financial time series and switching from positive to negative correlation regimes and vice versa. Wang et al. (2013) argue that extreme-value models and Markov-switching models outperform conventional single-copula models. This model provides useful information on systematic risk spillovers as all extreme return statuses are accounted for. The wavelet approach is a popular analytical tool that can be used in the time-frequency domain analysis. In our analysis, we apply the wavelet to explore the dependencies in time variation features.

The results show evidence of bivariate tail dependence (both crashing and both blooming) between almost all MENA stock markets and oil and the three global factors. This dependence structure is sensitive to the different correlation regimes and over the short and long time horizons. During the bearish stock market, gold, Bitcoin and VIX act as hedge assets in both short and long run horizons. More interestingly, the left tail dependence estimates (both crashing markets) are higher than the right tail dependence (both booming markets), regardless of the time horizons. The current hybrid model provides a true systemic risk emanating from various extreme return scenarios.

The remainder of this article is structured as follows. Section 2 presents a concise review of the relevant literature. Section 3 discusses the methodology. Section 4 describes the data and the descriptive statistics. Section 5 presents the empirical results, and Section 6 concludes the study.

2. Brief literature review

A large body of the empirical literature has addressed the dependence structure between stock markets and global factors, using different econometric methods. Chau et al. (2013) investigate the impact of political uncertainty related to the civil uprisings in the Arab World (i.e., Arab Spring) on the volatility of MENA stock markets. The results provide little evidence to suggest that MENA markets have become more integrated with international markets after the political revolution. Mensi et al. (2014) examine the dependence structure between the emerging BRICS stock markets and influential global factors under different market conditions, using the quantile regression approach. The results show that the BRICS (Brazil, Russia, India, China and South Africa) stock markets exhibit an asymmetric dependence with the global stock and commodity markets (the S&P index, oil, and gold) as well as with changes in the U.S. stock market uncertainty (represented by the CBOE Volatility Index). The authors also find that the U.S. economic policy uncertainty has no impact on the BRICS stock markets. Mensi et al. (2015) use the vine copula approach to consider the multivariate dependence between global factors and stock markets. Those authors examine whether the Sharia-compliant stocks, gold and the U.S. Treasury bills can serve as a hedge and/or a safe-haven in the Gulf Cooperation Council (GCC) stock markets. The results show that GCC and global investors can realize both risk diversification benefits and downside risk reductions during tranquil and downturn periods by including gold or Islamic stock market in their portfolios. More recently, Mensi et al. (2017b) examine the co-movements between BRICS stock markets and both crude oil prices and gold prices, using the wavelet approach. The results show an intensified co-movement between the considered

markets during the onset of the global financial crisis. In addition, gold can serve as a hedge or a safe haven for the BRICS against extreme market movements.

Neaime (2016) examines the contagion vulnerability and the international and regional financial linkages of the MENA stock markets. The author finds that GCC stock markets offer international investors' portfolio diversification potentials and that those markets are relatively less vulnerable to global and regional financial crises compared to the remaining MENA stock markets (i.e., Egypt, Morocco, and Tunisia). Dimic et al. (2016) investigate the effect of global financial market uncertainty and domestic macroeconomic factors on stock–bond correlation in emerging markets. Using the wavelet analysis approach, the authors find that stock–bond correlation patterns vary significantly between the time horizons. Moreover, the correlation in the short horizons changes signs rapidly, showing sustainable negative episodes, while the correlation in long horizons stays positive most of the time. The monetary policy and global stock market uncertainty play a more significant role in explaining the stock–bond relationships in emerging markets.

Tran (2017) applies the non-cointegration test with the Residuals-Augmented Least Squares method to explore the existence of periodically collapsing stock price bubbles in Asian and Latin American emerging stock markets. The author rejects the hypothesis of the formation of bubbles, suggesting the existence of a co-integration relation between prices and dividends. The author links speculative bubbles with macroeconomic and financial factors. Lin et al. (2018) examine the impact of fundamental economic factors and stock market uncertainty (implied volatility index) on stock-bond relation. The results show that the dependencies between stocks and bonds do vary over time (in the short-term and long-run). In addition, the fundamental economic factors which drive the stock-bond relations do not vary across time frequencies, while the impacts of crises do vary across the time frequencies. Don and Yoon (2018) explore the economic driver factors of the Asian stock markets and find that the financial factors, global investor sentiment and the global business cycle have a predictive power of the Asian stock index returns.[7] Junttila et al. (2018) applied the generalized diagonal DCC GARCH model to examine the time-varying correlations and hedging strategies between US aggregate and disaggregate stock and commodity (oil and gold) markets. These authors show that the return correlations between oil and stock indices have intensified during the 2008 crisis, while the correlations of gold futures and stock indices are negative, supporting the safe haven evidence of gold.

Although many empirical works have conducted fruitful analyses of the drivers of extreme movements of stock indexes, most researchers focus on the bivariate average and tail dependence or on the time-frequency dependence. In contrast, this paper contributes to and

[7] The global factors include the OECD industrial production as a proxy for the global business cycle, the U.S. economic policy uncertainty index as a proxy for economic uncertainty, the U.S. monetary policy uncertainty index for financial uncertainty, the MSCI world stock Index, the implied volatility of the S&P 500 index (VIX), the all commodity price index, gold prices, the U.S. federal funds rate, the trade weighted USD index and the OECD consumer confidence index.

complements the above empirical literature by investigating the driver factors of MENA stock markets (assessing the average, upper, and lower dependencies) and the relations between stock markets and global factors under different market regimes and over different time investment horizons.

3. Methodology

This section introduces the dependence-switching copula approach, the marginal models and the estimation procedure which we use to assess the regime-based dependence between MENA stock markets and four global risk factors (e.g., Bitcoin, oil, gold, and implied volatility index (VIX)).

3.1. The Marginal model

The marginal distribution models are essential to obtain the copulas. Given that the returns series (i.e., log-difference (*r*) of the time-series) may exhibit stylized facts (e.g., serial correlation, heteroscedasticity, fat tails and leverage effects), we model these series using the autoregressive (AR) - fractional integrated conditional heteroscedasticity (FIGARCH) with the t-distribution. Following the Granger and Joyeux (1980), and Hosking (1981), for the series $r_t, t = 1,...,T$ the ARFIMA(p, d, q) model may be expressed as follows:

$$\Psi(L)(1-L)^d(r_t-\mu) = \Theta(L)\varepsilon_t \quad (1)$$

$$\varepsilon_t = z_t\sigma_t \quad z_t \sim (0,1), \quad (2)$$

where μ is the conditional mean and ε_t is independent and identically distributed (i.i.d) with the variance σ^2, and L is the lag operator as denoted earlier, $\Psi(L) = \psi_1 L + \psi_2 L^2 + ... + \psi_r L^r$ and $\Theta(L) = \theta_1 L + \theta_2 L^2 + ... + \theta_s L^s$ are the autoregressive (AR) and moving-average (MA) polynomials lie outside of unit cycles, respectively.

The process is said to be long memory at the long run as long as d > 0 in Equation (1). In particular, for $d \in (0,0.5)$, and d ≠ 0, the series is covariance stationary and mean reverting, but with shocks disappearing in the long run; for $d \in (0.5,1)$, the series implies mean-reversion. However, it is not a covariance stationary process as there is no long run impact of an innovation on future values of the process. For d ≥ 1, the series is non-stationarity and non-mean-reverting. On the contrary, the process is said to exhibit intermediate memory, for $d \in (-0.5,0)$.

Following Baillie et al. (1996), to capture the long memory component in the return's volatility, the FIGARCH (p, d, q) model may be written as follows:

$$\phi(L)(1-L)^{\xi}\varepsilon_t^2 = \omega + [1-\beta(L)](\varepsilon_t^2 - \sigma_t^2)$$

Or

$$\sigma_t^2 = \omega + \beta(L)\sigma_t^2 + [1-\beta(L)]\varepsilon_t^2 - \phi(L)(1-L)^{\xi}\varepsilon_t^2$$

where $\phi(L) = \phi_1 L + \phi_2 L^2 + ... + \phi_q L^q$, and $\beta(L) = \beta_1 L + \beta_2 L^2 + ... + \beta_p L^p$. All the roots of $\phi(L)$ and $[1-\beta(L)]$ are assumed to stand in outside the unit root. The FIGARCH model provides a greater flexibility for modeling the volatility as it nests GARCH. If d = 0, the FIGARCH (p, d, q) process reduces to a GARCH (p, q) process. The impact of a shock is said to decrease at a hyperbolic rate when 0<d<1. By allowing ξ to take a value within 0 and 1, FIGARCH permits for an intermediate range of persistence.

3.2. Wavelet approach

In the second step, we use the maximal overlap DWT (MODWT) to decompose the standardised residuals to short, medium and long-frequencies in order to analyse the dependence at different time-scales. The MODWT is chosen to decompose the data to obtain results at different frequencies is because it does not require the dyadic length requirement (i.e., a sample size divisible by 2^J), and by the fact that the wavelet and scaling coefficients are not shift-invariant due to their sensitivity to circular shifts because of the decimation operation. The MODWT, besides providing all the functions of DWT, comes with extra benefits as it can handle any sample size, it does not introduce phase-shifts which would change the location of events in time, and it is a translation-invariant as a shift in the signal does not change the pattern of wavelet transform coefficients. Further, we use the least asymmetric 8 (also called Symmlet-8, or abbreviated LA8) wavelet filter with periodic boundary conditions in the wavelet transform. Finally, we for each *N*, the depth of decomposition, *J*, was determined by the conservative formula suggested in Percival and Walden (2000): $J = floor(log_2\left(\left(\frac{N}{L-1} - 1\right)\right)$. First level of decomposition (i.e., D1, which corresponds to 2-4 days of frequency) is termed as the short run. The third level of decomposition (i.e., D3, which corresponds to 8-16 days of frequency) is termed as the medium run, and the 8th level of decomposition (i.e., D8, which corresponds to 256-512 days of frequency) is termed as the long run.

3.3. Regime Switching Copula estimation

In this study, we examine the dependence and tail dependence between the MENA stock markets and four global risk factors e.g. Bitcoin, oil, gold, and volatility index (VIX), while considering switches among positive and negative correlation regimes conditional on an unobserved state variable. A positive bivariate correlation regime implies that a bull MENA stock market state is associated with a high global risk factor, and a bear MENA stock market coexists with a low global risk factor. However, a negative correlation regime consists of a period where a bull (bear) MENA stock market synchronizes with a low (high) global risk factor. Based on Sklar's (1959) theorem, a bivariate joint cumulative distribution function

(F) of MENA stock market changes ($x_{1,t}$) and global risk factor return ($x_{2,t}$) can be decomposed into two marginal cumulative distribution functions (Fx_1 and Fx_2) and a copula cumulative distribution function (C) that fully depicts the dependence structure among the two variables:

$$F(x_{1,t}, x_{2,t}; \partial_1, \partial_2, \theta^c) = C\left(F_{x_1}(x_{1,t}; \partial_1), F_{x_2}\left(x_{2,t}; \partial_2\right); \theta^c\right) \quad (3)$$

where $F_k\left(x_{k,t}; \partial_k\right), k = 1, 2,$ is the marginal cumulative distribution function of $x_{k,t}$ and ∂_k and θ^c are the parameter sets of $F_k\left(x_{k,t}; \partial_k\right)$ and C, respectively. Assuming that all cumulative distribution functions are differentiable, the bivariate joint density is there after denoted as:

$$f\left(x_{1,t}, x_{2,t}; \partial_1, \partial_2, \theta^c\right) = C\left(u_{1,t}, u_{2,t}; \theta^c\right) \cdot \prod_{k=1}^{2} f_k(x_{k,t}; \partial_k) \quad (4)$$

where $f\left(x_{1,t}, x_{2,t}; \partial_1, \partial_2, \theta^c\right) = \partial F^2\left(x_{1,t}, x_{2,t}; \partial_1, \partial_2, \theta^c\right)/\partial x_{1,t}\partial x_{2,t}$ is the joint density of and $x_{2,t}$; is the "probability integral transforms" of $x_{k,t}$ based on $F_k\left(x_{k,t}; \partial_k\right), k = 1,2; c\left(u_{1,t}, u_{2,t}; \theta^c\right) = \partial C^2\left(u_{1,t}, -u_{2,t}; \theta^c\right) = \partial C^2\left(u_{1,t}, u_{2,t}; \theta^c\right)/\partial u_{1,t}\partial u_{2,t}$ is the copula density function; and $f_k\left(x_{k,t}; \partial_k\right)$ is the marginal density of $x_{k,t}, k = 1,2$. Thus, the bivariate joint density of $x_{1,t}$ and $x_{2,t}$ is the product of the copula density and two marginal densities.

While trying to properly capture the dependence switching, we consider the following switching regime copula in which the unobserved state variable, S_t, exerts a significant impact on the copula function and the marginal models.

$$C_{St}\left(u_{1,t}, u_{2,t}; \theta_1^c, \theta_0^c\right) = \begin{cases} C_1\left(u_{1,t}, u_{2,t}; \theta_1^c\right), & if\ S_t = 1 \\ C_0\left(u_{1,t}, u_{2,t}; \theta_0^c\right), & if\ S_t = 2 \end{cases} \quad (5)$$

where $C_1\left(u_{1,t}, u_{2,t}; \theta_1^c\right)$ and $C_0\left(u_{1,t}, u_{2,t}; \theta_0^c\right)$ are two mixed copulas with a positive and negative dependence structure, respectively. The above copula functions mix the Clayton copula (C^C) with the Survival Clayton copula(C^{SC}):[8]

$$C_1\left(u_{1,t}, u_{2,t}; \theta_1^c\right) = 0.5C^C\left(u_{1,t}, u_{2,t}; \alpha_1\right) + 0.5C^{SC}\left(u_{1,t}, u_{2,t}; \alpha_2\right) \quad (6)$$

$$C_0\left(u_{1,t}, u_{2,t}; \theta_0^c\right) = 0.5C^C\left(1 - u_{1,t}, u_{2,t}; \alpha_3\right) + 0.5C^{SC}\left(1 - u_{1,t}, u_{2,t}; \alpha_4\right) \quad (7)$$

where

$\theta_1^c = (\alpha_1, \alpha_2)',\ \theta_0^c = (\alpha_3, \alpha_4)', C^C(u, v; \alpha) = (u^{-\alpha} + v^{-\alpha} - 1)^{-\frac{1}{\alpha}}, C^{SC}(u, v; \alpha) = u + v - 1 + C^C(1 - u, 1 - v; \alpha),$

[8]By mixing the Clayton and Survival Clayton copulas (where the first detects the left-side tail dependence, and the second consists of capturing the right-side tail dependence), we account for both symmetric and asymmetric tail dependence.

and after estimating the shape parameter, α_i, we transform it in order to obtain Kendall's τ_i, the correlation coefficient (ρ_i) and the tail dependence (φ_i), with $\tau_i = \frac{\alpha_i}{2+\alpha_i}, \rho_i = \sin\left(\pi * \frac{\tau_i}{2}\right)$ and $\varphi_i = 0.5 * 2^{-\frac{1}{\alpha_i}}$ for $i = 1,2,3,4$.

The dependence-switching approach permits to capture the systemic risk in four market circumstances. S_t follows a two-state Markov chain with a transition probability matrix:

$$P = \begin{bmatrix} P_{00} & 1 - P_{00} \\ 1 - P_{11} & P_{11} \end{bmatrix} \tag{8}$$

where $P_{ij} = P_r[S_t = j | S_{t-1} = i]$ for $i, j = 0,1$. S_t switches among a positive dependence regime ($S_t = 1$) and a negative dependence regime ($S_t = 0$). One may write the bivariate density function of the above model as follows:

$$f\left(\mathrm{x}_{1,\mathrm{t}}, \mathrm{x}_{2,t}; \theta_1^c, \theta_0^c, \partial_1^0, \partial_1^1, \partial_2^0, \partial_2^0\right) = \left\{\sum_{j=0}^{1} \Pr\left(S_t = j\right) C_j\left(\mathrm{u}_{1,t}, \mathrm{u}_{2,t}; \theta_j^c\right)\right\} \times \prod_{k=1}^{2}\left\{\sum_{j=0}^{1} \Pr\left(S_t = j\right) f_k\left(\mathrm{x}_{k,t}, \partial_k^j, S_t = j\right)\right\} \tag{9}$$

where $C_j(\cdot)$ is the copula under regime j, θ_j^c is its parameter set and ∂_k^j is the parameter set of the marginal distribution under regime j. It is the parameter set of the marginal distributions under regime j. It is worth noting that a single copula model can only model either a positive or a negative dependence regime but not both. However, the model with dependence switching allows one to discuss the dependence structure for four different market statuses: both markets are either booming or crashing, and one market is booming, while the other one is crashing. The above model covers the models of Patton (2006) and Ning (2010) as a special case by setting $S_t = 0$. The log-likelihood function of Eq.(5) is:

$$L(\Theta) = L_c(\psi_1) + \sum_{k=1}^{2} L_k\left(\psi_{2,k}\right) \tag{10}$$

where $(\Theta = (\theta_1^c)', (\theta_0^c)', (\partial_1^0)', (\partial_1^1)', (\partial_2^0)', (\partial_2^0), P_{00}, P_{11})'$; $L_c(\psi_1)$ and $L_k\left(-\psi_{2,k}\right)$ are the log of the copula density and the marginal density of the $x_{k,1}$, respectively. These two densities are given as follows:

$$L_c(\psi_1) = \log\left[\Pr(S_t = 1)\, C_1\left(\mathrm{u}_{1,t}, \mathrm{u}_{2,t}; \theta_1^c\right) + (1 - \Pr(S_t = 1)\, C_0\left(\mathrm{u}_{1,t}, \mathrm{u}_{2,t}; \theta_0^c\right)\right],$$
$$L_k\left(\psi_{2,k}\right) = \log\left[\Pr(S_t = 1)\, f_k\left(x_{k,t}, \partial_k^1, S_t = 1\right) + (1 - \Pr(S_t = 1)\, f_k\left(x_{k,t}, \partial_k^0, S_t = 1\right)\right],$$

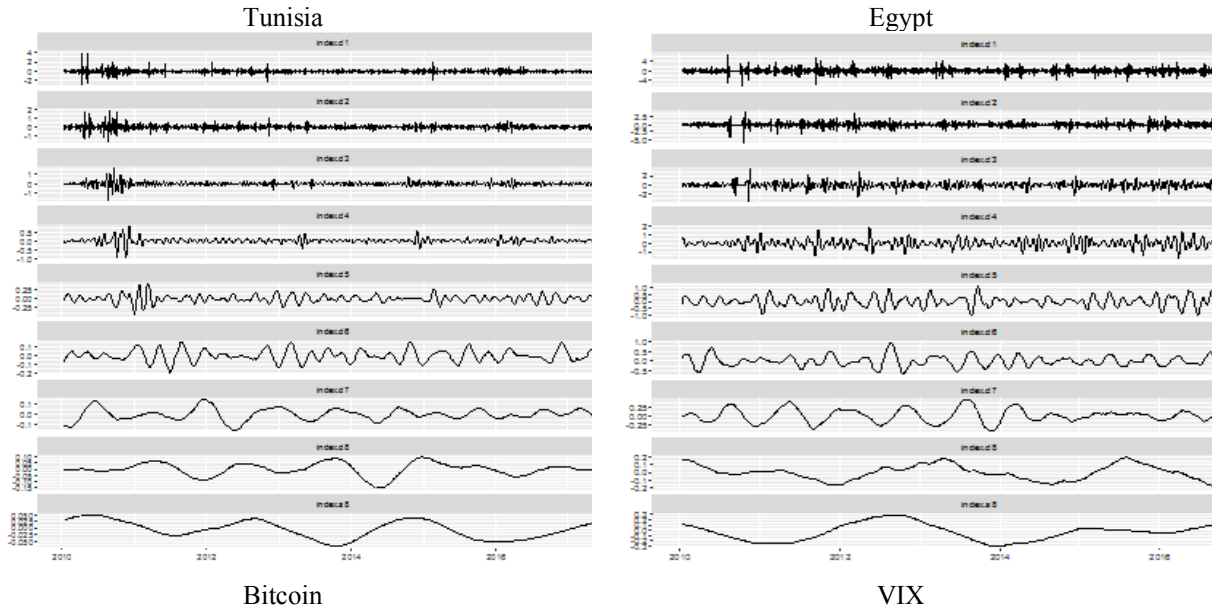
where $\psi_1 = ((\theta_1^c)', (\theta_0^c)', P_{11}, P_{00})'$; $\psi_{2,k} = ((\partial_k^0)', (\partial_k^1)', P_{11}, P_{00})'$.

4. Sample data and preliminary statistics

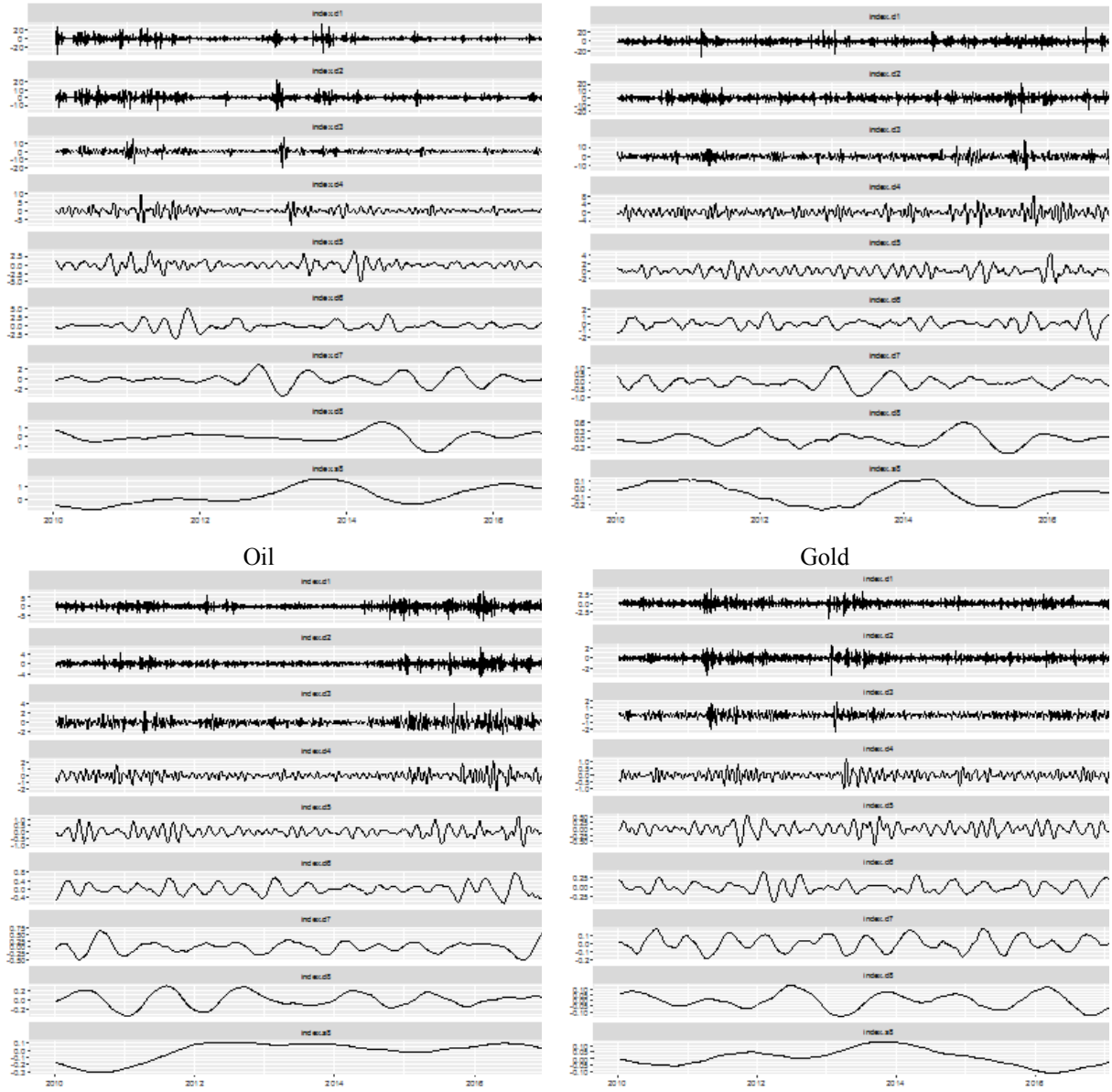
We consider daily closing spot prices for the twelve MENA stock markets (Bahrain, Egypt, J ordan, Kuwait, Lebanon, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Tunisia, and UAE), and for gold, oil, Bitcoin and implied volatility index (VIX). The sample period spans from S eptember 28, 2004 to May 15, 2017 covering the instability of the oil markets in both summer 2008 and mid-2014, the 2006 food crisis, the 2008-2009 GFC, and the 2010-2012 ESDC. The data are extracted from Bloomberg for the stock markets, the Gold Council website for gold, t he U.S. Energy Information Administration website for oil, the Coindesk Price Index website for Bitcoin and the yahoo finance website for the VIX index.

Fig. 1 plots the time variations of two stock prices, which are for Tunisia and Egypt as an exa mple, and the four global risk factors (gold, oil, VIX and Bitcoin) under different frequencies .[9] As clearly shown in this figure, all index series exhibit significant long-swing movements o ver the considered period in the short-term horizon but a slow variability in the long-term hori zon (d8 and s8). These trajectories provide insights into the dependence structure under differ ent time horizons. This graphical illustration shows the importance of accounting for time hor izons in portfolio management.

Figure 1. The return series across different scale bands



[9] The figures for the remaining series are not reported here in order to honor space limitations but will be available upon request.



The statistical results of the continuously compounded daily returns of all series (by taking the difference in the log values of two consecutive prices) are provided in Table 1. The results show that, among the twelve MENA stock markets, seven out of the twelve present a positive average return. More precisely, Egypt yields the highest average return. In addition, Egypt, Qatar and Saudi Arabia have the most volatile stock markets but Bahrain, Lebanon, Jordan and Tunisia possess the least volatile markets. As for the global factors, Bitcoin exhibits the highest average return, followed by gold, while oil and VIX show negative average returns. The skewness values are negative for almost all markets and the kurtosis is greater than three, indicating an asymmetry and fat tails. In addition, the Jarque Bera test strongly rejects the hypothesis of normal distribution, at the 1% significance level.

Further, we use the Dickey-Fuller (1979), Phillips and Perron (1988) unit root tests and the Kwiatkowski et al. (1992) stationarity test to check the stationarity for the selected return

series. The results indicate that all of the return series are stationary.[10] The unconditional correlations between the global factors and MENA stock markets are negative and the correlations between gold and the stock markets are weak. This result is consistent with the literature and documents that gold can serve as a hedge asset. For the remaining factors, the correlations are weak for the majority of the pairs.

[10] The results are not reported here but will be available upon request.

Table 1: Descriptive Statistics and statistical properties of return series

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque Bera	Correlation with Gold	Correlation with Bitcoin	Correlation with VIX	Correlation with Oil
Panel A: MENA stock markets												
UAE	0.034266	0.026539	6.487472	-7.15493	0.994671	-0.25602	12.24754	6136.782***	-0.00218	0.013689	-0.08563	0.029162
Bahrain	-0.00383	-0.01164	2.994904	-3.00086	0.485478	-0.13711	8.249502	1976.873***	0.010141	-0.00478	0.023886	-0.00712
Lebanon	-0.01501	-0.0113	2.808885	-3.90912	0.472665	-0.20887	10.96591	4552.214***	0.005336	0.011069	0.006829	0.014607
Qatar	0.022092	0.030055	10.79157	-8.74605	1.039326	-0.02824	18.09859	16309.4***	0.012365	-0.01437	-0.11018	0.04879
Egypt	0.044528	0.03812	12.81543	-13.1902	1.687554	-0.29024	11.4606	5145.178***	-0.01469	-0.00716	-0.03535	0.038666
Jordan	-0.00441	-0.00398	2.966922	-2.72262	0.50527	-0.08809	7.103407	1206.836***	-0.03772	-0.0031	0.001965	0.015897
Kuwait	0.001811	0.023888	5.209827	-4.9427	0.658061	-0.52164	14.10959	8907.754***	-0.01776	0.001375	-0.05664	0.005854
Morocco	-0.00028	0.004131	3.295461	-3.03383	0.625498	0.303391	6.046127	690.1678***	-0.00056	0.015328	-0.01995	-0.0036
Oman	-0.00812	0.000699	10.78106	-8.17047	0.785557	-0.39781	44.79099	124991.9***	-0.01701	0.003656	-0.07189	-0.02046
Palestine	0.001938	0	4.279582	-4.54348	0.568757	-0.41447	15.17812	10659.26***	-0.01606	0.033929	-0.02407	0.005299
Saudi Arabia	0.006811	0.028123	10.13603	-13.028	1.210456	-0.87597	20.79125	22864.56***	-0.04901	0.017548	-0.15458	0.077581
Tunisia	0.009117	0.006246	3.521306	-4.14392	0.559732	-0.86536	16.25669	12787.02***	-0.02673	-0.01971	0.007176	-0.0284
Panel B: Global factors												
Gold	0.002524	0	4.838746	-9.59617	1.081439	-0.54191	9.614465	3214.068***				
Bitcoin	0.580231	0.175937	49.9663	-47.0004	6.687651	0.004559	12.54254	6514.594***				
VIX	-0.05319	-0.34642	40.54651	-31.414	7.255331	0.70024	6.744998	1143.691***				
Oil	-0.02613	0	11.28922	-11.3562	2.168849	0.106619	6.160449	717.8427***				

Notes: The asterisk *** denotes the rejection of the null hypotheses at the 1% significance level.

5. Empirical results

5.1. Marginal model results

The best specification of the marginal model is of a primary interest in this section in order to avoid biased copula estimations. We consider a battery of GARCH family models with different lags (p, q) of the different return series, ranging from 0 to 2. The lag order is chosen by minimizing the relevant information criteria (i.e., the Akaike information criterion [AIC] and the Schwarz information criterion [SIC]). As shown in Table 2, the AR(1)-FIGARCH(1,d,1) model with student-t distributions (skewed student t-distributions for Kuwait and Saudi Arabia) has been found to best fit our considered return series (except for Bahrain where the AR(2)-FIGARCH(1,d,1) model was the best one). In this table, we report the estimated results of the mean equation and the variance equation along with the diagnostic tests.

The conditional mean parameter (AR) is negative (except for Tunisia) and statistically significant at the 5% level for all markets except Morocco and Oman. The slope parameters in the conditional variance equation are also generally significant at the conventional levels. The first lag of the squared returns of the stock markets and the global factors are significant for the majority of the series. The one-lag conditional variance coefficients affect the current conditional variance for eleven out of the sixteen series. The fractionally integrated parameter values are positive and statistically significant for all series, highlighting the presence of long memory in variance. The Kuwaiti equity market is the highest persistent market, while the Tunisian market is the least persistent. In addition, the tail parameter is statistically significant, suggesting the appropriateness of the student-t distribution. The asymmetry parameter is significant for a few cases (Kuwait and Saudi Arabia and global factors except BTC). These results show that selected AR-FIGARCH model with student-t distributions is the right choice. The diagnostic tests also support the evidence against any misspecification. In fact, the results of the Ljung–Box tests for serial correlation in the standardized residuals (the Q(5) statistic) and the squared standardized residuals (the $Q^2(5)$ statistic) do not reject the null hypothesis of no autocorrelation. Further, the results of the remaining ARCH effect support the null of no remaining ARCH effects. Now we can move to estimate the copula functions.

Before we apply the dependence-switching copula, we estimate the standard single copula functions (bivariate copula for the entire period). The results (not reported here to save space) show evidence of a significant average and extreme dependence between each of the four global factors (oil, gold, Bitcoin and VIX) and each of the 12 MENA stock markets. The one-regime copulas provide a preliminary picture of the dependence structure between the considered markets. In fact, the stock markets change from one regime to another one. This shift in regime affects the portfolio risk management and has implications for the systemic risk and portfolio diversification benefits of those markets. To this end, we carry out the dependence- switching copula model to consider all market statuses. Additionally, we combine our model with the wavelet approach to consider the time investment horizons.

Table 2. Marginal model results (AR(1)-FIGARCH(1,d,1))

	Mean equation		Variance equation						Diagnostic tests		
	Cst(M)	AR(1)	Cst(V)	d-FIGARCH	ARCH1	ARCH2	GARCH	Asymmetry	Tail	Q(5)	Q^2(5)	ARCH(5)
Panel A: MENA stock markets												
UAE	0.0170	-0.1105*	0.1866*	0.4300*	-0.2283		-0.0102	-0.0063	2.9807*	30.0764	5.0779	1.0183
Bahrain	-0.0126*	-0.1945*	0.01588	1.2256*	0.1011	0.2632*	0.9483*		2.3130*	42.747*	7.915	1.568
Lebanon	-0.0206*	-0.1202*	0.1966*	0.3941*	-0.9403*		-0.9520*	-0.0179	2.7768*	5.3720	2.5410	0.7418
Qatar	0.0278*	-0.1189*	0.0415*	0.5483*	0.4163*		0.7406*	-0.0222	2.9145*	56.9425	12.7625	2.5793
Egypt	0.0594*	-0.1234*	2.5581*	0.6149*	-0.2544		0.0098	-0.0126	2.4301*	37.0041	7.1717	1.4058
Jordan	-0.0068	-0.1616*	0.1669*	0.3985*	-0.3107*		-0.1377	-0.0171	2.6154*	25.3035	14.2884	2.7640
Kuwait	0.0084	-0.0894*	0.0379*	1.0579*	-0.0099		0.8373*	-0.0691*	2.5036*	88.6001	25.6098	5.1024
Morocco	-0.0079	0.03595	0.0271	0.2067*	0.7466*		0.6766*	-0.0082	5.2100*	18.7659	0.89256	0.1819
Oman	0.0125	-0.0433	0.0530*	0.9595*	0.1758		0.7577*	0.0217	2.5240*	59.8402	6.9612	1.4106
Palestine	-0.0046	-0.2508*	0.3325*	0.4835*	0.3190		0.1319	-0.0049	2.1766*	34.5092	2.5108	0.5031
S. Arabia	0.0479*	-0.1395*	0.0645*	0.6581*	0.4001*		0.7951*	0.0168*	2.4463*	29.2292	10.5513	2.0834
Tunisia	0.0151*	0.2031*	0.0426*	0.1384*	0.4991*		0.1969*	0.0409	4.6260*	10.8841	0.4215	0.0833
Panel B: Global factors												
Gold	-0.0039	-0.0297	0.1416	0.2632*	0.2758*		0.5289*	-0.0432	3.7145*	2.9443	0.8881	0.1729
Bitcoin	0.2673*	0.0041	0.7314*	0.9996*	0.1091		0.7791*	0.0132	2.9406*	32.1967	2.2784	0.4643
VIX	-0.0001	-0.0829*	11.4039*	0.2741*	-0.2662		-0.1518	0.1736*	4.9504*	18.1884	1.3659	0.2718
Oil	-0.0104	-0.0463*	0.0522	0.5268*	0.3864*		0.7609*	-0.0768*	6.0378*	1.9574	2.6268	0.5335

Note: Q(5) and Q^2(5) are the Ljung-Box test statistics for the serial correlation in the standardized residuals and for the squared standardized residuals, respectively. ARCH(5) is the ARCH Lagrange multiplier at lag 5, which supports the null of no remaining ARCH effects. The asterisk * denotes significance at the 5% level. For Bahrain AR(1)-FIGARCH (1, d, 2) with Student t- distribution model was estimated, because there were convergence problems with other specifications.

5.2. The results of the dependence-switching regime copula

As an illustration, we report in Tables 3.1-3.12 the estimation results for the short-term dependence-switching regime for all 12 MENA stock markets. The results of the estimation for the long-term dependence-switching regime are in the Appendix. To make the interpretations easy for the reader to understand, we have summarized all results in Table 3.0. We first diagnose our model using the information criteria AIC and BIC. The diagnosis tests reveal that the estimated AIC and BIC values from the dependence-switching copula model are smaller than those from the single-regime copula models for all cases (the results not reported here but are available upon request). This result underscores the appropriateness of the dependence-switching copula model over the single-regime copula models in examining the dependence structure between the global factors and the MENA stock markets. More importantly, the estimated transition probabilities *P11*and *P00* are high and close to one. This result reveals that the duration in each regime is long, and hence a shift across the four regimes is slow and not frequently observed.

This result is similar to that of Wang et al. (2013) who tested the switching dependence between stock and currency markets. Wang et al. (2013) argue that an advantage of the dependence-switching copula technique provides a complete information of the dependence and tail dependence across two financial assets for four different market statuses: bull or bear markets linked with upturns or downturns of global factors. Note that a significant tail dependence indicates a higher probability of extreme events, and hence a larger estimate of the Value at Risk than that is implied by a bivariate normal distribution. However, missing modelling the extreme dependence (particularly the lower dependence) may underestimate the portfolio risk management. In this study, we consider two correlation regimes. The positive correlation regime embeds two extreme regimes where both return series commove in an inverse direction: (i) the bear stock market that is associated with the upside global factors (ii) and a bull market linked to downside global factors. The set of negative correlation regimes includes two extreme regimes: (iii) the bear stock market that is associated with the downside global factors, indicating that stock market-global factors are crashing (iv) and a bull market linked to an upside global factors, meaning that both markets are booming. In addition, the left (lower) and right (upper) tail dependence, where φ_3 and φ_4 stand for the probability of simultaneous large losses and gains in stock and global factors. Hence, these two parameters are a true measure of systemic risk during a financial crisis (boom) period (Wang et al., 2013). Investors hold a long position in stock markets that suffer from huge losses if φ_3 is very large, while if φ_4 is very high, investors thus hold a short position in stock markets that generates huge profits. Looking now to the positive correlation regime, the parameter $\varphi_1(\varphi_2)$ indicates tail dependence where the downside (upside) stock market is tied with the upside (downside) global factors. A large value of the tail dependence parameters exhibits that investors hold a long position in stock markets which generates large losses (profits), while a short position in global factors earns important profits (losses).

Table 3. Summary results

	Time horizons	UAE	Bahrain	Lebanon	Qatar	Egypt	Jordan	Kuwait	Morocco	Oman	Tunisia	Palestine	KSA
Gold													
Bear-Bull	ST			●	●			●			●		
	LT	●	●	●	●	●	●	●	●	●		●	
Bull-Bear	ST			●				●			●		
	LT	●	●	●	●	●	●	●	●	●			●
Bear-Bear	ST	●	●			●	●		●	●		●	
	LT	●	●	●	●	●	●	●	●	●	●	●	●
Bull-Bull	ST		●			●	●		●	●		●	●
	LT	●	●	●		●	●	●	●	●	●	●	●
Oil													
Bear-Bull	ST			●	●		●						●
	LT	●	●	●	●	●	●	●	●	●	●	●	●
Bull-Bear	ST			●	●		●						●
	LT	●	●	●	●	●	●	●	●	●		●	●
Bear-Bear	ST	●	●			●		●	●	●	●	●	●
	LT	●		●	●			●	●	●	●	●	●
Bull-Bull	ST		●			●		●	●	●	●	●	
	LT	●	●	●	●			●	●	●	●	●	●
VIX													
Bear-Bull	ST			●	●	●	●					●	●
	LT	●	●	●	●	●	●	●	●	●	●	●	●
Bull-Bear	ST			●	●	●							●
	LT			●	●	●	●	●	●	●		●	●

Bear-Bear	ST			•				•			•	•	•	•	•	
	LT	•	•			•	•	•			•	•	•	•		•
Bull-Bull	ST			•				•	•	•	•			•		
	LT	•	•		•	•	•	•			•	•	•	•	•	•
Bitcoin																
Bear-Bull	ST			•												•
	LT	•	•	•	•		•		•	•	•	•	•	•	•	•
Bull-Bear	ST															•
	LT	•	•	•	•	•	•	•	•	•			•		•	•
Bear-Bear	ST	•	•			•	•	•	•	•	•	•				
	LT	•	•	•	•	•	•	•	•	•	•	•	•			
Bull-Bull	ST	•	•		•	•	•	•	•	•	•	•				
	LT		•	•	•	•	•	•	•	•	•	•	•			

Note: Bear-Bull (Bull-Bear) indicates that a bear (bull) stock market coexists with bull (bear) global factors. A Bear-Bear (Bull-Bull) denotes that stock and global factors are crashing (booming). ST and LT denote respectively short term and long term. The dot • stands for statistically significant relationship between stock and global factors.

5.2.1. Commodity (oil and gold) results

Before we start the interpretations of the results, we should note that the coefficient values for the dependence estimate are positive in Tables 3.1-3.12 and Tables A1-A12 under the negative regime but they exhibit a negative dependence between two markets. Under the negative correlation regime, we observe a strong evidence of a left tail dependence (φ_4) between gold and stock markets for all MENA markets in the long term where both stock and gold markets are crashing. The result indicates that for the long term, bull MENA stock markets are connected with a bull gold market; bear MENA stock markets coexist with a downside gold market, indicating that stock-gold pairs are booming or crashing together. This result is similar in the short term for seven out of the twelve markets (Bahrain, Egypt, Jordan, Morocco, Oman, Palestine and UAE). More precisely, when these seven MENA stock markets show an upside (downside), the gold market also exhibits an upside (downside).

Regarding the positive regime, we find that bull (bear) stock markets coexist with downside (upside) gold prices. The result is in line with the flight-to-quality empirical literature regarding the role of gold as a safe haven asset, regardless of the time horizon. For Lebanon and Kuwait (Tunisia only for the short term), we show evidence of a positive correlation regime, indicating when the upside (downside) of these three MENA stock markets coexists with a downside (upside) stock market. This result shows that during bearish markets, the investors dealing with Lebanon, Kuwait and Tunisia markets can reduce their risk exposure in the short term using gold. Investors holding a long (short) position in stock markets and a short (long) position in gold markets generate large losses (profits) in equities and high profits (losses) in gold

Looking at the oil market for the long-term, we show evidence of left and right tail dependences for stock-oil pairs, regardless of the considered regime for nine out of the twelve MENA stock markets, namely Kuwait, Tunisia, Saudi Arabia, Palestine, Oman, morocco, UAE and Lebanon (except the bullish stock-oil pair case). The result is also similar for Bahrain (Lebanon) except the crashing (booming) case for both markets. Egypt and Jordan are not linked with gold during both crashing and booming oil and stock markets. It is evident that oil plays a crucial role in oil-importing and oil-exporting MENA countries. Furthermore, we find less evidence in the short-term compared to the long-term. Specifically, we show evidence of a negative correlation regime for UAE, Bahrain, Egypt Kuwait, Morocco, Oman, Palestine and Tunisia, while a positive correlation regime for Lebanon, Qatar and Jordan stock markets. As for Saudi Arabia, we find evidence of short- and long-term tail dependence for all regimes. It is worth noting that Saudi Arabia is the largest oil producer in the world. Oil reduces the exposure to risk for MENA stock investors, and thus it can be embodied into a stock portfolio in order to reduce risk.

5.2.2 VIX and BTC results

The evidence of a long-term tail dependence structure between MENA stock markets and the VIX index is more evident than those of the short-term dependence, regardless of the correlation regimes. The results that the tail dependence

φ_2 is significant for all cases indicate that investors holding a long position in stock markets and a short position in VIX generate large losses in stock markets and hug profits in VIX products, in the long term. The tail dependence φ_1 is significant for six out of the twelve markets in the short term. We observe a left and right tail dependence in the short term for some cases. For example, Egypt's stock market presents a positive and a negative short- and long tail dependence regardless of the regime. Tunisia, Saudi Arabia, Oman, morocco, Jordan, Qatar, Lebanon, UAE and Bahrain (for Bahrain and UAE except the bull stock market associated with the bear VIX) are dependent with the VIX index in the long-run, while in the short-run the significant tail dependence is mixed between positive and negative regimes. For UAE, there is a tail independence between the UAE stock market and the VIX index in the short-term.

Despite that Bitcoin is an emerging market and recently traded in the MENA region, we find a tail dependence between Bitcoin price returns and the majority of te MENA stock market returns (some exceptions for UAE, Kuwait and Egypt) especially in the long term and for all regimes. This result shows that the copula parameter estimates (α_i) are statistically significant at the conventional level for almost all countries and variables regardless of the considered regimes. Looking at the UAE market, the estimates of the left dependence ρ_3 (tail dependence φ_3) is equal to 0.54 (0.27) for Bitcoin, when the UAE stock market and the VIX are in a bear condition.

To sum up, the above results reveal that the probability of simultaneously suffering extreme losses in the stock markets and global factors is generally high for an investor holding a long position in both markets/factors. On the whole, gold and Bitcoin are a good hedge for MENA investors in the short- and particularly in long-term horizons. These results are consistent with the previous works of Baur and Lucey (2010) and Bouri et al. (2010) for other markets.

Table 3.1. Estimation of the short-term dependence-switching copula model for UAE

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.2071	0.2785**	0.0333	0.0740
	(0.1296)	(0.1239)	(0.0680)	(0.0684)
ρ_1	0.1469*	0.1908***	0.0257	0.0560
	(0.0827)	(0.0736)	(0.0517)	(0.0499)
φ_1	0.0176	0.0415	0.0000	0.0000
	(0.0369)	(0.0459)	(0.0000)	(0.0004)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.3702**	0.2399**	0.1205	0.1295*
	(0.1505)	(0.1097)	(0.0836)	(0.0727)
ρ_2	0.2429***	0.1674**	0.0891	0.0954*
	(0.0817)	(0.0677)	(0.0581)	(0.0501)
φ_2	0.0769	0.0278	0.0016	0.0024
	(0.0585)	(0.0367)	(0.0063)	(0.0071)
Panel C: Bear markets associated with bear global factors				
α_3	0.8672**	1.1127***	-0.1329	1.1700***
	(0.3712)	(0.2727)	(0.1467)	(0.4365)
ρ_3	0.4574***	0.5325***	-0.1116	0.5478***
	(0.1261)	(0.0749)	(0.1314)	(0.1142)
φ_3	0.2248***	0.2682***	92.0195	0.2765***
	(0.0769)	(0.0409)	(529.6858)	(0.0611)
Panel D: Bull markets associated with bull global factors				
α_4	0.7767**	1.2598***	0.1033	1.1903***
	(0.3515)	(0.4108)	(0.0000)	(0.4287)
ρ_4	0.4254***	0.5705***	0.0771	0.5531***
	(0.1296)	(0.0997)	(0.0000)	(0.1103)
φ_4	0.2048**	0.2884***	0.0006	0.2793***
	(0.0827)	(0.0517)	`(0.0000)	(0.0586)
Panel E: Diagnostic test				
P11	0.9312	0.9226	0.9986	0.9741
P00	0.8811	0.8303	0.9930	0.8310
RealCL	-4048.3957	-5590.4726	-25469.9525	-22259.7660
AICT	8136.7914	11220.9453	50979.9049	44559.5320
BICT	8245.7347	11329.8887	51088.8483	44668.4754

Notes: α_i is the shape parameter of the dependence-switching copula, and ρ_i and φ_i are the measures of dependence and tail dependence, respectively. Although ρ_3 and ρ_4 are positive in the table, they denote a negative correlation between the MENA stock returns and changes in the global factors. The numbers in parentheses are the standard deviations. 'REALCL', 'AICT' and 'BICT' denote the estimated log likelihood value based on Equation (4), the Akaike information criterion, and the Bayes information criterion, respectively. P11 and P00 are two transition probabilities. Values are in the order of fist parameter and the standard error. *,** and *** denote significance at the 10%, 5% and 1% levels of significance, respectively. The tables for the long run results are provided in the Appendix.

Table 3.2. Estimation of the short-term dependence-switching copula model for Bahrain

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.0920	0.2241**	0.2217**	-0.0119
	(0.0653)	(0.0871)	(0.0986)	(0.0552)
ρ_1	0.0690	0.1576***	0.1561**	-0.0094
	(0.0468)	(0.0546)	(0.0620)	(0.0439)
φ_1	0.0003	0.0227	0.0219	1.21E+25***
	(0.0014)	(0.0273)	(0.0305)	(0.5967)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.0569	0.0010	0.1932*	-0.0649
	(0.0618)	(0.0600)	(0.1047)	(0.0536)
ρ_2	0.0434	0.0008	0.1379**	-0.0526
	(0.0459)	(0.0471)	(0.0677)	(0.0449)
φ_2	0.0000	1.307948e-311	0.0138	21867.0604
	(0.0000)	(0.0000)	(0.0269)	(192996.0064)
Panel C: Bear markets associated with bear global factors				
α_3	1.3069**	1.6268**	0.9553	-0.1345
	(0.5428)	(0.6687)	(0.6507)	(0.2056)
ρ_3	0.5817***	0.6477***	0.4862**	-0.1130
	(0.1268)	(0.1217)	(0.2045)	(0.1844)
φ_3	0.2942***	0.3265***	0.2420**	86.6830
	(0.0648)	(0.0572)	(0.1196)	(683.4362)
Panel D: Bull markets associated with bull global factors				
α_4	1.4146**	2.8762**	1.4800***	-0.0050
	(0.6730)	(1.4179)	(0.4551)	(0.1200)
ρ_4	0.6058***	0.7995***	0.6194***	-0.0040
	(0.1443)	(0.1125)	(0.0927)	(0.0948)
φ_4	0.3063***	0.3929***	0.3130***	4.00E+59***
	(0.0714)	(0.0467)	(0.0451)	(1.3873)
Panel E: Diagnostic test				
P11	0.9801	0.9629	0.9861	0.9979
P00	0.8515	0.6682	0.9227	0.9918
RealCL	-3728.35	-5276.566	-25116.310	-21934.257
AICT	7496.716	10593.133	50272.620	43908.515
BICT	7605.659	10702.077	50381.563	44017.458

Notes: See the notes of Table 3.1.

Table 3.3. Estimation of the short-term dependence-switching copula model for Lebanon

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.8483**	1.4016	1.3427***	0.1486*
	(0.4280)	(1.0355)	(0.4125)	(0.0784)
ρ_1	0.4510***	0.6030***	0.5899***	0.1085**
	(0.1479)	(0.2243)	(0.0936)	(0.0531)
φ_1	0.2209**	0.3049***	0.2984***	0.0047
	(0.0910)	(0.1114)	(0.0473)	(0.0116)
Panel B: Bull stock markets associated with bear global factors				
α_2	1.1941***	1.7270**	1.5294***	0.0590
	(0.4620)	(0.7180)	(0.3866)	(0.0828)
ρ_2	0.5541***	0.6653***	0.6293***	0.0450
	(0.1184)	(0.1212)	(0.0758)	(0.0613)
φ_2	0.2798***	0.3347***	0.3178***	0.0000
	(0.0628)	(0.0559)	(0.0364)	(0.0001)
Panel C: Bear markets associated with bear global factors				
α_3	0.0744	0.1651	0.1222	0.8360*
	(0.0829)	(0.1097)	(0.0867)	(0.5032)
ρ_3	0.0563	0.1195	0.0903	0.4467**
	(0.0604)	(0.0730)	(0.0602)	(0.1758)
φ_3	0.0000	0.0075	0.0017	0.2182**
	(0.0005)	(0.0209)	(0.0069)	(0.1089)
Panel D: Bull markets associated with bull global factors				
α_4	0.0990	0.1152	0.1238	0.7315**
	(0.0836)	(0.1096)	(0.0962)	(0.3485)
ρ_4	0.0740	0.0855	0.0914	0.4084***
	(0.0594)	(0.0767)	(0.0667)	(0.1339)
φ_4	0.0005	0.0012	0.0018	0.1938***
	(0.0027)	(0.0070)	(0.0080)	(0.0875)
Panel E: Diagnostic test				
P11	0.8277	0.7664	0.8437	0.9858
P00	0.9644	0.9378	0.9596	0.8969
RealCL	-3724.4222	-5271.7813	-25112.8011	-21921.9046
AICT	7488.8444	10583.5626	50265.6022	43883.8092
BICT	7597.7878	10692.5060	50374.5456	43992.7526

Notes: See the notes of Table 3.1.

Table 3.4. Estimation of the short-term dependence-switching copula model for Egypt

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.3796**	0.1996**	0.4628***	0.0966
	(0.1620)	(0.0822)	(0.1702)	(0.0706)
ρ_1	0.2480***	0.1421***	0.2909***	0.0723
	(0.0870)	(0.0528)	(0.0844)	(0.0503)
φ_1	0.0805	0.0155	0.1118*	0.0004
	(0.0627)	(0.0222)	(0.0616)	(0.0020)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.2732**	0.1449*	0.4358***	0.0757
	(0.1301)	(0.0745)	(0.1342)	(0.0769)
ρ_2	0.1877**	0.1059**	0.2773***	0.0572
	(0.0777)	(0.0506)	(0.0683)	(0.0560)
φ_2	0.0396	0.0042	0.1019**	0.0001
	(0.0478)	(0.0103)	(0.0499)	(0.0005)
Panel C: Bear markets associated with bear global factors				
α_3	0.6398**	3.0052***	0.8254***	1.3878**
	(0.2760)	(0.7988)	(0.2984)	(0.5870)
ρ_3	0.3716***	0.8094***	0.4429***	0.6000***
	(0.1155)	(0.0588)	(0.1053)	(0.1285)
φ_3	0.1692**	0.3970***	0.2159***	0.3034***
	(0.0791)	(0.0243)	(0.0655)	(0.0641)
Panel D: Bull markets associated with bull global factors				
α_4	0.9637***	1.8218***	0.7605***	1.2401***
	(0.3346)	(0.5065)	(0.2227)	(0.4781)
ρ_4	0.4889***	0.6807***	0.4193***	0.5656***
	(0.1044)	(0.0798)	(0.0834)	(0.1180)
φ_4	0.2436***	0.3418***	0.2010***	0.2859***
	(0.0608)	(0.0362)	(0.0536)	(0.0616)
Panel E: Diagnostic test				
P11	0.9340	0.9498	0.8800	0.9730
P00	0.8963	0.8143	0.8203	0.8529
RealCL	-4716.7506	-6249.1033	-26109.4053	-22923.4766
AICT	9473.5011	12538.2067	52258.8106	45886.9531
BICT	9582.4445	12647.1500	52367.7539	45995.8965

Notes: See the notes of Table 3.1.

Table 3.5. Estimation of the short-term dependence-switching copula model for Tunisia

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	1.6804***	0.2318*	0.0853	0.3052***
	(0.6409)	(0.1196)	(0.0668)	(0.1092)
ρ_1	0.6573***	0.1624**	0.0642	0.2065***
	(0.1120)	(0.0744)	(0.0482)	(0.0632)
φ_1	0.3310***	0.0251	0.0001	0.0516
	(0.0521)	(0.0388)	(0.0009)	(0.0419)
Panel B: Bull stock markets associated with bear global factors				
α_2	2.5236***	0.1585	0.1839**	0.1952*
	(0.8253)	(0.1390)	(0.0808)	(0.1048)
ρ_2	0.7684***	0.1151	0.1319**	0.1392**
	(0.0811)	(0.0931)	(0.0528)	(0.0677)
φ_2	0.3799***	0.0063	0.0115	0.0143
	(0.0341)	(0.0242)	(0.0191)	(0.0274)
Panel C: Bear markets associated with bear global factors				
α_3	0.1508**	0.8615***	3.4908***	1.0062*
	(0.0673)	(0.2934)	(1.3330)	(0.5638)
ρ_3	0.1099**	0.4555***	0.8407***	0.5019***
	(0.0454)	(0.1002)	(0.0752)	(0.1695)
φ_3	0.0050	0.2236***	0.4100***	0.2511***
	(0.0103)	(0.0613)	(0.0311)	(0.0969)
Panel D: Bull markets associated with bull global factors				
α_4	0.0057	1.5097**	2.8576**	1.4595**
	(0.0546)	(0.6691)	(1.2378)	(0.7422)
ρ_4	0.0045	0.6254***	0.7981***	0.6152***
	(0.0426)	(0.1332)	(0.0993)	(0.1536)
φ_4	0.0000	0.3159***	0.3923***	0.3110***
	(0.0000)	(0.0643)	(0.0412)	(0.0751)
Panel E: Diagnostic test				
P11	0.8839	0.9445	0.9640	0.9366
P00	0.9861	0.8154	0.7454	0.7747
RealCL	-3753.7310	-5307.0600	-25151.1022	-21946.3499
AICT	7547.4619	10654.1200	50342.2045	43932.6997
BICT	7656.4053	10763.0633	50451.1478	44041.6431

Notes: See the notes of Table 3.1.

Table 3.6. Estimation of the short-term dependence-switching copula model for Qatar

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	-0.02015	2.37919*	1.324951***	0.64472
	(0.03003)	(1.42832)	(0.636075)	0.49467
ρ_1	-0.01599	0.7535***	0.58586***	0.37363*
	(0.02406)	(0.153826)	(0.14649)	(0.20609)
φ_1	4.299E+16***	0.37363***	0.29633***	0.17063
	(0.30060)	(0.06535)	(0.0744)	(0.140751)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.02171	1.28089*	1.10071***	0.60822
	(0.06962)	(0.64824)	(0.3433)	(0.75611)
ρ_2	0.01687	0.57553***	0.5292***	0.358166
	(0.05350)	(0.15471)	(0.0952)	(0.32601)
φ_2	6.90E-15	0.2910***	0.2663***	0.15997
	(7.06E-13)	(0.07971)	(0.0524)	(0.22663)
Panel C: Bear markets associated with bear global factors				
α_3	-0.14457	0.42197***	0.198663*	0.08286
	(0.105753)	(0.1467)	(0.11564)	(0.073559)
ρ_3	-0.12208	0.27027***	0.14145*	0.062448
	(0.095784)	(0.07566)	(0.074396)	(0.05316)
φ_3	60.42689	0.09673	0.01526	0.0001164
	(211.9343)	(0.05525)	(0.031002)	(0.000865)
Panel D: Bull markets associated with bull global factors				
α_4	-0.00943541	0.32129***	0.254721***	0.078188
	(0.1587)	(0.1392)	(0.10293)	(0.070578)
ρ_4	-0.007446	0.21571***	0.17652***	0.05906
	(0.12586)	(0.07927)	(0.06261)	(0.05125)
φ_4	4.01E+31***	0.05781	0.03289	7.06E-05
	(1.756131)	(0.05405)	(0.03618)	(0.000565)
Panel E: Diagnostic test				
P11	0.998551701	0.6912365	0.770172	0.991258
P00	0.994115267	0.897367007	0.901324	0.99863
RealCL	-4099.2724	-5614.78997	-25481.079	-22294.795
AICT	8238.5448	11269.57994	51002.1595	44629.590
BICT	8347.488167	11378.52331	51111.10294	44738.534

Notes: See the notes of Table 3.1.

Table 3.7. Estimation of the short-term dependence-switching copula model for Jordan

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.09108	1.23028**	0.40991***	0.22382*
	(0.07457)	(0.49597)	(0.130251)	(0.12000)
ρ_1	0.06837	0.56320***	0.264018***	0.15743**
	(0.05345)	(0.1233)	(0.06795)	(0.07528)
φ_1	0.00024	0.28463***	0.09217**	0.02259
	(0.00154)	(0.06464)	(0.04952)	(0.03751)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.02867	1.36726**	0.41738***	0.39474**
	(0.06874)	(0.60566)	(0.16172)	(0.142861)
ρ_2	0.02220	0.59544***	0.26790***	0.25604***
	(0.05246)	(0.13482)	(0.08376)	(0.07565)
φ_2	1.59E-11	0.30116***	0.09500	0.08637
	(9.22E-10)	(0.06763)	(0.06113)	(0.05489)
Panel C: Bear markets associated with bear global factors				
α_3	2.68694***	0.16882**	0.61047*	1.19877**
	(0.984331)	(0.07711)	(0.33269)	(0.48095)
ρ_3	0.783643***	0.12196**	0.35913**	0.55525***
	(0.08744)	(0.05111)	(0.14314)	(0.12281)
φ_3	0.386309***	0.00823	0.16064	0.28044***
	(0.03650)	(0.01545)	(0.09940)	(0.06505)
Panel D: Bull markets associated with bull global factors				
α_4	1.818755***	0.02959	0.68383***	0.95903**
	(0.52937)	(0.06544)	(0.2180)	(0.42086)
ρ_4	0.680263***	0.0229	0.38963***	0.48739***
	(0.08358)	(0.04990)	(0.08760)	(0.13185)
φ_4	0.341551***	3.36E-11	0.18145***	0.24270***
	(0.037887)	(1.74E-09)	(0.058655)	(0.07697)
Panel E: Diagnostic test				
P11	0.970886	0.86295	0.900244	0.89635
P00	0.78527	0.97084	0.844105141	0.76202
RealCL	-3729.14	-5284.73	-25122.9123	-21918.363
AICT	7498.288	10609.46	50285.82456	43876.726
BICT	7607.232	10718.41	50394.76793	43985.6702

Notes: See the notes of Table 3.1.

Table 3.8. Estimation of the short-term dependence-switching copula model for Kuwait

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	2.14682***	0.21249	0.34864**	0.20880**
	(0.69806)	(0.111049)	(0.153691)	(0.09326)
ρ_1	0.7264***	0.1503**	0.23107***	0.14794**
	(0.08763)	(0.07046)	(0.085163)	(0.05939)
φ_1	0.36203***	0.01916	0.06847	0.01808
	(0.03801)	(0.03266)	(0.060013)	(0.02681)
Panel B: Bull stock markets associated with bear global factors				
α_2	1.66383***	0.28269**	0.314931**	0.170905*
	(0.508536)	(0.12982)	(0.151041)	(0.090714)
ρ_2	0.654360***	0.19331**	0.212074**	0.12334**
	(0.089996)	(0.076792)	(0.086532)	(0.060009)
φ_2	0.329643***	0.04306	0.055349	0.00866
	(0.041973)	(0.04848)	(0.058425)	(0.018645)
Panel C: Bear markets associated with bear global factors				
α_3	0.058621	0.85435***	1.336024**	2.16369***
	(0.071043)	(0.277312)	(0.5286073)	(0.63069)
ρ_3	0.044715	0.453033***	0.58840***	0.72860***
	(0.052613)	(0.09533)	(0.1206541)	(0.07828)
φ_3	3.66E-06	0.22213***	0.297613***	0.362946***
	(5.25E-05)	(0.05849)	(0.061091)	(0.033891)
Panel D: Bull markets associated with bull global factors				
α_4	0.06902	0.808916***	0.89314**	1.80387***
	(0.06358)	(0.245546)	(0.381280)	(0.595392)
ρ_4	0.05238	0.437089***	0.466138***	0.6779***
	(0.046595)	(0.087936)	(0.126606)	(0.09503)
φ_4	2.18E-05	0.212241***	0.230104***	0.340479***
	(0.0002013)	(0.055205)	(0.076234)	(0.043182)
Panel E: Diagnostic test				
P11	0.852201	0.9332446	0.915471	0.946148
P00	0.977029585	0.834538779	0.779275129	0.78689
RealCL	-3802.54753	-5348.03014	-25199.9834	-21994.7576
AICT	7645.095064	10736.06027	50439.96685	44029.5153
BICT	7754.038431	10845.00364	50548.91022	44138.45866

Notes: See the notes of Table 3.1.

Table 3.9. Estimation of the short-term dependence-switching copula model for Morocco

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.04568	0.03182	0.104145	0.10466*
	(0.0597)	(0.0700)	(0.07509)	(0.061886)
ρ_1	0.03506	0.02460	0.077668	0.078034*
	(0.04484)	(0.05326)	(0.053126)	(0.043758)
φ_1	1.28E-07	1.74E-10	0.00064	0.00066
	(2.55E-06)	(8.34E-09)	(0.003087)	(0.00260)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.02602	0.15120	0.13248**	0.014242
	(0.06094)	(0.100538)	(0.06646)	(0.05751)
ρ_2	0.02017	0.110184	0.097434**	0.01111
	(0.04663)	(0.06783)	(0.045698)	(0.044531)
φ_2	1.35E-12	0.005106	0.002671	3.65E-22
	(8.42E-11)	(0.015563)	(0.00701)	(7.17E-20)
Panel C: Bear markets associated with bear global factors				
α_3	0.90857**	0.775500*	2.01254***	3.156822***
	(0.3935)	(0.41612)	(0.61700)	(0.87386)
ρ_3	0.47123***	0.42493***	0.70884***	0.8201***
	(0.12889)	(0.15361)	(0.08492)	(0.05907)
φ_3	0.23316***	0.20454**	0.35431***	0.40143***
	(0.0770)	(0.09810)	(0.03741)	(0.024399)
Panel D: Bull markets associated with bull global factors				
α_4	1.55892**	1.070753*	1.197395***	2.74270***
	(0.6688)	(0.57948)	(0.362231)	(1.054434)
ρ_4	0.6350***	0.520748***	0.554905***	0.78852***
	(0.1281)	(0.164818)	(0.09260)	(0.090573)
φ_4	0.32053***	0.261716***	0.280263***	0.38834***
	(0.0611)	(0.09169)	(0.04908)	(0.037731)
Panel E: Diagnostic test				
P11	0.9961	0.95516	0.971175	0.98489
P00	0.97458	0.763107062	0.845310838	0.88474
RealCL	-3780.6581	-5341.68603	-25181.1958	-21972.9881
AICT	7601.316261	10723.37206	50402.39163	43985.97614
BICT	7710.259629	10832.31543	50511.335	44094.91951

Notes: See the notes of Table 3.1.

Table 3.10. Estimation of the short-term dependence-switching copula model for Oman

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.33145**	0.25829**	0.43288*	0.01903
	(0.13054)	(0.101166)	(0.23722)	(0.056044)
ρ_1	0.22146***	0.178696***	0.275866**	0.014803
	(0.073578)	(0.061316)	(0.121024)	(0.043187)
φ_1	0.061768	0.034159	0.100823	7.57E-17
	(0.050875)	(0.035904)	(0.08847)	(8.13E-15)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.284294**	0.080148	0.43941**	0.030359
	(0.137235)	(0.085728)	(0.171975)	(0.055355)
ρ_2	0.19425**	0.060485	0.27918***	0.023485
	(0.081051)	(0.062128)	(0.087181)	(0.042173)
φ_2	0.04366	8.77E-05	0.103251	6.07E-11
	(0.051387)	(0.000811)	(0.06374)	(2.53E-09)
Panel C: Bear markets associated with bear global factors				
α_3	0.639115**	1.20404***	1.01518	4.376832**
	(0.307937)	(0.444450)	(0.667558)	(1.818087)
ρ_3	0.371292***	0.556599***	0.504561**	0.881079***
	(0.128968)	(0.112996)	(0.199163)	(0.066433)
φ_3	0.16902*	0.281160***	0.252606**	0.426768***
	(0.088326)	(0.059747)	(0.113413)	(0.028074)
Panel D: Bull markets associated with bull global factors				
α_4	0.554878**	2.11302***	0.540062*	8.129749**
	(0.270003)	(0.496752)	(0.2766)	(3.22749)
ρ_4	0.334572**	0.722201***	0.327804**	0.952292***
	(0.122461)	(0.063807)	(0.12728)	(0.030156)
φ_4	0.143368*	0.360168***	0.138538	0.459136***
	(0.087147)	(0.027775)	(0.09109)	(0.015540)
Panel E: Diagnostic test				
P11	0.924043	0.950666016	0.882233	0.976058
P00	0.889190288	0.82092323	0.784011747	0.721683171
RealCL	-3908.1764	-5442.44306	-25307.4905	-22105.1569
AICT	7856.352808	10924.88612	50654.98103	44250.31378
BICT	7965.296175	11033.82949	50763.92439	44359.25714

Notes: See the notes of Table 3.1.

Table 3.11. Estimation of the short-term dependence-switching copula model for Palestine

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.091229	0.068531	-0.00825	0.15978**
	(0.07066)	(0.061268)	(0.0546273)	(0.073887)
ρ_1	0.068472	0.052017	-0.006505	0.115946**
	(0.050641)	(0.044923)	(0.043259)	(0.049426)
φ_1	0.000250	2.02E-05	1.56E+36***	(0.006530
	(0.001475)	(0.000183)	(0.611368)	(0.013100)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.15937**	0.05458	-0.03699	0.103897
	(0.07724)	(0.05943)	(0.0521093)	(0.0709)
ρ_2	0.115677**	0.041722	-0.02960	0.077493
	(0.05169)	(0.044196)	(0.042465)	(0.050213)
φ_2	0.006459	1.53E-06	68398459.46	0.000633
	(0.013614)	(2.11E-05)	(1804670)	(0.00288)
Panel C: Bear markets associated with bear global factors				
α_3	2.30344***	4.20278**	-0.15530***	3.168230***
	(0.742437)	(1.794330)	(7.19E-07)	(0.926949)
ρ_3	0.745162***	0.874457***	-0.13186***	0.820868***
	(0.083989)	(0.071074)	(6.58E-07)	(0.062265)
φ_3	0.370069***	0.423978***	43.37383***	0.401749***
	(0.035893)	(0.029853)	(0.000896)	(0.025715)
Panel D: Bull markets associated with bull global factors				
α_4	1.728867***	2.343176***	-0.02804	2.51298***
	(0.635627)	(0.697277)	(0.160099)	(0.900406)
ρ_4	0.66559***	0.749599***	-0.022335	0.767334***
	(0.107181)	(0.07686)	(0.129311)	(0.089060)
φ_4	0.334849***	0.371962***	27170164	0.379472***
	(0.049357)	(0.032743)	(3.83444E+12)	(0.037502)
Panel E: Diagnostic test				
P11	0.964348	0.9894690	0.9987205	0.966472
P00	0.830345767	0.858636846	0.993278024	0.779379028
RealCL	-3742.45908	-5301.32638	-25161.6455	-21940.5386
AICT	7524.918168	10642.65276	50363.291	43921.07723
BICT	7633.861535	10751.59613	50472.23436	44030.0206

Notes: See the notes of Table 3.1.

Table 3.12. Estimation of the short-term dependence-switching copula model for the Saudi Arabia

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	-0.13566*	0.834299***	2.52377***	-0.02384
	(0.079443)	(0.261045)	(0.68006)	(0.061426)
ρ_1	-0.11405	0.446076***	0.768398***	-0.01895
	(0.071337)	(0.09136)	(0.066812)	(0.049406)
φ_1	82.77198	0.217847***	0.37992***	2.11077E+12***
	(247.6442)	(0.056630)	(0.028116)	(0.595125)
Panel B: Bull stock markets associated with bear global factors				
α_2	-0.0995	0.6843***	2.942856***	-0.00317
	(0.06487)	(0.190222)	(0.83379)	(0.055512)
ρ_2	-0.08220	0.389841***	0.80472***	-0.00249
	(0.056241)	(0.07637)	(0.06364)	(0.043738)
φ_2	527.5541	0.18158***	0.39507***	4.20E+94***
	(2392.861)	(0.051124)	(0.02636)	(0.653786)
Panel C: Bear markets associated with bear global factors				
α_3	-0.13876***	0.696242***	0.2410***	-0.14882
	(0.038915)	(0.19398)	(0.08553)	(0.111116)
ρ_3	-0.11684***	0.39459***	0.16818***	-0.12594
	(0.035049)	(0.077027)	(0.05274)	(0.101055)
φ_3	73.84750	0.184759***	0.028208	52.68852
	(103.4490)	(0.05124)	(0.028772)	(183.2242)
Panel D: Bull markets associated with bull global factors				
α_4	-0.00412	0.609577***	0.31774***	0.03172***
	(0.161420)	(0.18606)	(0.104426)	(4.28E-09)
ρ_4	-0.00324	0.358747***	0.21368***	0.024525***
	(0.127303)	(0.080123)	(0.05965)	(3.26E-09)
φ_4	4.37E+72***	0.160374***	0.05644	1.62E-10***
	(1.88260)	(0.055663)	(0.04046)	(4.78E-16)
Panel E: Diagnostic test				
P11	0.997869	0.796666	0.70525	0.998485
P00	0.996254634	0.80445541	0.928888519	0.992997
RealCL	-4214.02609	-5724.40256	-25582.3879	-22416.568
AICT	8468.052182	11488.80511	51204.77578	44873.13606
BICT	8576.995549	11597.74848	51313.71915	44982.07942

Notes: See the notes of Table 3.1.

Figs. A1 plots the smoothing probability of the positive correlation regime between the MENA stock markets and the global factors in the short- and long run. Fig. A2 illustrates the

smoothing short- and long-term correlations between the stock markets and the global factors. These figures reflect a positive correlation regime over the sample period. The graphical evidence exhibits a time-varying correlation and that the dependence structure is sensitive to the switching regime and term horizons. The correlations experience negative and positive phases for both the short- and long-term horizons. In addition, the relationship between the considered series switches between the positive and negative correlation regimes. The portfolio rebalancing effect is usually dominating.

To sum up, the graphical evidence is in line with the results of the dependence-switching copulas between the MENA stock markets and the global factors and supports the appropriateness of adopting the dependence-switching copula model to examine the average and tail dependence structure between those stock markets and oil, gold, Bitcoin and VIX index.

6. Conclusions

Financial liberalization has considerably increased the financial integration of global stock markets. This integration has in turn sharply increased financial contagion among stock markets and made those markets more vulnerable to local and international global factors. Monitoring thus the dependence structure between stock markets and both oil and global factors is of primary interest for each market participant. The purpose of this paper is to investigate the dependence structure between major MENA stock markets (Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Tunisia, and UAE) and oil as weel as three influential global factors (bitcoin, VIX and gold) under different regimes and time horizons. To do this, we apply the copula-switching model along with wavelet approach for daily data ranging between 2004 and 2017. The choice of these factors (except BTC) is attributed to their strong relationship to the MENA economies. This hybrid method has a crucial advantage by considering all market scenarios and the market heterogeneity hypothesis.

Our results show evidence of a tail dependence between the majority of the MENA stock markets and both oil and global factors. The dependence structure depends on the correlations regimes and the time horizons. The left tail dependence (both markets are crashing) estimates are high than the right tail dependence (both markets are booming), regardless of the time horizons. More precisely, during bear stock markets, gold, Bitcoin and VIX serve as hedge assets, particularly on the long time investment horizons.

These results have strong implications for traders and policy makers. In fact, investors can include gold and Bitcoin to hedge their positions against the extreme downward stock markets and invest in these assets to benefit from portfolio diversification. For the positive correlation regime, investors may realize large losses if they hold long positions in the MENA stock markets, but gain huge profits if they hold short positions in BTC, oil, gold and the VIX products in the case of the bear-bull pair. As for the bull-bear case, investors may take long

positions in equity shares and long positions on the oil and other global factors, regardless of the time horizons.

As for the negative regime, investors can include oil, gold, BTC and VIX in their equity portfolios during the downside market status. Policy makers should keep an eye on the different regimes to maintain healthy stock markets in their countries and regulate their volatility and increase their efficiency and functioning. Policy makers should also pay attention to the time horizons since the dependence structure is not only switching under different market conditions but also over the short and long time investment horizons. By establishing the appropriate policies, an optimal asset allocation and risk management can be achieved in the MENA countries.

References

Baur, D.G., Lucey, B.M., 2010. Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold. Financial Review 45, 217–229.

Baur, D.G., McDermott, T.K., 2010. Is gold a safe haven? International evidence. Journal of Banking and Finance 34, 1886–1898.

Bouri, E., Molnár, P., Azzi, G., Roubaud, D., Hagfors, L., 2017. On the hedge and safe haven properties of Bitcoin: Is it really more than a diversifier? Finance Research Letters 20, 192–198.

Chau, F., Deesomsak, R., Wang, J., 2014. Political uncertainty and stock market volatility in the Middle East and North African (MENA) countries. Journal of International Financial Markets, Institutions & Money 28, 1– 19.

Chiang, T.C., Li, J., Yang, S.Y., 2015. Dynamic stock-bond return correlations and financial market uncertainty Review of Quantitative Finance and Accounting, 45, 59– 88

Connolly, C.T. Stivers, L. Sun, L., 2005. Stock market uncertainty and the stock-bond return relation

The Journal of Financial and Quantitative Analysis, 40 161– 194

Das, S.R., Uppal, R., 2004. Systemic risk and international portfolio choice. Journal of Finance 59, 2809–2834.

Dickey, D., Fuller, W., 1979. Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association 74, 427–431.

Dimic, N., Kiviaho, J., Piljak, V., Äijö, J., 2016. Impact of financial market uncertainty and macroeconomic factors on stock–bond correlation in emerging markets. Research in International Business and Finance 36, 41–51.

Junttila, J., Pesonen, J., Raatikainen, J., 2018. Commodity market based hedging against stock market risk in times of financial crisis: The case of crude oil and gold. J. Int. Financ. Markets Inst. Money 56, 255–280.

Kwiatkowski, D., Phillips, P.C. B., Schmidt, P., Shim, Y., 1992. Testing the null hypothesis of stationarity against the alternative of a unit root: how sure are we that economic time series are non-stationary? Journal of Econometrics 54, 159–178.

Lin, F., Yang, S., Marsh, T., Chen, Y., 2018. Stock and bond return relations and stock market uncertainty: Evidence from wavelet analysis. International Review of Economics and Finance 55, 285–294.

Mensi, W. Hammoudeh, S., Reboredo, J.C., Nguyen, D.K., 2014. Do global factors impact BRICS stock markets? A quantile regression approach. Emerging Markets Review 19, 1–17.

Mensi, W., Hammoudeh, S., Reboredo, J.C., Nguyen, D.K., 2015. Are Sharia stocks, gold and U.S. Treasury hedges and/or safe havens for the oil-based GCC markets? Emerging Markets Review 24, 101–121.

Mensi, W., Hammoudeh, S., Shahzad, S.J.H., Shahbaz, M., 2017a. Modeling systemic risk and dependence structure between oil and stock markets using a variational mode decomposition-based copula method. Journal of Banking & Finance 75, 258–279.

Mensi, W., Hkiri, B., Yahyaee, K., Kang, S.H., 2017b. Analyzing time–frequency co-movements across gold and oil prices with BRICS stock markets: A VaR based on wavelet approach. International Review of Economics and Finance, 74–102.

Neaime, S., 2012. The global financial crisis, financial linkages and correlations in returns and volatilities in emerging MENA stock markets. Emerging Markets Review, 13, 268-282.

Neaime, S., 2016. Financial crises and contagion vulnerability of MENA stock markets. Emerging Markets Review 27, 14–35.

Ning, C., 2010. Dependence structure between the equity market and the foreign exchange market – a copula approach. Journal of International Money and Finance 29, 743–759.

Okimoto, T., 2008. New evidence of asymmetric dependence structures in international equity markets. Journal of Financial and Quantitative Analysis 43, 787–816.

Percival, D. and Walden, A. 2000. Wavelet Methods for Time Series Analysis, Cambridge University Press, Cambridge, UK.

Philips, P.C.B., Perron, P., 1988. Testing for unit roots in time series regression. Biometrika 75, 335–346.

Patton, A., 2006. Modelling asymmetric exchange rate dependence. International Economic Review 47, 527–556.

Poon, S.-H., Rockinger, M., Tawn, J., 2004. Extreme value dependence in financial markets: diagnostics, models, and financial implications. Review of Financial Studies 17, 581–610.

Appendix

Table A.1. Estimation of the long-term dependence-switching copula model for UAE

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.4268***	2.2042***	-0.2417***	0.6474***
	(0.0705)	(0.1383)	(0.0293)	(0.0901)
ρ_1	0.2728***	0.7336***	-0.2142***	0.3747***
	(0.0362)	(0.0167)	(0.0291)	(0.0374)
φ_1	0.0986***	0.3651***	8.8022***	0.1714***
	(0.0264)	(0.0072)	(3.0655)	(0.0255)
Panel B: Bull stock markets associated with bear global factors				
α_2	2.6891***	1.6603***	-0.1995*	1.3511***
	(0.2108)	(0.1392)	(0.1190)	(0.2042)
ρ_2	0.7838***	0.6537***	-0.1731	0.5918***
	(0.0187)	(0.0247)	(0.1136)	(0.0460)
φ_2	0.3864***	0.3294***	16.1520	0.2993***
	(0.0078)	(0.0115)	(33.4844)	(0.0232)
Panel C: Bear markets associated with bear global factors				
α_3	6.0610***	6.3580***	3.1924***	2.9793***
	(0.4943)	(0.8649)	(0.2130)	(0.4977)
ρ_3	0.9250***	0.9302***	0.8225***	0.8075***
	(0.0091)	(0.0143)	(0.0141)	(0.0372)
φ_3	0.4460***	0.4484***	0.4024***	0.3962***
	(0.0042)	(0.0066)	(0.0058)	(0.0154)
Panel D: Bull markets associated with bull global factors				
α_4	6.7103***	8.3556***	2.2833***	-0.0935
	(0.6450)	(1.5293)	(0.2137)	(0.0865)
ρ_4	0.9357***	0.9543***	0.7429***	-0.0770
	(0.0094)	(0.0134)	(0.0245)	(0.0745)
φ_4	0.4509***	0.4602***	0.3691***	828.0948
	(0.0045)	(0.0070)	(0.0105)	(5674.8129)
Panel E: Diagnostic test				
P11	0.9915	0.9930	0.9983	0.9916
P00	0.9864	0.9615	0.9953	0.9861
RealCL	-2533.8265	-2433.7725	-2572.4356	-3218.8982
AICT	5107.6531	4907.5451	5184.8712	6477.7964
BICT	5216.5964	5016.4884	5293.8146	6586.7397

Notes: See the notes of Table 3.1.

Table A.2. Estimation of the long-term dependence-switching copula model for Bahrain

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	3.0902***	2.0725***	-0.3736***	0.5589***
	(0.3345)	(0.2166)	(0.0048)	(0.0771)
ρ_1	0.8155***	0.7169***	-0.3530***	0.3364***
	(0.0235)	(0.0286)	(0.0053)	(0.0348)
φ_1	0.3995***	0.3579***	3.1976***	0.1447***
	(0.0097)	(0.0125)	(0.0757)	(0.0248)
Panel B: Bull stock markets associated with bear global factors				
α_2	2.6216***	2.7747***	0.0626	0.3811***
	(0.4523)	(0.2171)	(0.0780)	(0.1214)
ρ_2	0.7777***	0.7912***	0.0476	0.2488***
	(0.0418)	(0.0183)	(0.0575)	(0.0651)
φ_2	0.3838***	0.3895***	0.0000	0.0811*
	(0.0175)	(0.0076)	(0.0001)	(0.0470)
Panel C: Bear markets associated with bear global factors				
α_3	1.9494***	0.2859***	10.5860***	4.3198***
	(0.1760)	(0.1044)	(1.1071)	(0.3540)
ρ_3	0.6999***	0.1952***	0.9690***	0.8790***
	(0.0253)	(0.0615)	(0.0054)	(0.0133)
φ_3	0.3504***	0.0443	0.4683***	0.4259***
	(0.0112)	(0.0392)	(0.0032)	(0.0056)
Panel D: Bull markets associated with bull global factors				
α_4	6.8471***	-0.2588***	9.3648***	4.0283***
	(0.5952)	(0.0091)	(0.7800)	(0.2566)
ρ_4	0.9376***	-0.2313***	0.9620***	0.8673***
	(0.0083)	(0.0092)	(0.0052)	(0.0110)
φ_4	0.4519***	7.2829***	0.4643***	0.4210***
	(0.0040)	(0.6846)	(0.0029)	(0.0046)
Panel E: Diagnostic test				
P11	0.9877	0.9982	0.9885	0.9889
P00	0.9939	0.9943	0.9812	0.9893
RealCL	-2396.3775	-2764.9929	-2529.6258	-2960.3811
AICT	4832.7551	5569.9858	5099.2515	5960.7623
BICT	4941.6984	5678.9291	5208.1949	6069.7056

Notes: See the notes of Table 3.1.

Table A.3. Estimation of the long-term dependence-switching copula model for Lebanon

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	10.6820***	9.1244***	-0.2696***	4.5617***
	(0.8445)	(0.9187)	(0.0061)	(0.4098)
ρ_1	0.9695***	0.9604***	-0.2423***	0.8876***
	(0.0040)	(0.0065)	(0.0062)	(0.0138)
φ_1	0.4686***	0.4634***	6.5411***	0.4295***
	(0.0024)	(0.0035)	(0.3822)	(0.0059)
Panel B: Bull stock markets associated with bear global factors				
α_2	6.0607***	11.9763***	2.0713***	3.1450***
	(0.7465)	(1.2170)	(0.3474)	(0.3202)
ρ_2	0.9250***	0.9748***	0.7168***	0.8193***
	(0.0137)	(0.0044)	(0.0459)	(0.0218)
φ_2	0.4460***	0.4719***	0.3578***	0.4011***
	(0.0063)	(0.0028)	(0.0201)	(0.0090)
Panel C: Bear markets associated with bear global factors				
α_3	0.8443***	-0.1913***	3.7967***	1.3841***
	(0.1109)	(0.0320)	(0.5657)	(0.2473)
ρ_3	0.4496***	-0.1654***	0.8567***	0.5992***
	(0.0385)	(0.0303)	(0.0273)	(0.0543)
φ_3	0.2200***	18.7141*	0.4166***	0.3030***
	(0.0237)	(11.3194)	(0.0113)	(0.0271)
Panel D: Bull markets associated with bull global factors				
α_4	0.5890***	-0.1154***	3.3540***	3.9035***
	(0.1194)	(0.0360)	(0.2358)	(0.4846)
ρ_4	0.3498***	-0.0960***	0.8327***	0.8617***
	(0.0524)	(0.0317)	(0.0143)	(0.0222)
φ_4	0.1541***	202.8890	0.4066***	0.4187***
	(0.0368)	(380.0200)	(0.0059)	(0.0092)
Panel E: Diagnostic test				
P11	0.9790	0.9762	0.9926	0.9909
P00	0.9906	0.9897	0.9927	0.9870
RealCL	-2609.2377	-2634.9049	-2734.1220	-2789.8476
AICT	5258.4755	5309.8098	5508.2440	5619.6952
BICT	5367.4189	5418.7531	5617.1874	5728.6386

Notes: See the notes of Table 3.1.

Table A.4. Estimation of the long-term dependence-switching copula model for Egypt

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	1.5082***	7.2048***	1.3766***	-0.1893***
	(0.1134)	(0.7047)	(0.1801)	(0.0380)
ρ_1	0.6251***	0.9423***	0.5975***	-0.1635***
	(0.0226)	(0.0087)	(0.0398)	(0.0360)
φ_1	0.3158***	0.4541***	0.3022***	19.4515
	(0.0109)	(0.0043)	(0.0199)	(14.3117)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.7399***	7.1560***	1.6900***	1.7906***
	(0.1472)	(0.8471)	(0.3537)	(0.1957)
ρ_2	0.4116***	0.9417***	0.6590***	0.6758***
	(0.0562)	(0.0107)	(0.0614)	(0.0315)
φ_2	0.1959***	0.4538***	0.3318***	0.3395***
	(0.0365)	(0.0052)	(0.0285)	(0.0144)
Panel C: Bear markets associated with bear global factors				
α_3	5.6731***	0.0861	2.3511***	6.2950***
	(0.5087)	(0.0666)	(0.3044)	(0.6947)
ρ_3	0.9173***	0.0648	0.7505***	0.9291***
	(0.0108)	(0.0480)	(0.0334)	(0.0117)
φ_3	0.4425***	0.0002	0.3723***	0.4479***
	(0.0048)	(0.0010)	(0.0142)	(0.0054)
Panel D: Bull markets associated with bull global factors				
α_4	5.3278***	0.1639***	4.1743***	5.6819***
	(0.4391)	(0.0602)	(0.3142)	(0.4069)
ρ_4	0.9095***	0.1187***	0.8733***	0.9175***
	(0.0107)	(0.0401)	(0.0126)	(0.0086)
φ_4	0.4390***	0.0073	0.4235***	0.4426***
	(0.0047)	(0.0113)	(0.0053)	(0.0039)
Panel E: Diagnostic test				
P11	0.9909	0.9782	0.9901	0.9887
P00	0.9859	0.9919	0.9907	0.9904
RealCL	-2498.4241	-2803.6147	-2673.2491	-2808.5804
AICT	5036.8481	5647.2294	5386.4981	5657.1607
BICT	5145.7915	5756.1728	5495.4415	5766.1041

Notes: See the notes of Table 3.1.

Table A.5. Estimation of the long-term dependence-switching copula model for Tunisia

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.1674***	7.5169***	2.5357***	1.9110***
	(0.0589)	(0.7376)	(0.2408)	(0.2345)
ρ_1	0.1210***	0.9460***	0.7696***	0.6944***
	(0.0391)	(0.0083)	(0.0235)	(0.0347)
φ_1	0.0079	0.4560***	0.3804***	0.3479***
	(0.0116)	(0.0041)	(0.0099)	(0.0155)
Panel B: Bull stock markets associate with bear global factors				
α_2	0.3849***	11.0110***	0.8300***	2.3916***
	(0.0596)	(1.0278)	(0.1243)	(0.3081)
ρ_2	0.2508***	0.9710***	0.4446***	0.7549***
	(0.0319)	(0.0046)	(0.0437)	(0.0329)
φ_2	0.0826***	0.4695***	0.2169***	0.3742***
	(0.0230)	(0.0028)	(0.0271)	(0.0140)
Panel C: Bear markets associated with bear global factors				
α_3	5.8034***	0.6538***	5.0396***	1.6295***
	(0.7311)	(0.0915)	(0.4177)	(0.1847)
ρ_3	0.9200***	0.3774***	0.9021***	0.6482***
	(0.0148)	(0.0378)	(0.0114)	(0.0335)
φ_3	0.4437***	0.1732***	0.4357***	0.3268***
	(0.0067)	(0.0257)	(0.0050)	(0.0158)
Panel D: Bull markets associated with bull global factors				
α_4	5.6785***	0.8538***	3.6968***	2.0353***
	(1.0138)	(0.1332)	(0.2971)	(0.1794)
ρ_4	0.9175***	0.4528***	0.8518***	0.7120***
	(0.0215)	(0.0458)	(0.0151)	(0.0243)
φ_4	0.4425***	0.2220***	0.4145***	0.3557***
	(0.0096)	(0.0281)	(0.0062)	(0.0107)
Panel E: Diagnostic test				
P11	0.9908	0.9831	0.9874	0.9878
P00	0.9684	0.9912	0.9895	0.9933
RealCL	-2909.1554	-2580.3767	-2539.0746	-2818.5032
AICT	5858.3109	5200.7533	5118.1491	5677.0063
BICT	5967.2542	5309.6967	5227.0925	5785.9497

Notes: See the notes of Table 3.1.

Table A.6. Estimation of the long-term dependence-switching copula model for Qatar

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	6.543172***	2.491086***	-0.29855***	5.88845***
	(0.72740)	(0.15306)	(0.003806)	(0.42041)
ρ_1	0.933145***	0.765153***	-0.27215***	0.921740***
	(0.011255)	(0.015350)	(0.00397)	(0.008231)
φ_1	0.449741***	0.378553***	5.0963***	0.444475***
	(0.005296)	(0.006472)	(0.150867)	(0.003735)
Panel B: Bull stock markets associated with bear global factors				
α_2	3.50225***	4.66646***	0.563494***	1.974967***
	(0.356744)	(0.298952)	(8.85E-07)	(0.26100)
ρ_2	0.841380***	0.891000***	0.338464***	0.703600***
	(0.02000)	(0.009594)	(3.98E-07)	(0.036876)
φ_2	0.410220***	0.43098***	0.146133***	0.352003***
	(0.008269)	(0.004101)	(2.82E-07)	(0.016326)
Panel C: Bear markets associated with bear global factors				
α_3	-0.27677***	11.49676***	1.927989***	0.88406***
	(0.00537)	(1.28807)	(0.123857)	(0.12763)
ρ_3	-0.24962***	0.973031***	0.69685***	0.463112***
	(0.005504)	(0.005124)	(0.01808)	(0.042725)
φ_3	6.117774***	0.470745***	0.349006***	0.22827***
	(0.297431)	(0.00317)	(0.00806)	(0.025839)
Panel D: Bull markets associated with bull global factors				
α_4	0.285172**	9.567404***	2.89578***	1.623284***
	(0.116331)	(1.173376)	(0.171598)	(0.147692)
ρ_4	0.194770***	0.963345***	0.801083***	0.647073***
	(0.068645)	(0.007390)	(0.013462)	(0.0269)
φ_4	0.043990	0.465056***	0.393564***	0.326230***
	(0.043618)	(0.004132)	(0.005582)	(0.012674)
Panel E: Diagnostic test				
P11	0.969216	0.993573	0.998203	0.988646
P00	0.980160	0.974693	0.994976	0.991029
RealCL	-2843.82792	-2012.69154	-2654.94375	-2936.48017
AICT	5727.655841	4065.383078	5349.887508	5912.960335
BICT	5836.599208	4174.326445	5458.830875	6021.903702

Notes: See the notes of Table 3.1.

Table A.7. Estimation of the long-term dependence-switching copula model for the Jordan

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	9.054101***	9.946610***	6.80194***	2.356330***
	(0.59746)	(1.01679)	(0.841583)	(0.236591)
ρ_1	0.95988***	0.965622***	0.936977***	0.751043***
	(0.004307)	(0.005818)	(0.011923)	(0.025859)
φ_1	0.463150***	0.466342***	0.451557***	0.37257***
	(0.002339)	(0.003322)	(0.005693)	(0.011004)
Panel B: Bull stock markets associated with bear global factors				
α_2	4.208030***	7.777821***	6.314503***	0.824464***
	(0.843286)	(0.879045)	(0.641973)	(0.101697)
ρ_2	0.874664***	0.948826***	0.929461***	0.442618***
	(0.033320)	(0.009121)	(0.01076)	(0.03591)
φ_2	0.424065***	0.457368***	0.448019***	0.215698***
	(0.013998)	(0.004606)	(0.00499)	(0.022368)
Panel C: Bear markets associated with bear global factors				
α_3	0.977359***	0.072141	0.663586***	3.959883***
	(0.197853)	(0.057197)	(0.080506)	(0.433338)
ρ_3	0.49308***	0.054659	0.381424***	0.864257***
	(0.061001)	(0.041786)	(0.03295)	(0.019280)
φ_3	0.246017***	3.36E-05	0.175925***	0.419710***
	(0.035320)	(0.000255)	(0.022294)	(0.008039)
Panel D: Bull markets associated with bull global factors				
α_4	-0.31196***	0.171910***	0.993810***	5.14709***
	(0.002819)	(0.05305)	(0.102618)	(0.41283)
ρ_4	-0.28624***	0.124011***	0.498123***	0.90493***
	(0.002978)	(0.03506)	(0.031188)	(0.010804)
φ_4	4.612221***	0.0088691	0.248923***	0.437003***
	(0.092612)	(0.011036)	(0.017927)	(0.00472)
Panel E: Diagnostic test				
P11	0.979950	0.979683	0.967103	0.989296
P00	0.983417732	0.991548238	0.990903235	0.986324874
RealCL	-2653.24158	-2672.26799	-2804.87761	-2858.37088
AICT	5346.483156	5384.535988	5649.755227	5756.741765
BICT	5455.426524	5493.479356	5758.698594	5865.685133

Notes: See the notes of Table 3.1.

Table A.8. Estimation of the long-term dependence-switching copula model for Kuwait

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.738089***	0.652304***	5.877622***	-0.24100***
	(0.02265)	(0.108691)	(0.61233)	(0.000203)
ρ_1	0.410889***	0.376781***	0.921527***	-0.21355***
	(0.008656)	(0.044962)	(0.012037)	(0.000201)
φ_1	0.195487***	0.172775***	0.444379***	8.872440***
	(0.005636)	(0.030591)	(0.005459)	(0.021526)
Panel B: Bull stock markets associated with bear global factors				
α_2	-0.27266***	0.403517***	7.34791***	0.212724***
	(0.003185)	(0.08542)	(0.875358)	(0.056546)
ρ_2	-0.24542***	0.260669***	0.944056***	0.15043***
	(0.003251)	(0.044850)	(0.010378)	(0.035869)
φ_2	6.353352***	0.089733***	0.454990***	0.019224
	(0.188675)	(0.032632)	(0.005113)	(0.016651)
Panel C: Bear markets associated with bear global factors				
α_3	3.537110***	3.76626***	0.285363***	6.230602***
	(0.202938)	(0.614643)	(0.072008)	(0.358495)
ρ_3	0.843317***	0.855219***	0.194883***	0.928034***
	(0.01117)	(0.030098)	(0.042483)	(0.00619)
φ_3	0.411020***	0.415950***	0.044062	0.447358***
	(0.004621)	(0.012493)	(0.027007)	(0.002863)
Panel D: Bull markets associated with bull global factors				
α_4	2.411504***	4.222504***	0.244564***	4.898771***
	(0.473849)	(0.38217)	(0.053114)	(0.285557)
ρ_4	0.756967***	0.875234***	0.170317***	0.898092***
	(0.049983)	(0.014998)	(0.03263)	(0.00829)
φ_4	0.37509***	0.424305***	0.029382	0.434030***
	(0.021185)	(0.006304)	(0.018085)	(0.003579)
Panel E: Diagnostic test				
P11	0.998228	0.990802	0.973494	0.996121
P00	0.995219131	0.979974623	0.99067	0.99390
RealCL	-2404.83641	-2879.54208	-2836.76508	-2793.64324
AICT	4849.67282	5799.084166	5713.530156	5627.286478
BICT	4958.616187	5908.027533	5822.473523	5736.229846

Notes: See the notes of Table 3.1.

Table A.9. Estimation of the long-term dependence-switching copula model for the Morocco

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.901204***	5.486593***	1.083517***	11.3373***
	(0.120050)	(0.624028)	(0.26335)	(0.930184)
ρ_1	0.46880***	0.913240***	0.524359***	0.972386***
	(0.039579)	(0.014250)	(0.074092)	(0.00383)
φ_1	0.231706***	0.44065***	0.263720***	0.470346***
	(0.023740)	(0.006331)	(0.04100)	(0.002359)
Panel B: Bull stock markets associated with bear global factors				
α_2	2.709096***	8.973502***	0.82078***	7.59629***
	(0.371204)	(0.660182)	(0.140453)	(0.679338)
ρ_2	0.785598***	0.959298***	0.441318***	0.94688***
	(0.032538)	(0.00486)	(0.04976)	(0.007452)
φ_2	0.387125***	0.462832***	0.214888***	0.456395***
	(0.013571)	(0.002630)	(0.031053)	(0.0037)
Panel C: Bear markets associated with bear global factors				
α_3	1.755290***	1.02506***	10.12435***	1.45721***
	(0.219023)	(0.10313)	(0.94029)	(0.150859)
ρ_3	0.670007***	0.507495***	0.966617***	0.614766***
	(0.036221)	(0.030509)	(0.00514)	(0.031274)
φ_3	0.336877***	0.254273***	0.466913***	0.310735***
	(0.016599)	(0.017299)	(0.002968)	(0.015301)
Panel D: Bull markets associated with bull global factors				
α_4	2.04587***	1.273158***	7.341548***	2.430410***
	(0.262073)	(0.192167)	(0.59479)	(0.254399)
ρ_4	0.713375***	0.573679***	0.943981***	0.758949***
	(0.035247)	(0.046155)	(0.007066)	(0.026512)
φ_4	0.356311***	0.290085***	0.454952***	0.375932***
	(0.01546)	(0.023837)	(0.00348)	(0.011222)
Panel E: Diagnostic test				
P11	0.991782	0.987563	0.988753	0.989267
P00	0.991975352	0.989553	0.98767	0.993719
RealCL	-2812.88931	-2408.58441	-2412.02493	-2566.66582
AICT	5665.778612	4857.168817	4864.049868	5173.331646
BICT	5774.721979	4966.112184	4972.993235	5282.275014

Notes: See the notes of Table 3.1.

Table A.10. Estimation of the long-term dependence-switching copula model for Oman

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	0.36857***	5.24085***	-0.5153***	4.6914***
	(0.10579)	(0.59212)	(2.75E-05)	(0.40800)
ρ_1	0.242003***	0.90734***	-0.51861***	0.89179***
	(0.057481)	(0.01491)	(3.35E-05)	(0.012952)
φ_1	0.076246*	0.43805***	1.91916***	0.43132***
	(0.041158)	(0.00654)	(0.00014)	(0.00554)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.75366***	4.26396***	-0.48288***	4.531507***
	(0.07960)	(0.34406)	(0.000163)	(0.35001)
ρ_2	0.416796***	0.87684***	-0.47939***	0.88653***
	(0.02997)	(0.01324)	(0.000195)	(0.011925)
φ_2	0.199318***	0.424982***	2.10074***	0.429081***
	(0.019362)	(0.00557)	(0.00102)	(0.005069)
Panel C: Bear markets associated with bear global factors				
α_3	3.785085***	-0.3600***	8.82388***	0.98710***
	(0.314500)	(0.00027)	(0.715972)	(0.17993)
ρ_3	0.856136***	-0.3380***	0.958173***	0.49608***
	(0.015255)	(0.00029)	(0.00549)	(0.055008)
φ_3	0.416331***	3.4287***	0.462226***	0.247747***
	(0.006334)	(0.00496)	(0.00294)	(0.031712)
Panel D: Bull markets associated with bull global factors				
α_4	5.480460***	0.14708***	7.73259***	0.73468***
	(0.435929)	(2.27E-05)	(0.74694)	(0.10026)
ρ_4	0.913099***	0.1073***	0.94835***	0.40958***
	(0.009979)	(1.54E-05)	(0.00785)	(0.03842)
φ_4	0.440597***	0.00449***	0.45713***	0.19463***
	(0.004432)	(3.26E-06)	(0.003958)	(0.02506)
Panel E: Diagnostic test				
P11	0.989698	0.99823	0.988458489	0.98696
P00	0.988802246	0.993722	0.990698345	0.990628
RealCL	-2645.43081	-2301.83966	-1941.76058	-2914.4568
AICT	5330.861627	4643.67932	3923.521159	5868.9136
BICT	5439.804994	4752.622687	4032.464527	5977.8569

Notes: See the notes of Table 3.1.

Table A.11. Estimation of the long-term dependence-switching copula model for the Palestine

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	1.78783***	3.97925***	6.60127***	0.852967***
	(0.26377)	(0.31508)	(0.63753)	(0.104197)
ρ_1	0.67532***	0.86511***	0.934035***	0.452555***
	(0.04259)	(0.013887)	(0.009669)	(0.035863)
φ_1	0.33930***	0.42006***	0.450161***	0.221845***
	(0.01940)	(0.00579)	(0.004565)	(0.022023)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.55598***	3.814758***	5.372036***	0.622912***
	(0.113795)	(0.41733)	(0.486035)	(0.06531)
ρ_2	0.33507***	0.85756***	0.91056***	0.364454***
	(0.05155)	(0.019945)	(0.011614)	(0.027773)
φ_2	0.14372***	0.41692***	0.439474***	0.164327***
	(0.036673)	(0.008287)	(0.00513)	(0.019172)
Panel C: Bear markets associated with bear global factors				
α_3	2.596072***	2.09280***	-0.03346	7.97219***
	(0.334356)	(0.21784)	(0.048534)	(0.73351)
ρ_3	0.77534***	0.71958***	-0.02672	0.95078***
	(0.03140)	(0.02837)	(0.0394124)	(0.007180)
φ_3	0.38283***	0.35903***	496524773.5	0.458363***
	(0.013164)	(0.012378)	(1492052)	(0.003666)
Panel D: Bull markets associated with bull global factors				
α_4	4.716622***	1.000476***	-0.005336	7.147382***
	(0.310027)	(0.111891)	(0.067341)	(0.629285)
ρ_4	0.892592***	0.500144***	-0.004202	0.941601***
	(0.009734)	(0.03381)	(0.053173)	(0.007956)
φ_4	0.431664***	0.2500826***	1.30E+56***	0.453787***
	(0.004169)	(0.01938)	(0.775832)	(0.003874)
Panel E: Diagnostic test				
P11	0.988164	0.986465	0.978059983	0.992788
P00	0.990181004	0.991560535	0.988000955	0.982205
RealCL	-2648.59299	-2693.00061	-2742.12979	-2889.559
AICT	5337.185973	5426.001219	5524.259572	5819.1181
BICT	5446.129341	5534.944586	5633.202939	5928.0615

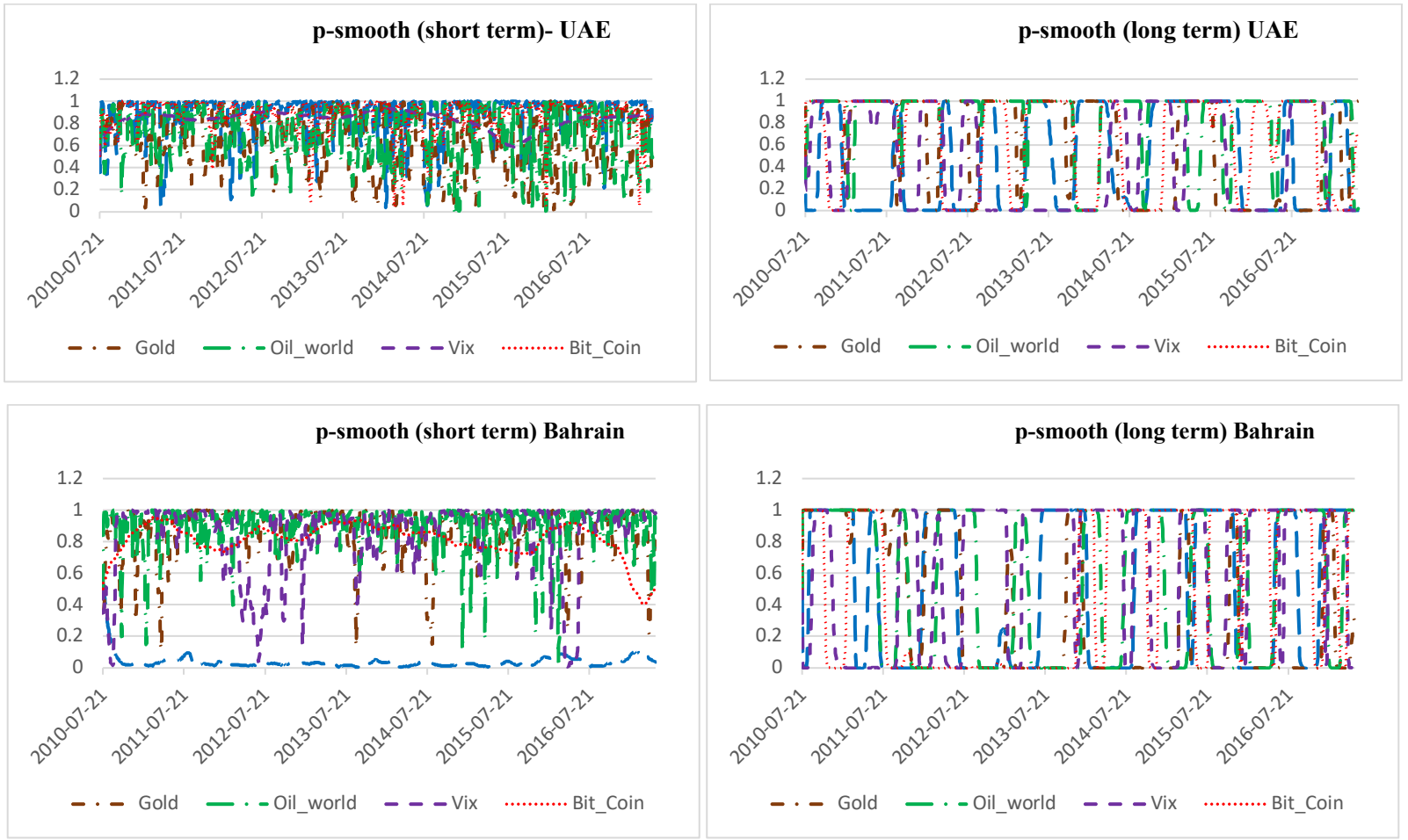
Notes: See the notes of Table 3.1.

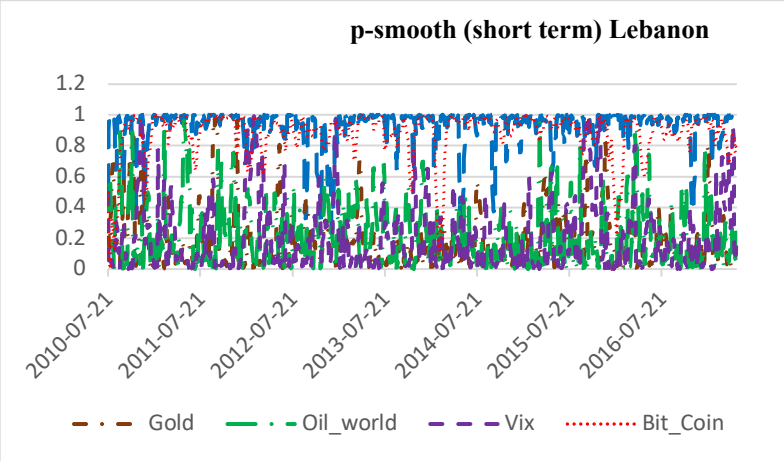
Table A.12. Estimation of the long-term dependence-switching copula model for the Saudi Arabia

	Gold	Oil	VIX	Bitcoin
Panel A: Bear stock markets associated with bull global factors				
α_1	-0.03186	13.20016***	0.9268***	-0.1001**
	(0.05577)	(0.99547)	(0.2537)	(0.04982)
ρ_1	-0.0254	0.97872***	0.47717***	-0.0826
	(0.04522)	(0.00278)	(0.08176)	(0.04321)
φ_1	140903	0.47442***	0.23669***	508.506
	(536827)	(0.001879)	(0.04845)	(1752.748)
Panel B: Bull stock markets associated with bear global factors				
α_2	0.60905***	17.4886***	3.08902***	-0.24736***
	(0.110138)	(1.30152)	(0.44807)	(0.02987)
ρ_2	0.35852***	0.98703***	0.81542***	-0.21988***
	(0.047451)	(0.00173)	(0.03146)	(0.02981)
φ_2	0.160217***	0.48057***	0.3995***	8.23995***
	(0.03297)	(0.001417)	(0.0130)	(2.78839)
Panel C: Bear markets associated with bear global factors				
α_3	8.36089***	-0.3264***	4.78636***	5.15525***
	(0.58328)	(0.00419)	(0.25133)	(0.42750)
ρ_3	0.95438***	-0.30156***	0.894749***	0.905151***
	(0.00509)	(0.00448)	(0.007656)	(0.011151)
φ_3	0.460220***	4.18121***	0.43259***	0.437096***
	(0.00266)	(0.11399)	(0.003289)	(0.00487)
Panel D: Bull markets associated with bull global factors				
α_4	4.742303***	-0.4401	9.73651***	7.86850***
	(0.30859)	(0.00071)	(0.56708)	(0.836223)
ρ_4	0.89339***	-0.42881***	0.964387***	0.949754***
	(0.00958)	(0.000823)	(0.00342)	(0.008443)
φ_4	0.43201***	2.41525***	0.465642***	0.457838***
	(0.004109)	(0.006098)	(0.00193)	(0.004286)
Panel E: Diagnostic test				
P11	0.991762	0.99296	0.988014	0.990022
P00	0.992362	0.9865064	0.99383744	0.975552
RealCL	-2496.98927	-1748.20523	-2165.16704	-3045.29
AICT	5033.978532	3536.410451	4370.334071	6130.58620
BICT	5142.921899	3645.353818	4479.277438	6239.529576

Notes: See the notes of Table 3.1.

Figure A1. Smoothing probability of the positive correlation regime between the stock and global factors in the short- and long term

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0.2
0
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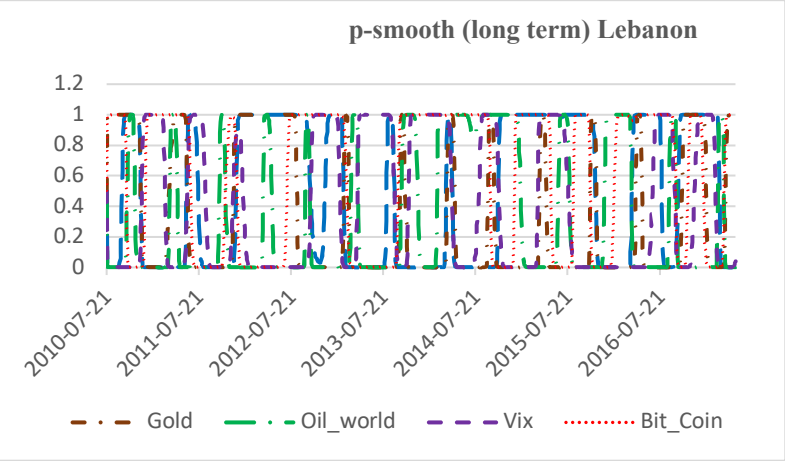
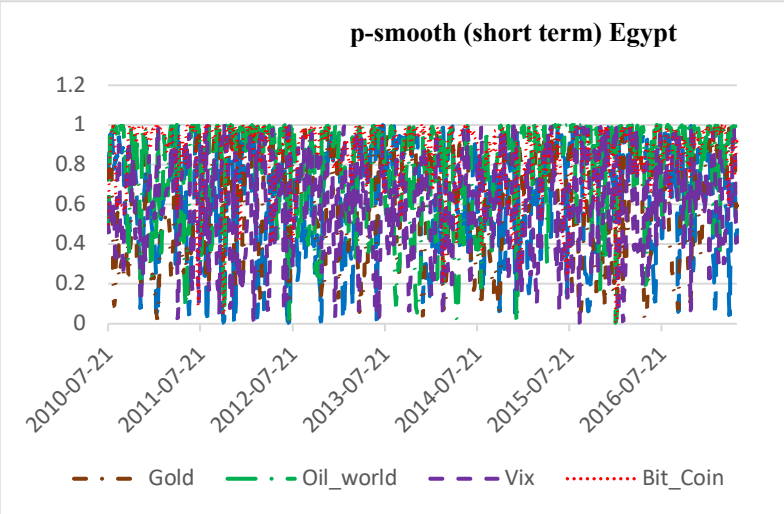
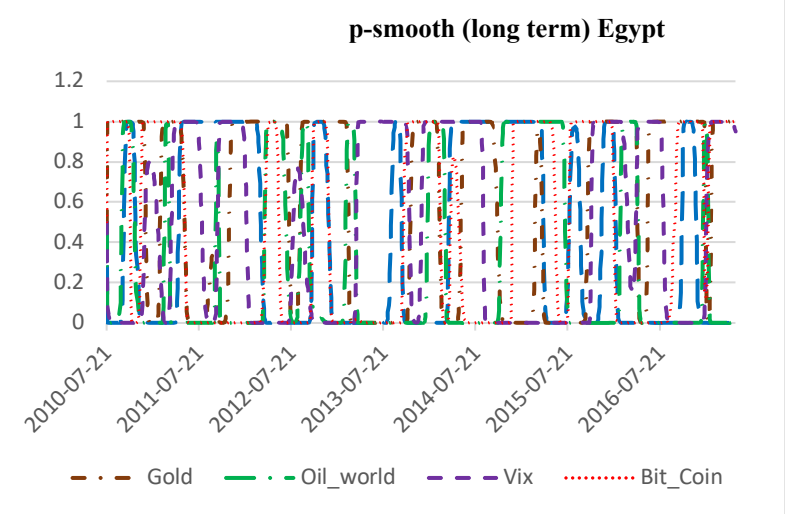
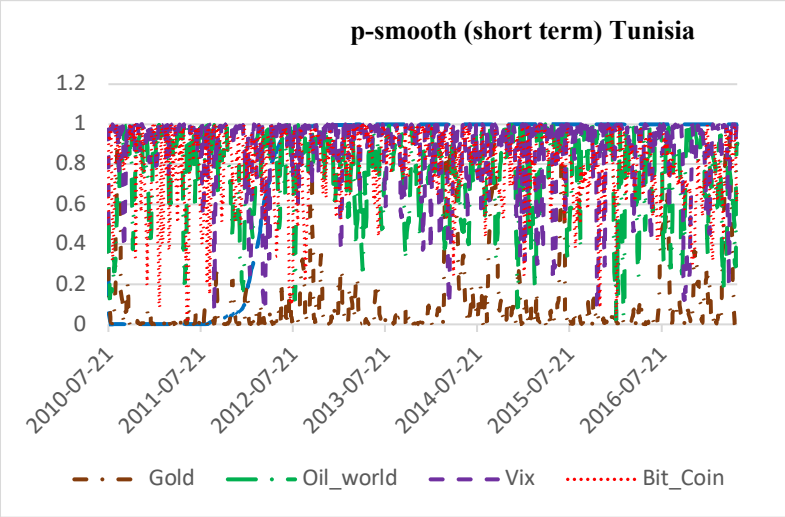
2016-07-21
Gold
Oil_world
Vix
Bit_Coin


p-smooth (long term) Lebanon
1.2
1
0.8
0.6
0.4
0.2
0
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin


p-smooth (short term) Egypt
1.2
1
0.8
0.6
0.4
0.2
0
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin


p-smooth (long term) Egypt
1.2
1
0.8
0.6
0.4
0.2
0
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin


p-smooth (short term) Tunisia
1.2
1
0.8
0.6
0.4
0.2
0
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin

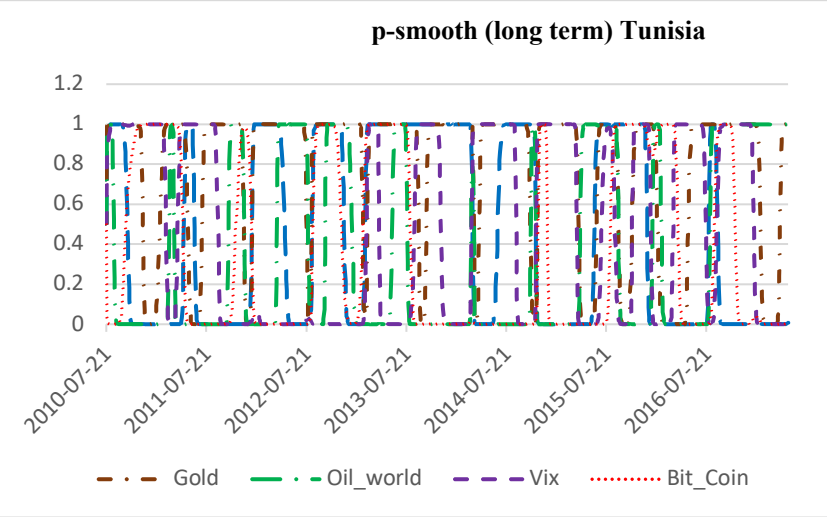
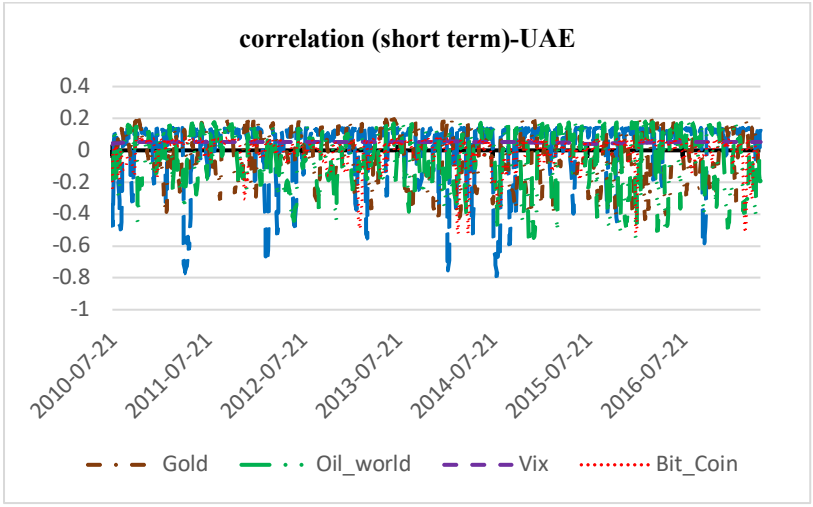
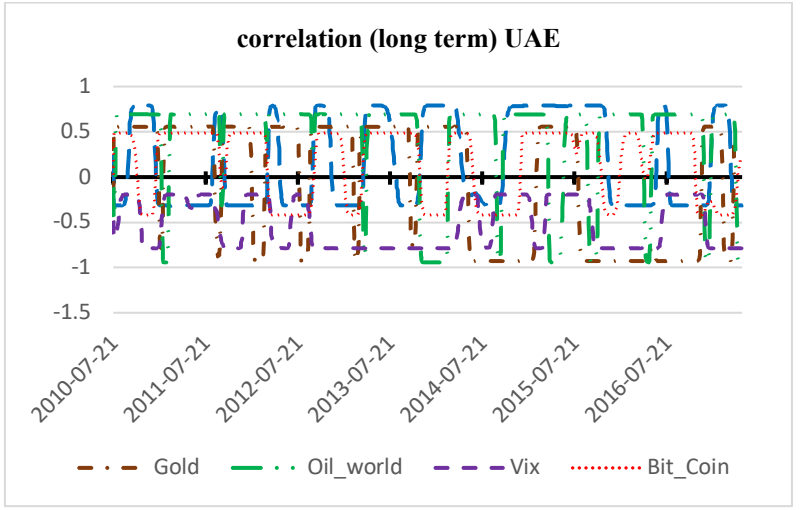
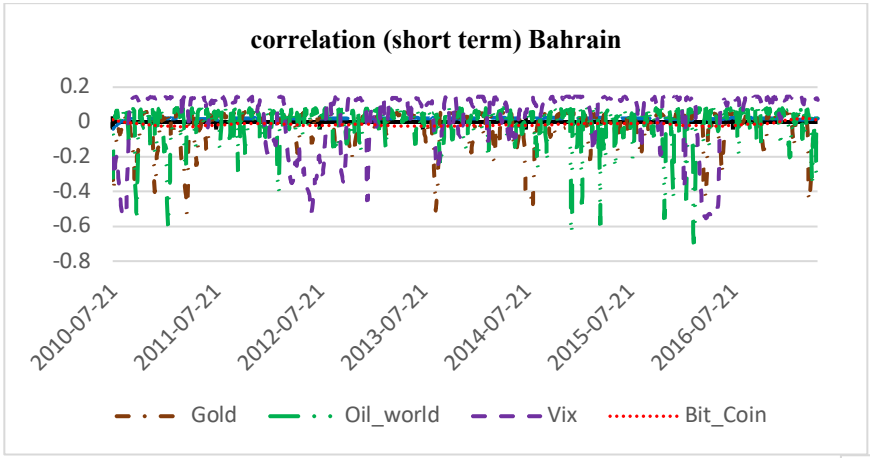
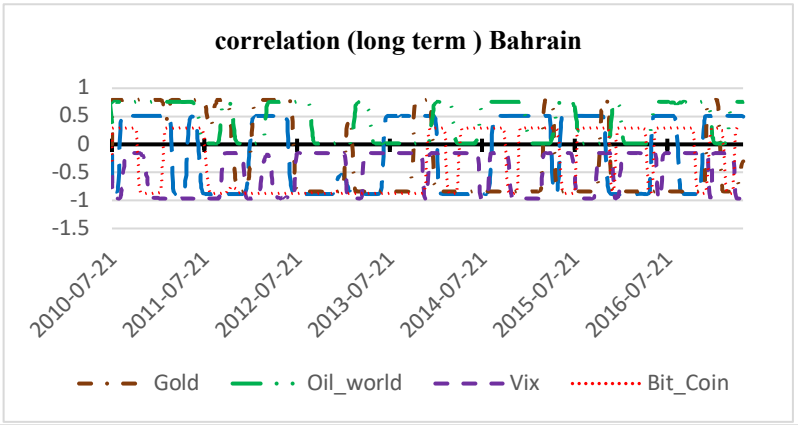

p-smooth (long term) Tunisia
1.2
1
0.8
0.6
0.4
0.2
0
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin

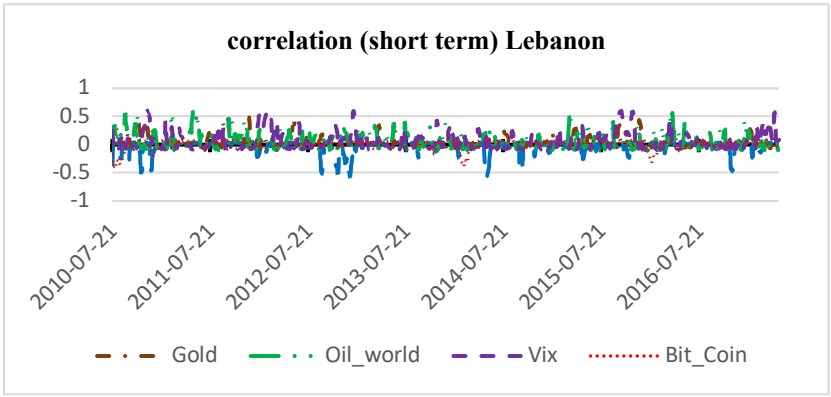
Figure A2. Smoothing short and long-term correlations between the stock markets and global factors

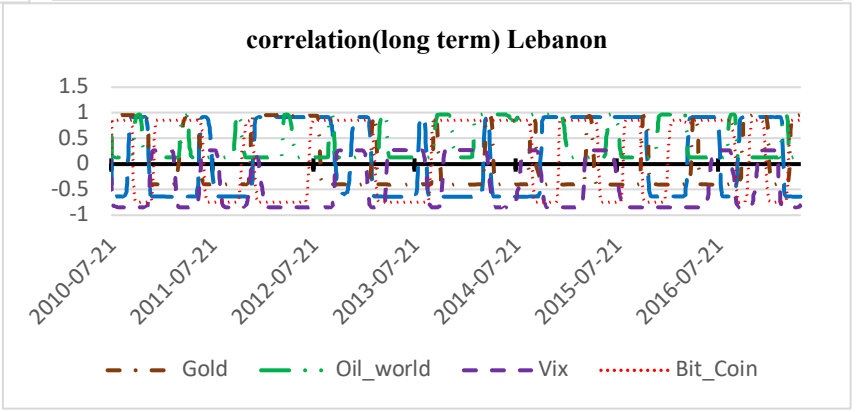


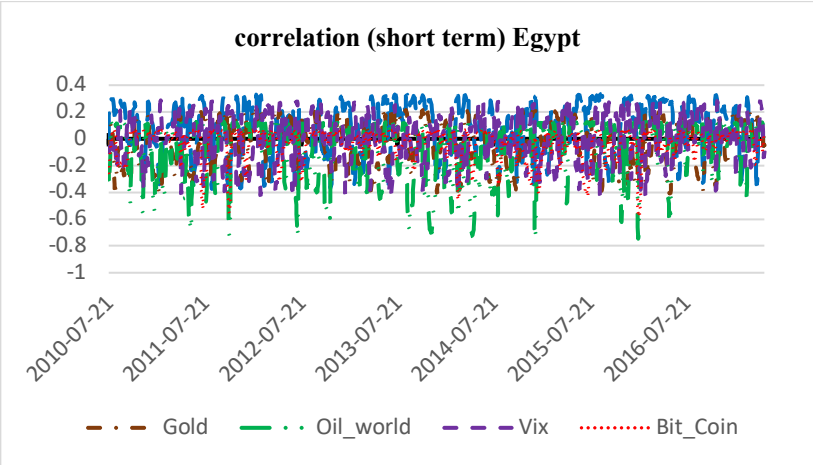


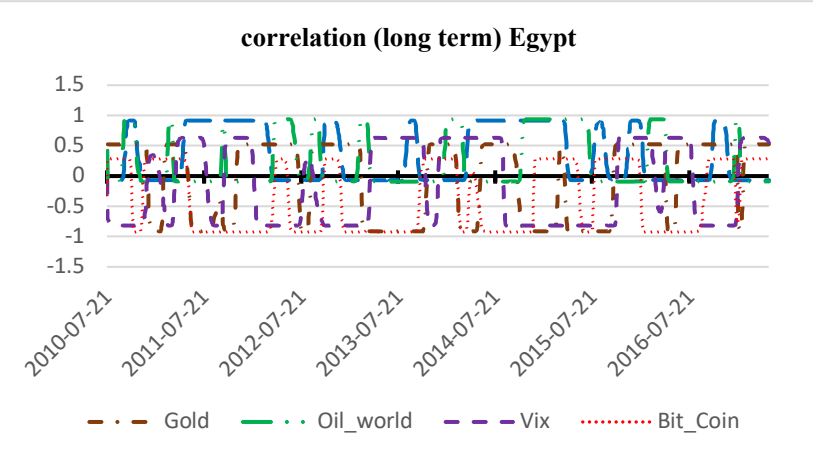

correlation (short term) Bahrain
0.2
0
-0.2
-0.4
-0.6
-0.8
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin


correlation (long term) Bahrain
1
0.5
0
-0.5
-1
-1.5
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin


correlation (short term) Lebanon
1
0.5
0
-0.5
-1
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin


correlation(long term) Lebanon
1.5
1
0.5
0
-0.5
-1
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin


correlation (short term) Egypt
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin


correlation (long term) Egypt
1.5
1
0.5
0
-0.5
-1
-1.5
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
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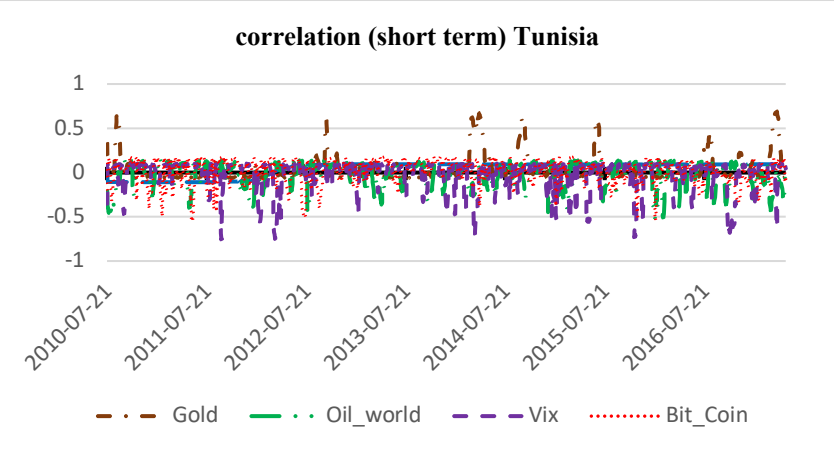
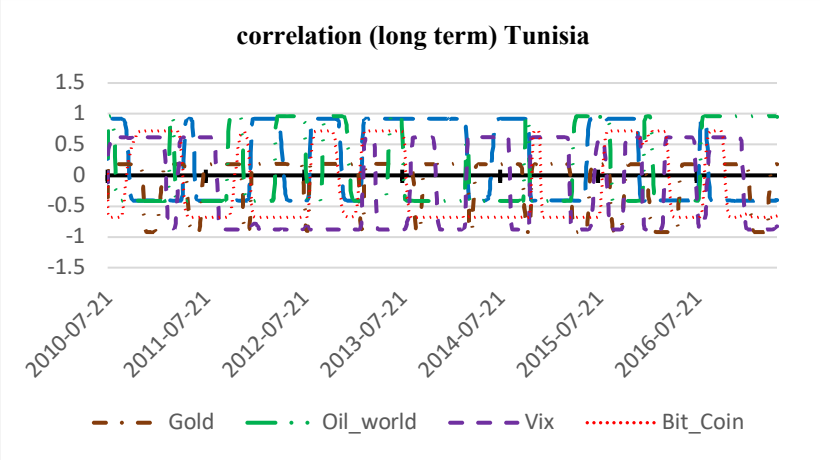
2016-07-21
Gold
Oil_world
Vix
Bit_Coin


correlation (short term) Tunisia
1
0.5
0
-0.5
-1
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin


correlation (long term) Tunisia
1.5
1
0.5
0
-0.5
-1
-1.5
2010-07-21
2011-07-21
2012-07-21
2013-07-21
2014-07-21
2015-07-21
2016-07-21
Gold
Oil_world
Vix
Bit_Coin