ECONOMIC RESEARCH FORUM

منتدى البحوث الاقتصادية

2008

working paper series

RATIONAL SPECULATIVE BUBBLES: AN EMPIRICAL INVESTIGATION OF THE MIDDLE EAST AND NORTH AFRICAN (MENA) STOCK MARKETS

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Working Paper No. 388

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March 2008

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Abstract

Despite recent extreme fluctuations of Middle East and North African (MENA) stock markets, we do not find strong evidence of rational speculative bubbles from the perspective of both domestic and U.S-based investors. Fractional integration tests built on ARFIMA models do not support the possibility of bubbles in MENA stock markets. Similarly, duration dependence tests based on nonparametric Nelson-Aalen hazard functions not only reject the existence of bubbles but also support equality of hazard functions between domestic and U.S-based investors without regard to the rapid financial liberalization and integration in the MENA stock markets.

ملخص

بالرغم من التقلبات الشديدة التي شهدتها أسواق المال في منطقة الشرق الأوسط وشمال إفريقيا فليس ثمة دليل قوي علي وجود فقاعة مضاربات من جانب المستثمرين المحليين أو المقيمين في الولايات المتحدة الأمريكية. فاختبارات التكامل الجزئي المبنية علي نماذج AFRIMA (نموذج الانحدار الذاتي للأوساط المتحركة المتكاملة جزئيا) لا تعزز إمكانية حدوث فقاعة مضاربات في أسواق المال في منطقة الشرق الأوسط وشمال إفريقيا. كذلك فان اختبارات الاعتماد علي المدة المبنية علي دالة المخاطرة لنلسون الين لا ترفض وجود تلك الفقاعات بل تؤيد تساوي دالات المخاطرة بين المستثمرين المحلين والمقيمين في الولايات المتحدة الأمريكية دون النظر إلى ما جري من تحرر مالي سريع وتكامل في أسواق المال في منطقة الشرق الأوسط وشمال إفريقيا.

1. Introduction

Real economic growth rate across Middle East and North African (MENA) countries averaged 5% in 2005 and is expected to be sustained at similar levels in 2006, creating benign prospects for most countries in the region. The UAE is expected to be the world's fastest growing economy in 2006, with GDP rising by just under 14% following up on its breathtaking 16% expansion in 2005. As for liquidity and capital market sizes in MENA countries, bond issuance by the Middle Easter region – being the ideal mechanism for addressing an asset-liability mismatch – exploded from $5 billion in 2004 to $10 billion in 2005. Between 2002 and 2004 local commercial banks issued dollar-denominated Floating-Rate Note (FRN) in the $300 to $500 million range to target largely investors within the Middle East, with some distribution into Europe and Asia. In March 2006, Abu Dhabi Commercial Bank launched the first Swiss franc denominated FRN by a Middle Eastern bank, with Sfr 300 million five year deal led by BNP Paribas and placed entirely with Swiss accounts for the purpose of risk diversification from U.S. dollar deals (*EuroWeek*, 2006).

While the current state of the MENA region economies suggests that economic growth this year will continue to be solid, one may argue that the 10 to 79 percent increases of the monthly stock price index returns for most MENA regions is a symptom of persistent deviations of stock prices from the market fundamentals called rational speculative bubbles, fads, sunspots, or self-fulfilling prophecies as observed in NASDAQ (between November 1998 and March 2000) and the Chinese stock market (from July 1994 to June 2001). However, the no-bubble hypothesis cannot be rejected easily if non-observable fundamental variables, such as investor rational expectations and market sentiment, are the cause of this rapid and sharp divergence of indexes from fundamental values in the MENA stock markets.

Therefore, for policy-making decisions and international portfolio diversification purposes, it is very important to identify whether the recent MENA stock market movements have been driven by rational speculative bubbles. For example, Chan et al. (2003) explain that if rational bubbles are not present, then it is only necessary to take control of the market fundamentals in conducting monetary policy. Otherwise, positive policy action will be needed to control expectations from the bubble path.

However, regardless of capital market growth potentials, sizes and rapid financial liberalization in the MENA countries, information on the MENA stock markets to international and domestic investors who are seeking portfolio diversification for hedging purposes is generally less available than in other financial markets. On a similar note, despite the potential benefits of portfolio diversification in emerging markets in general and MENA countries in particular, there is a lack of research and relatively nothing is known about the existence of rational speculative bubbles of MENA stock markets.

For developed and other emerging markets, most previous studies (e.g., Brooks and Katsaris, 2003; Gürkaynak, 2005, among others) have applied bubble tests for integer orders of integration to the log dividend yield or have tested for integer cointegration between stock dividends and prices. However, in this paper, to complement and overcome well-known shortcomings of the traditional bubble tests, such as unit root and cointegration tests, mainly relying on expectations of future streams of dividends, we employ newer approaches – fractional integration tests and duration dependence tests – to investigate the evidence of rational speculative bubbles in the MENA stock markets.

Fractional integration tests rely on ARFIMA models. Cuñado et al. (2005) test for the presence of rational bubbles in the NASDAQ stock market index by means of a methodology based on fractional processes. Koustas and Serletis (2005) also indicate that the notion of fractional integration allows more flexible modeling of the low frequency dynamics of stock prices, dividends and their equilibrium relationship, while allowing significant deviations from equilibrium in the short run. They yield robust rejections of the null hypothesis of rational bubbles based on tests for fractional integration and conclude that a fractionally integrated dividend yield is inconsistent with rational bubbles in annual SP500 composite stock market index from 1871 through 2000.

In addition, many financial researchers have supported duration dependence tests based on survival analysis in many distinct academic contexts (e.g., McQueen and Thorley, 1994; Cochran and DeFina, 1996; Chan et al., 1998; Cameron and Hall, 2003; Tudela, 2004; Buehler, Kaiser, and Jaeger, 2006). Traditionally, researchers have preferred fitting parametric hazard functions such as log-logistic, exponential, Weibull, and Gompertz specifications along with semi-parametric tests based on Cox regression model. However, we find that nonparametric hazard functions have much better small-sample properties and are more intuitive to interpret whether hazard functions are decreasing or increasing. Therefore, we estimate nonparametric Nelson-Aalen smoothed hazard functions together with traditional parametric and semi-parametric hazard specifications to investigate duration dependence in runs of positive excess returns of the MENA stock markets because we have relatively small sizes of samples to fit parametric hazard functions. We firmly believe that our approach to plot nonparametric smoothed hazard functions is more reliable to obtain the robust empirical results of duration dependence tests to identify the existence of bubbles in the MENA stock markets.

We summarize the main results as follows. Despite recent extreme fluctuations in MENA stock markets, we do not find strong evidence of rational speculative bubbles in the perspective of both domestic and U.S-based investors. Fractional integration tests built on ARFIMA models do not support the possibility of bubbles in the MENA stock markets. Similarly, duration dependence tests derived from nonparametric Nelson-Aalen hazard functions strongly reject the existence of bubbles. In addition, it seems that domestic and U.S-based investors do not observe rational speculative bubbles in the MENA region – supported by the statistically identical hazard functions across them – although MENA countries have recently experienced rapid financial liberalization and integrations with developed countries.

The organization of this paper is as follows. In Section 2, we provide sample selection criteria and descriptive statistics on MENA stock markets data. Section 3 points out empirical challenges of traditional econometric tests to detect rational speculative bubbles. In Section 4, we describe the newer approaches of rational speculative bubble identification. Section 5 analyzes the empirical results. Section 6 concludes.

2. Data and Descriptive Statistics

2.1. Data and Sample Selection Criteria

To investigate whether rational speculative bubbles exist or not in the MENA region, we collect monthly S&P/IFCG price indexes of the eight MENA stock markets: Bahrain (1999:01 – 2003:03), Egypt (1996:01 – 2003:03), Jordan (1979:01 – 2003:03), Morocco (1996:01 – 2003:03), Israel (1997:01 – 2003:03), Oman (1999:01 – 2003:03), Saudi Arabia (1998:01 – 2003:03), and Turkey (1987:01 – 2003:03). The sample periods for indexes are chosen on the basis that they represents the longest periods over which reliable data for MENA region is available. All stock indexes are expressed in local currencies and US dollar denomination to examine both domestic and U.S-based investors' perspectives. Then, we compute monthly simple returns rather than continuous compounded returns obtained by log differences to perform duration dependence tests to examine the existence of rational speculative bubbles in the MENA stock markets.

In addition, reliable dividend yields data is essential to perform formal econometric bubble tests such as fractional integration tests. Therefore, we consider slightly different sample periods of dividend yields for MENA region from those of S&P/IFCG price indexes: Bahrain (2000:01 – 2003:03), Egypt (1996:12 – 2003:03), Jordan (1984:12 – 2003:03), Morocco (1996:12 – 2003:03), Israel (1997:11 – 2003:03), Oman (2000:01 – 2003:03), Saudi Arabia (1998:11 – 2003:03), and Turkey (1987:11 – 2003:03).

The source of this data is the Emerging Markets Data Base (EMDB) published by Standard & Poor's. We believe that S&P/IFCG price indexes are more suitable for our study since they reflect adjusted share price changes and represent stock market performances without taking into account restrictions on foreign investors from the domestic investor's perspective. According to Standard & Poor's S&P/IFCG index stock selection guidelines, all of MENA stocks included in S&P/IFCG indexes must be actively traded and target market share should consist of 60% to 75% of total market capitalization. Of course, they should be well-diversified across different industries. Therefore, S&P/IFCG Indexes are intended to represent the performance of the most active stocks in their respective stock markets and to be the broadest possible indicator of market movements.

2.2. Descriptive Statistics

In Table 1, we report descriptive statistics of monthly index returns for eight MENA stock markets. During our sample periods, most of the MENA stock markets experienced severe stock markets fluctuations. From the domestic investors' perspective, Egypt and Turkey were somewhat extreme, evidenced by 7.4% and 19.64% of standard deviations. Maximum and minimum monthly returns for Egypt and Turkey were 26.14% (79.33%) and -11.98% (-39.27%) respectively. Similarly, from the U.S-based investors' perspective, Israel and Turkey had the highest uncertainty in their monthly stock market movements among others. Maximum and minimum monthly returns for Israel and Turkey were 14.53% (71.29%) and -19.07% (-40.66%) respectively.

We also find that, except for Morocco, Israel, and Saudi Arabia, monthly index returns for the MENA stock markets are far from normally distributed with positive or negative skewness and leptokurtosis as seen from significant Jarque-Bera statistics. It is worth noting that although Israel suffered the largest fluctuations on market movements from the perspective of U.S. investors, it seems that those volatilities did not contribute to leptokurtosis, evidenced by the lowest excess kurtosis value (2.7206) and insignificant Jarque-Bera statistics (3.0571). Therefore, maximum and minimum values for Israel might be considered outliers since they cannot be representatives of normal market movements for Israel.

In Figure 1, we illustrate theoretical Quantile-Quantile (QQ) plots for the MENA stock markets from the perspective of U.S-based investors. Although some countries include significant numbers of outliers in QQ plots, they might result from temporary or false shocks not directly related to bubbles. This is supported by the insignificant values of the Ljung-Box Portmanteau test statistics for 12 autocorrelations $Q(12)$, except Morocco. Therefore, we should be equipped with further formal econometric tests to detect the existence of bubbles in those rapidly growing MENA stock markets for various practical and academic reasons such as investments, portfolio diversifications, risk managements and, monetary policy and regulation purposes.

3. Empirical Challenges of Traditional Bubble Tests

According to theories of bubbles (e.g., Brooks and Katsaris, 2003; Cuñado et al., 2005; Kirman and Teyssière, 2005), the actual MENA stock market indexes deviate from the fundamental values if $Bubble_t > 0$. In this case, the market indexes are called to have rational speculative bubbles;

$$\begin{aligned} MENA_t^a &= MENA_t^f + Bubble_t + \mu_t \\ &= \sum_{k=1}^{\infty} \frac{1}{(1+i)^k} E_t\left(Div_{t+k}\right) + \frac{E_t\left(Bubble_{t+1}\right)}{(1+i)} + \mu_t \end{aligned} \tag{1}$$

where $MENA_t^a$ is the actual index of the MENA stock markets considered in time t, Div_t is the dividend at period t, $MENA_t^f$ is the fundamental value of the index in time t, i is the market discount rate, $E(\cdot)$ is the mathematical expectation operator, and μ_t is an identically and independently distributed (*i.i.d.*) stochastic process. $Bubble_t$ is the value of the bubble component in time t and is entirely consistent with rational expectations and the time path of expected returns.

However, previous studies on empirical tests to detect rational speculative bubbles concentrating on developed and emerging stock markets still remain inconclusive. Therefore, many financial economists have tried to explain the main sources of the controversy on the tests of bubbles detection. For example, Blanchard (1979) explains that speculative bubbles may take all kinds of shapes and their fundamentals may be stochastic. Kaizoji (2000) argues that bubbles and crashes come from the collective crowd behavior of many interacting agents. In theory, although an asset's fundamental value can be obtained by discounting the asset's future earnings stream, the difficulties in estimating the earnings stream, and in proper discounting, make the identification of bubbles empirically challenging (See Chen, 2001). Gürkaynak (2005) surveys the formal econometric tests of asset price bubbles and concludes that we cannot distinguish bubbles from time-varying or regime-switching fundamentals.

More importantly, many researchers have also reported that it is very difficult to detect rational speculative bubbles by precisely using traditional econometric tests, such as unit root tests and cointegration tests, which mainly rely on expectations of future steams of dividends especially in small samples. For example, Taylor and Peel (1998) point out that although rational speculative bubbles imply non-cointegration of index or stock prices and dividends, the traditional cointegration tests are subject to size distortion or specification errors, especially in small samples. Due to these undesirable properties of cointegration tests, they apply the robust non-cointegration test with a much smaller size distortion and good power characteristics to a long run of U.S. real stock price and dividend data, and then reject the bubbles hypothesis on U.S. data. More recently, using SP 500 log dividend yields, Koustas and Serletis (2005) show that Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit-root tests are unable to reject a unit root in the price-dividend ratios (dividend yields), which suggests the lack of a cointegrating relationship between stock prices and dividends. Therefore, in the following section, we briefly summarize the general idea of newer approaches to identify rational speculative bubbles in the MENA stock markets.

4. Newer Econometric Tests to Identify Rational Speculative Bubbles

4.1. Fractional Integration Tests

With a fractional integration parameter *d*, the ARFIMA (*p*, *d*, *q*) is written as

$$\Phi(L)(1-L)^d(y_t-\mu_t)=\Theta(L)\varepsilon_t \tag{2}$$

and the fractional differencing operator, $(1-L)^d$, is defined by

$$(1-L)^d=1-dL-\frac{d(1-d)}{2!}L^2-\frac{d(1-d)(2-d)}{3!}L^3-\dots \tag{3}$$

where y_t is log (dividend yields), μ_t is the mean of dividend yields and *L* is the lag operator, $L^k y_t = y_{t-k}$. $\Phi(L)=1-\sum_{i=1}^{p}\phi_i L^i$ and $\Theta(L)=1+\sum_{i=1}^{q}\theta_i L^i$ represent stationary autoregressive and moving average polynominal in the lag operation *L*. The *p* and *q* are integers, but *d* is real values, respectively.

We check the log dividend yield for a fractional exponent in the differencing process using the Exact Maximum Likelihood (EML). If rational speculative bubbles are present in the MENA stock markets, the fractional integrating parameter of log dividend yields, *d*, should not be statistically equal to zero.

4.2. Duration Dependence Tests

To identify rational speculative bubbles in the perspective of domestic and U.S-based investors, we estimate the following semi-parametric Cox proportional hazards

$$h_i\left(t \mid Currency\right) = h_0\left(t\right)\exp\left\{\beta \cdot Currency\right\} \tag{4}$$

where $h_0\left(t\right)$ is the base-line hazard at time *t* and β is an unknown parameter to estimate. The variable *Currency* is a dummy variable with values 1 or 0; it equals 1 in the case of local currency denomination and 0 otherwise. By definition, $\exp\left\{\beta \cdot Currency\right\}$ is called the hazard ratio. We consider a variety of parametric hazard functions specifications, such as exponential, Weibull, and Gompertz regressions, depending on the expected shapes of hazard functions by making reasonable assumptions about the shape of the baseline hazard, $h_0\left(t\right)$. Then, we estimate parameter values and hazard ratios in each semi-parametric and parametric hazard specification to decide whether the bubble identifications between domestic and U.S-based investors are affected by different currency denominations.

We also perform bubble tests by plotting an estimate of the nonparametric Nelson-Aalen smoothed hazard function, $h(t)$, calculated as a Gaussian kernel smooth of the estimated hazard contributions to consider the relative small sample sizes of the MENA stock markets (For more technical details, Cleves et al., 2004). Therefore, we can estimate the hazard functions as follows.

$$\hat{h}\left(t\right) = b^{-1}\sum_{j=1}^{D} K\left(\frac{t - t_j}{b}\right)\Delta\hat{H}\left(t_j\right) \tag{5}$$

for some symmetric Gaussian kernel density function and bandwidth *b*. The estimated hazard contribution, $\Delta\hat{H}\left(t_j\right)$, is defined as

$$\Delta\hat{H}\left(t_j\right) = \hat{H}\left(t_j\right) - \hat{H}\left(t_{j-1}\right) \tag{6}$$

and

$$\hat{H}\left(t\right) = \sum_{j \mid t_j \le t} \frac{d_j}{n_j} \tag{7}$$

where n_j is the number at risk at time t_j, d_j is the number of failures at time t_j, and the sum is over all distinct failure times less than or equal to t. For each observed run ends time t_j, $\hat{H}\left(t_j\right)$ is the estimated cumulative Nelson-Aalen estimator.

In any case, the null hypothesis (H_0) of no duration dependence implies that the probability of a run ending is independent of the prior returns or that positive and negative abnormal returns are random. The alternative hypothesis (H_1) of duration dependence suggests that the probability of a positive run ending should have a decreasing function of the run length. Therefore, if bubbles are detected, the hazard rates should decrease as the run length increases.

5. Results

Since rational speculative bubbles must be persistent to survive several months or years until the market crashes, we should observe statistically significant positive autocorrelations, skewness, and leptokurtosis due to excess returns during bubble periods if bubbles do in fact exist in the MENA Stock markets. In our study, although summary statistics show excess kurtosis and positive or negative skewness evidenced by significant Jarque-Bera statistics except Morocco, Israel, and Saudi Arabia, many other factors, not directly related with bubbles, can affect market returns. Therefore, a great deal of care should be taken to associate higher moments of market returns with the possibility of rational speculative bubbles. However, unlike Jarque-Bera normality tests, most MENA stock markets do not show significant positive autocorrelations – except Morocco – based on the Ljung-Box Portmanteau tests statistics for 12 autocorrelations $Q(12)$ which, to some degree, supports no bubbles in the MENA stock markets.

The results of these autocorrelation tests question whether the MENA stock markets have really experienced rational speculative bubbles during our sample periods even though they had suffered a lot of extreme positive or negative monthly returns. As Koustas and Serletis (2005) insightfully point out, rational speculative bubbles must be continually expanding and persistent in order to survive since stock buyers will pay a price higher than that suggested by the fundamentals if they believe that someone else will subsequently pay an even higher price. Therefore, statistically significant positive autocorrelations among monthly returns are a prerequisite for rational speculative bubbles to be present in the MENA stock markets.

The estimation results of fractional integration tests via exact maximum likelihood (EML) methods in Panel A of Table 2 for log dividend yields of the MENA stock markets strongly support the results of the Ljung-Box autocorrelations tests statistics shown in Table 1. We also test whether the fractional integrating parameter ($\hat{d}$) is statistically 0 (no unit root) or 1 (unit root) by performing linear restriction tests in Panel B of Table 2. Unlike previous studies (e.g., Brooks and Katsaris, 2003; Gürkaynak, 2005, among others) that have tested for integer orders of integration, we are able to obtain robust rejections of a unit root in the log dividend yield from the linear restriction tests. Therefore, we confirm that fractional integrating parameters of log dividend yields, d, are not statistically different from zero and reveal no bubbles based on ARFIMA approaches, implying stationarity of log dividend yields.

In a recent study, Koustas and Serletis (2005) also report empirical findings similar to ours using SP500 log dividend yields. They also find the possibility of bubbles based on unit root tests, but they reject the null hypothesis of bubbles based on ARFIMA methods.

They clarify that fractional integration tests are robust for the choice of parametric estimator of the fractional differencing parameter and data frequency, and bootstrap inference fully supports the estimation results. Therefore, our results of the fractional integration tests are inconsistent with rational speculative bubbles in the MENA stock markets.

In Panel A of Table 2, the parameters, $\hat{\phi}$ and $\hat{\theta}$, are the estimators of the first order autoregressive, AR(1), and moving average, MA(1) processes in ARFIMA (1, *d*, 1) models respectively. To check model adequacy, we also tabulate residual tests for normality, ARCH effects, and serial correlations (Portmanteau tests) in Panel C of Table 2 along with the *p*-values in square brackets.

For the MENA stock markets, we can reject the null hypothesis of normality of residuals – except Morocco and Israel – even after the ARFIMA fitting, which suggests using alternative fatter-tailed distributions such as skewed *t*-distribution and generalized error distribution (GED) rather than simply assuming normal distributions. For ARCH tests, it appears that ARFIMA settings are well-suited to fit residuals in all of the MENA stock markets even though we assume constant volatility rather than time-varying GARCH-families for the convenience. For Portmanteau tests, it is likely that our ARFIMA (1, *d*, 1) model successfully captures the serial correlations of residuals except Israel. However, although further complexity of model setups considering alternative fatter-tailed distributions and higher orders of AR or MA processes might improve the overall fits of our ARFIMA models, we do not believe that these additional computational efforts will change our main results of fractional cointegration tests to detect bubbles in the MENA stock markets.

In Table 3, to perform duration dependence tests, we compute the actual number of positive runs (sequences of excess returns of the same sign) for monthly positive excess index returns during our sample periods from the perspectives of both domestic and U.S-based investors. We find the longest positive runs (10 months) in Egypt (sample period: 1996:01 – 2003:03), and the next 8 months in Bahrain (sample period: 1999:01 – 2003:03). All of the MENA countries experienced at least 5-month positive runs of monthly positive excess index returns during our sample periods. However, it seems that those numbers of positive runs are too short, transient and spurious to be considered as rational speculative bubbles.

For example, before the worst market crash like Black Thursday (October 24th, 1929), the bull markets lasted about 63 months. The presence of a positive and increasing bubble premium continued about 18 months before the crash of Black Monday (October 19th, 1987). When the NASDAQ index of technology stocks in the U.S. peaked, the market tripled in value between November 1998 and March 2000 (17 months). More recently, the Chinese stock market index had rose 700 percent, propelled by China's double digit growth rates and surging corporate profitability from July 1994 till June 2001 (84 months).

As we can also find from Figure 2, none of the non-parametric smoothed hazard functions is monotonically decreasing, pointing to no bubbles in the MENA stock markets. Even though the non-parametric Nelson-Aalen smoothed hazard functions have different values of hazard rates depending on the types of currency denominations –

except Bahrain, Oman, and Saudi Arabia –we observe that Jordan, Morocco, Israel, Saudi Arabia and Turkey generally show increasing hazard functions, which are not acceptable if bubbles do in fact exist in those markets. Bahrain, Egypt, and Oman also show distinct patterns which are not completely consistent with bubbles. Non-parametric smoothed hazard functions initially increase then decrease.

In Table 4, we provide the comprehensive test results for the equality of hazard functions between domestic and U.S-based investors. Panel A and B of Table 4 shows the estimation results of hazard ratios, $\exp(\beta)$, of semi-parametric Cox and parametric proportional hazards models, respectively, when the currencies are U.S. dollar denominated. It seems that the hazard ratios are insensitive to model specifications, such as Cox, exponential, Weibull, and Gompertz models. In addition, all the hazard rates are not only very close to 1 but also statistically insignificant, implying that currency denominations do not make any difference for bubble identification for the MENA stock markets. We also obtain non-parametric statistical test results supporting the equality of hazard functions between domestic and U.S-based investors from log-rank, Wilcoxon, Tarone-Ware, and Peto-Peto tests in Panel C of Table 4. Therefore, we do not find any statistically significant evidence of bubbles from both fractional integration tests and duration dependence tests for all of the 8 MENA stock markets.

6. Conclusions

When we consider sizable market capitalizations and the degree of liberalization in the MENA countries, we believe that the reliable results of bubble tests of the MENA stock markets could provide domestic and international investors as well as policy makers with an invaluable benchmark to better understand the irregular and highly fluctuating stock market behaviors of the MENA stock markets compared to other developed and emerging stock markets. For domestic and international investors, the formal analysis of MENA stock markets behavior, including rational speculative bubbles, will help them in their portfolio decisions and hedging purposes. Similarly, the empirical results of bubble tests in this paper will be also helpful to policymakers in MENA countries to take actions to improve the functioning of these dynamic stock markets.

For this purpose, we extended the speculative bubble literature to the MENA stock markets from the perspectives of domestic and U.S-based investors. This paper has employed fractional integration techniques and duration dependence tests based on the ARFIMA models and non-parametric Nelson-Aalen smoothed hazard functions in the MENA stock markets. In this study, we do not find any strong evidence of rational speculative bubbles in the MENA stock markets regardless of the currency, whether local or U.S. dollar denominated. Fractional integration tests do not support the possibility of rational speculative bubbles in the MENA stock markets, supported by the statistically zero fractional integrating parameter values of log dividend yields. Similarly, duration dependence tests strongly reject the existence of bubbles as well, supported by non-decreasing non-parametric Nelson-Aalen smoothed hazard functions. These test results to identify rational speculative bubbles in MENA region do not differ between domestic and U.S-based investors.

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Figure 1: Theoretical Quantile-Quantile (QQ) Plots for the MENA Stock Markets (U.S-Based Investors' Perspective)

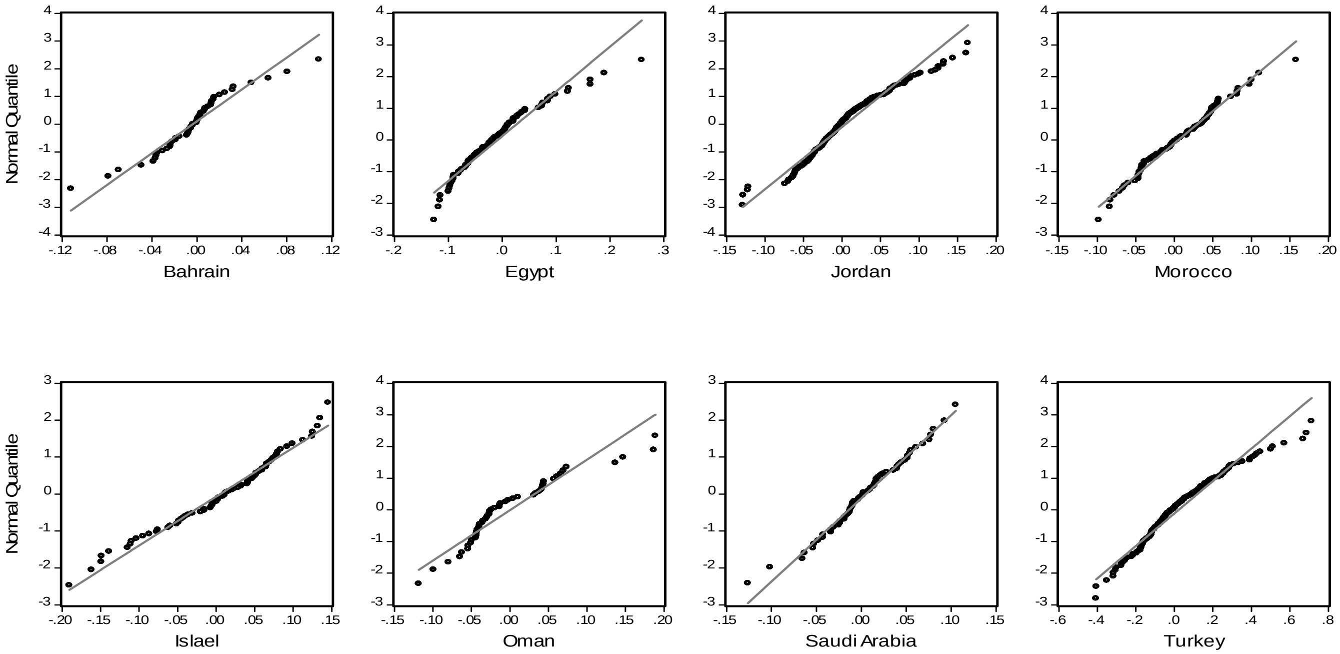

Figure 2: Nonparametric Nelson-Aalen Smoothed Hazard Functions

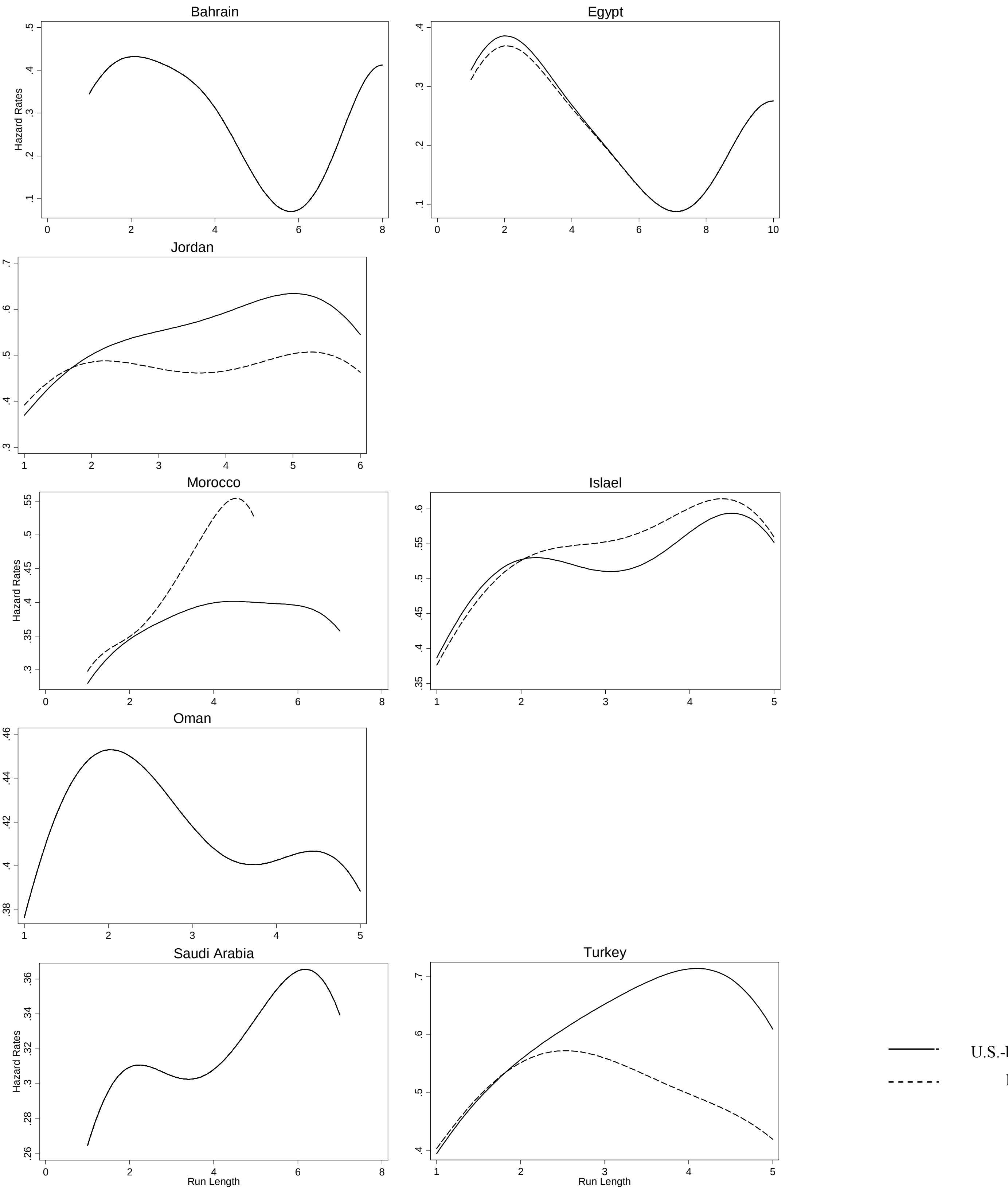

Table 1: Descriptive Statistics of Monthly Index Returns for the Middle East and North African (MENA) Countries

The table explains descriptive statistics of the 8 MENA stock markets monthly index returns. The $Q(12)$ is the Ljung-Box Portmanteau test statistic for 12 autocorrelations. The p-values are reported in square brackets.

	Bahrain	**Egypt**	**Jordan**	**Morocco**	**Israel**	**Oman**	**Saudi Arabia**	**Turkey**
Sample Periods	**1999:01 ~ 2003:03**	**1996:01 ~ 2003:03**	**1979:01 ~ 2003:03**	**1996:01 ~ 2003:03**	**1997:01 ~ 2003:03**	**1999:01 ~ 2003:03**	**1998:01 ~ 2003:03**	**1987:01 ~ 2003:03**
Panel A: Domestic investors' perspective								
Mean	-0.0036	-0.0025	0.0076	0.0071	0.0096	0.0005	0.0052	0.0616
Median	-0.0031	-0.0122	-0.0011	0.0030	0.0123	-0.0237	0.0028	0.0263
Maximum	0.1085	0.2614	0.1819	0.1513	0.1472	0.1889	0.1046	0.7933
Minimum	-0.1124	-0.1198	-0.1288	-0.1073	-0.1677	-0.1184	-0.1259	-0.3927
Std. Dev.	0.0361	0.0748	0.0446	0.0480	0.0674	0.0659	0.0447	0.1964
Skewness	0.1406	1.0258	0.9979	0.5498	-0.4149	1.0975	-0.2123	1.0156
Kurtosis	5.3572	4.2276	4.9725	3.2317	2.8775	4.1264	3.3981	4.6300
$Q(12)$	0.0810	-0.0140	0.0040	0.2130	0.0520	-0.1310	0.0190	-0.0350
	[0.2960]	[0.5160]	[0.8620]	[0.0050]	[0.8740]	[0.2070]	[0.7640]	[0.5060]
Jarque-Bera	11.9749	20.7214	95.4778	4.5777	2.1989	12.9348	0.8890	55.1115
	[0.0025]	[0.0000]	[0.0000]	[0.1014]	[0.3331]	[0.0016]	[0.6411]	[0.0000]
Panel B: U.S-based investors' perspective								
Mean	-0.0036	-0.0086	0.0046	0.0054	0.0054	0.0005	0.0052	0.0226
Median	-0.0034	-0.0183	-0.0014	0.0040	0.0113	-0.0237	0.0027	-0.0087
Maximum	0.1087	0.2588	0.1637	0.1582	0.1453	0.1889	0.1052	0.7129
Minimum	-0.1121	-0.1262	-0.1288	-0.0980	-0.1907	-0.1184	-0.1260	-0.4066
Std. Dev.	0.0360	0.0730	0.0455	0.0493	0.0764	0.0659	0.0447	0.1994
Skewness	0.1477	1.0476	0.6209	0.3040	-0.4744	1.0984	-0.2114	0.8369
Kurtosis	5.3561	4.4809	4.4293	2.9734	2.7206	4.1283	3.4014	4.1187
$Q(12)$	0.0810	-0.0090	0.0030	0.1700	0.1330	-0.1310	0.0190	-0.0480
	[0.3040]	[0.2870]	[0.7880]	[0.0420]	[0.8700]	[0.2090]	[0.7650]	[0.4910]
Jarque-Bera	11.9813	23.8642	43.4703	1.3426	3.0571	12.9605	0.8919	32.9328
	[0.0025]	[0.0000]	[0.0000]	[0.5110]	[0.2169]	[0.0015]	[0.6402]	[0.0000]

Table 2: Fractional Integration Bubble Tests in the MENA Stock Markets

The table reports the estimation results of fractional integration tests via exact maximum likelihood (EML) methods. We also test if fractional integrating parameter ($\hat{d}$) is statistically 0 (no unit root) or 1 (unit root) by performing linear restriction tests. The parameters, $\hat{\phi}$ and $\hat{\theta}$, are the estimators of the first order autoregressive (AR(1)) and moving average (MA(1)) processes in ARFIMA (1, *d*, 1) models. To check model adequacy, we also tabulate residual tests for normality, ARCH effects, and serial correlations (Portmanteau tests). The *p*-values are reported in square brackets.

	Bahrain	**Egypt**	**Jordan**	**Morocco**	**Israel**	**Oman**	**Saudi Arabia**	**Turkey**
Sample Periods	**2000M01 ~ 2003M03**	**1996M12 ~2003M03**	**1984M12 ~2003M03**	**1996M12 ~2003M03**	**1997M11 ~ 2003M03**	**2000M01 ~ 2003M03**	**1998M11 ~ 2003M03**	**1987M11 ~ 2003M03**
Panel A: Parameter estimates								
$\hat{d}$	-0.9975	-0.0624	0.0693	-0.0808	-0.1899	-0.0547	-0.1607	-0.3102
	[0.2020]	[0.8480]	[0.8290]	[0.8530]	[0.3820]	[0.8790]	[0.6950]	[0.4480]
AR1 ($\hat{\phi}$)	0.8368	0.8449	0.8084	0.8104	0.9724	0.8388	0.8967	0.8637
	[0.0420]	[0.0000]	[0.0000]	[0.0020]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
MA1 ($\hat{\theta}$)	0.1094	0.3935	-0.0089	0.3353	0.1850	-0.0431	0.0446	0.0779
	[0.7770]	[0.0630]	[0.9740]	[0.1680]	[0.5500]	[0.8830]	[0.9010]	[0.8140]
Panel B: Tests for linear restriction								
$\hat{d}=0$	1.6873	0.0370	0.0475	0.0349	0.7831	0.0234	0.1560	0.5880
	[0.1940]	[0.8474]	[0.8273]	[0.8516]	[0.3762]	[0.8783]	[0.6928]	[0.4432]
$\hat{d}=1$	6.7659	10.7321	8.5720	6.2570	30.7339	8.6935	8.1384	10.4895
	[0.0093]	[0.0011]	[0.0034]	[0.0124]	[0.0000]	[0.0032]	[0.0043]	[0.0012]
	Bahrain	**Egypt**	**Jordan**	**Morocco**	**Israel**	**Oman**	**Saudi Arabia**	**Turkey**
Panel C: Residual tests for model adequacy								
Normality	17.3540	47.2560	38.2540	4.1913	2.6637	7.4711	33.5220	12.6530
	[0.0002]	[0.0000]	[0.0000]	[0.1230]	[0.2640]	[0.0239]	[0.0000]	[0.0018]
ARCH	0.0458	0.0563	0.2528	0.2275	0.4366	3.1417	0.0149	1.7492
	[0.8317]	[0.8138]	[0.6183]	[0.6364]	[0.5132]	[0.0853]	[0.9033]	[0.1948]
Portmanteau	0.6899	2.6376	2.5505	0.9440	8.4031	1.4901	1.8141	0.8278
	[0.8756]	[0.4509]	[0.4662]	[0.8148]	[0.0384]	[0.6846]	[0.6119]	[0.8428]

Table 3: Duration Dependence Bubbles Tests in the MENA Stock Markets

The table reports the results of duration dependence tests to detect the possibility of rational speculative bubbles. For this purpose, we compute the actual number of positive runs for monthly positive excess index returns from the perspectives of domestic (Panel A) and U.S-based (Panel B) investors. A run is defined as a sequence of excess returns of the same sign.

	Bahrain		**Egypt**		**Jordan**		**Morocco**		**Israel**		**Oman**		**Saudi Arabia**		**Turkey**	
Panel A: Domestic investors' perspective																
Positive Runs	Length	Count	Length	Count	Length	Count	Length	Count	Length	Count	Length	Count	Length	Count	Length	Count
	1	6	1	8	1	39	1	11	1	10	1	7	1	6	1	29
	2	3	2	5	2	16	2	1	2	7	2	2	2	4	2	11
	3	1	3	1	3	3	3	4	3	2	3	1	4	1	3	8
	4	1	5	1	4	3	4	1	4	1	5	1	5	1	5	1
	8	1	10	1	5	1	5	2	5	1			7	1		
					6	2										
Total	12		16		64		19		21		11		13		49	
Panel B: U.S-based investors' perspective																
Positive Runs	Length	Count	Length	Count	Length	Count	Length	Count	Length	Count	Length	Count	Length	Count	Length	Count
	1	6	1	10	1	38	1	12	1	10	1	7	1	6	1	27
	2	3	2	5	2	17	2	2	2	9	2	2	2	4	2	11
	3	1	3	1	3	8	3	2	3	1	3	1	4	1	3	7
	4	1	4	1	4	3	4	2	4	1	5	1	5	1	4	2
	8	1	10	1	5	2	5	1	5	1			7	1	5	1
					6	1	7	1								
Total	12		18		69		20		22		11		13		48	

Table 4: Tests for Equality of Hazard Functions between Domestic and U.S.-Based Investors

This table provides hazard ratios in each of semi-parametric (Panel A) and parametric (Panel B) hazard specifications to decide whether different currency denominations make shifts on the bubble identifications between domestic and U.S.-based investors. We also provide test results for equality of hazard functions (Panel C) between domestic and U.S.-based investors. We do not report the test results for Bahrain, Oman, and Saudi Arabia because their hazard functions between domestic and U.S.-based investors are identical as illustrated in Figure 2.

	Egypt	**Jordan**	**Morocco**	**Israel**	**Turkey**
	Panel A: Semi-parametric tests based on Cox regression model				
Cox	0.9544	1.0437	1.0298	0.9875	1.0586
	[0.8910]	[0.8060]	[0.9280]	[0.9670]	[0.7800]
	Panel B: Parametric tests for proportional hazards models				
Exponential	0.9356	1.0551	1.0230	0.9790	1.0591
	[0.8450]	[0.7570]	[0.9430]	[0.9450]	[0.2800]
Weibull	0.9166	1.0626	1.0772	0.9482	1.1404
	[0.7980]	[0.7260]	[0.8170]	[0.8620]	[0.5180]
Gompertz	0.9356	1.0406	1.0928	0.9572	1.1276
	[0.8450]	[0.8190]	[0.7840]	[0.8860]	[0.5550]
	Panel C: Nonparametric tests for equality of hazard functions				
Log-rank	0.0400	0.1400	0.0200	0.0000	0.2000
	[0.8394]	[0.7087]	[0.8976]	[0.9514]	[0.6585]
Wilcoxon	0.0400	0.5700	0.0100	0.0000	0.1500
	[0.8422]	[0.4518]	[0.9246]	[0.9685]	[0.7004]
Tarone-Ware	0.0400	0.4500	0.0000	0.0000	0.1900
	[0.8347]	[0.5009]	[0.9809]	[0.9452]	[0.6613]
Peto-Peto	0.0400	0.5200	0.300	0.0000	0.1300
	[0.8488]	[0.4701]	[0.8736]	[0.9650]	[0.7229]