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Testing the evolving efficiency of Arab stock markets

Walid Abdmoulah *

Arab Planning Institute, Kuwait

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ABSTRACT

Our goal is to examine whether Arab stock markets are becoming more efficient during the last decade thanks to organizational improvements and agents' learning. To achieve this goal a test of evolving weak-form efficiency using GARCH-M (1,1) approach along with state–space time-varying parameters is implemented for 11 Arab stock markets for periods ending in March 2009, rather than studying their efficiency/inefficiency at a given point of time as commonly done. All markets show high sensitivity to the past shocks and are found to be weak-form inefficient. Moreover, the efficiency does not clearly improve towards the first quarter of 2009 and negatively reacts to contemporaneous crises, except temporary sub-periods of efficiency improvement for the largest markets. This contrasts with mature markets and reveals the ineffectiveness of the reforms so far undertaken and calls to intensify efforts to expand and deepen these markets besides improving their liquidity and transparency and counteracting the shortcomings of the large individual trading by enhancing investment culture and spreading institutional trading.

1. Introduction

Most of the Arab countries reconsidered the role of stock markets in the early 1990s, by attempting to revitalize dormant existing markets, such as Egyptian, Saudi, Tunisian or Kuwaiti stock markets, or launching new ones, such us Dubai and Abu Dhabi stock markets.[1] These actions aimed at developing their financial systems in order to stimulate economic growth and foster international integration. Overall, the pace of changes has been gradual and slow, and capital markets remain dominated by the banking systems. Nonetheless, certain policy measures, including new regulation allowing the entry of foreign investors and wider dissemination of information through the operation of electronic trading systems, resulted in growth in terms of capitalization and caused increase in the number of listed companies.

Moreover, the issue of market efficiency, as introduced by Fama (1965, 1970), remains the most important from resource allocation and portfolio investment's point of view. Efficient mature markets are generally found to be weak-form efficient. Hence, conclusions for emerging markets are very mixed and generally support the idea of a departure from weak efficiency (as for Arab stock markets see for example Civelek (1991), Butler and Malaikah (1992), Al-Loughani (1995), El-Erian and Kumar (1995), Abraham et al. (2002), Onour (2004), Moustafa (2004), Smith (2004), Squalli (2006), Asiri (2008), Lagoarde-Segot and Lucey (2008),[2] Marashdeh and Shrestha (2008) and Awad and Daraghma (2009)).

Nonetheless, the limitation to the above literature is twofold. First, it has been argued that conventional efficiency tests are only reliable if the methodology adopted accounts for the institutional features of the emerging markets leading to wrongly accept or reject the efficiency hypothesis (see, for example, Miller et al., 1994 and Antoniou et al., 1997). Thus, the family of GARCH models, developed by Engle (1982) and extended by Bollerslev (1986) and Nelson (1991), is found to better fit empirical data of stock returns and accommodate for non-linear and infrequent trading caused by thinness, lack of liquidity and regulatory changes and became commonplace in empirical finance. Though, only few have tested GARCH models using daily data from Arab stock markets. Asal (1998), Mecagni and Sourial (1999) and Tooma (2003) investigated the Egyptian stock market while Hassan et al. (2003) investigated the Kuwaiti stock market. Both markets exhibit significant departure from the efficient market hypothesis, even

* Arab Planning Institute in Kuwait. PO Box 5834, Safat, 13059, Kuwait. Tel.: +965 24843130x228; fax: +965 24842935.
E-mail address: walid@api.org.kw.

[1] Syria stock exchange was launched in March 2009. A stock market is under construction in Libya as well. Algeria, Sudan, Lebanon and Palestine stock markets are not included due to unavailable data.

[2] Lagoarde-Segot and Lucey (2008) studied the random-walk properties of the stock exchanges in Egypt, Morocco, Tunisia, Jordan and Lebanon in addition to Israel and Turkey. They used a battery of econometric tests including unit-root analysis, the heteroscedasticity robust Lo and McKinlay (1988) variance ratio framework, the non-parametric Chow and Denning multiple variance ration, a wild bootstrap version of the later and the Wright (2000) non-parametric rank-based methodology. In addition, they used the technical analysis by applying the variable moving average, trading range break levels and breakeven transaction cost method. Results suggested that only the most developed markets – Israel and Turkey– seem to follow a random walk.

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though Asal (1998) by investigating efficiency on a yearly basis shows that efficiency improves towards 1997. Likewise, Hassan et al. (2003) show that Kuwaiti market efficiency improves towards the last sub-period of the 1990s. More recently, Alagidede and Panagiotidis (2009) investigated Egyptian, Moroccan and Tunisian stock markets in addition to Kenya, Nigeria, South Africa and Zimbabwe. The random-walk model was rejected in all cases. In addition, they found that the empirical stylized facts of volatility clustering, leptokurtosis and leverage effects are present in all cases, and thus GARCH, GARCH-M and EGARCH-M were fitted to model the conditional variance. Second, it is hardly credible for an infant stock market to be efficient at its early stages of development as it takes time to gradually evolve towards more efficiency as regulatory environment and trading conditions improve and trade participants become more sophisticated. Therefore, the steady-variable approaches testing its efficiency as fixed throughout the entire estimation period could not trace the efficiency evolution and lead to biased results.

To overcome these problems, a new stand of research has developed since Emerson et al. (1997) and Zalewska-Mitura and Hall (1999) examine the evolution of the efficiency of stock exchanges over time rather than assessing it at a given point of time. Thus, Emerson et al. (1997), Zalewska-Mitura and Hall (1999), Rockinger and Urga (2000, 2001), Hall and Urga (2002), Harrison and Paton (2004) and Posta (2008) revisited the weak-form efficiency of many European transition stock exchanges by using a GARCH-M (1,1) model of the daily index returns volatility as well as a Kalman filter state–space in estimating the time-varying dependency of the daily returns on their lagged values. This time-varying dependency is expected to become more stable and infinitely small if the market moves towards more efficiency. Changing levels of inefficiency were found in Bulgaria, Hungary, Czech, Poland, Russia and Romania stock markets, some of them showing however a tendency towards becoming more efficient. This methodology allows to explore a continuous and smooth change in the behavior of stock prices and thus captures the evolution of efficiency over time rather than splitting the period into sub-periods on the basis of postulated factors as in Antoniou et al. (1997), Muslumov et al. (2003), Hassan et al. (2003), Abrosimova et al. (2005), Coronel-Brizio et al. (2007) and Lim and Brooks (2009).

This line of inquiry is highly relevant for emerging markets at early stage of development for which previous studies regarding their efficiency should be reconsidered. For instance, Li (2003), Maghyereh and Omet (2003) and Jeferis and Smith (2005) implemented the test of evolving efficiency to investigate Chinese, Jordanian and African stock markets respectively. Li (2003) shows that Shanghai and Shenzhen stock markets were inefficient but showed a steady convergence towards efficiency. Maghyereh and Omet (2003) found that Jordanian stock market pricing efficiency is not improving despite the move to electronic trading system. In Jeferis and Smith (2005) Morocco and Egypt stock markets become weak-form efficient towards June 2001, which is not the case for Kenya and Zimbabwe stock markets.

The aim of the present paper is to implement the Evolving Efficiency Test for the most formal Arab stock markets. Therefore, the paper follows the Emerson et al. (1997) and Zalewska-Mitura and Hall (1999) methodology in order to investigate the dynamics of their weak-form efficiency/inefficiency rather than taking a snap shot of it at a given point of time. To this end we use daily data of 11 Arab stock markets that cover a wide time period up to March 2009, allowing us to test for the impact of the many organizational reforms undertaken by the authorities during the last decade. The sample period also allows us to account for the contemporaneous crisis effects on Arab stock market efficiency. The present paper is therefore better able to answer the numerous questions raised by markets' authorities, anxious to know whether the reforms so far undertaken are effective, and investors eager to safely diversify their investments through stock markets. The remainder of the paper is organized as follows. In Section 2, we present the data and discuss the markets' characteristics. Methodology and empirical results are presented in Section 3. Section 4 concludes.

2. Highlights from data

The data include daily prices of the national indexes of Saudi Arabia, Kuwait, Tunisia, Dubai, Egypt, Qatar, Jordan, Abu Dhabi, Bahrain, Morocco and Oman. In addition, we use data of the AMEX index for comparative purposes.

Table 1 shows a very significant but variable growth from a market to another regarding their size and liquidity. Saudi and Kuwait stock markets are the largest in terms of market capitalization, followed by Egypt and Qatar. Oman and Tunisia markets are far behind. With regard to the number of listed companies Egyptian market is by far the largest market followed by Jordan, Kuwait, Saudi Arabia and Oman. Tunisia, Morocco, Dubai, Qatar, Abu Dhabi and Bahrain grew actually little. Furthermore, these markets vary much regarding their liquidity as measured by value and shares traded. Indeed, stock markets of Tunisia, Morocco, Oman and Bahrain show the lowest liquidity, contrary to Dubai, Abu Dhabi and to a lesser extent Qatar which have succeeded in few years to increase their liquidity to a level that is close to that of Saudi and Kuwaiti stock markets.

In sum, a market expansion is found in the 11 markets but the group is very heterogeneous. In fact, Saudi and Kuwaiti markets remain superior in terms of size and liquidity. Dubai, Abu Dhabi,

Table 1
Arab stock market development.
Sources: Arab Monetary Fund, Golfbase.com and Markets' sites. Capitalization/GDP ratio was obtained from the World Development Indicators.

	Value traded ($ million)			Shares traded (million)			Market capitalization ($ million)					Number of listed companies		
	2003	2008	Growth rate (in %)	2003	2008	Growth rate (in %)	2003	%GDP	2008	%GDP	Growth rate (in %)	2003	2008	Growth rate (in %)
Abu Dhabi	3336	61,280	1736	652	48,347	7315	55,519	67	61,887	22	11	30	65	116
Jordan	2598	27,079	942	997	5112	412	10,967	107	35,984	184	228	161	243	50
Bahrain	255	1905	647	368	1480	302	9701	100	19,954	101	105	44	50	13
Morocco	2211	14,231	543	35	222	534	11,556	26	63,420	70	448	52	80	53
Qatar	1646	41,250	2406	68	3400	4900	40,435	113	76,656	65	89	28	43	53
Dubai	11,628	69,880	501	4149	66,066	1492	35,109	42	65,217	24	85	13	65	400
Egypt	4423	65,167	1373	1180	21,072	1685	27,909	32	83,185	52	198	967	444	−54
Kuwait	53,300	116,023	117	48,766	75,820	55	61,311	124	113,527	71	85	108	204	88
Oman	1224	8034	556	276	3881	1306	6615	23	15,643	28	136	141	127	−9
Saudi Arabia	158,568	483,122	204	5531	54,442	884	157,164	73	246,809	46	57	70	127	81
Tunisia	152	1425	837	13	148	1038	2194	10	6381	15	190	45	53	17
AMEX	563,433	561,602	−0.3	17,508	na	na	96,120	0.8	132,367	0.9	37	557	486	−12

Jordan, Egypt and Qatar stock markets grew significantly, contrary to Tunisia, Morocco and Oman which are still underdeveloped. Still, these markets are by far dramatically small as compared to developed stock markets. The number of listed companies is low, most of the stocks are infrequently traded and the trading volume is low. Woertz (2006) emphasizes that GCC markets have seen lots of hyping, dumping and insider trading.

From a microstructural point of view, trading evolved in the recent years from a manual to fully-electronic continuous order driven markets. Thus, liquidity is totally provided by limit order traders relying solely on the competition among public investors to determine the inside spread. Besides, market authorities are still implementing reforms aiming at increasing the transparency and the efficiency of these markets by imposing disclosure rules, by revealing part of the order book (generally the five best bid and the five best ask prices) and by the registration of brokerage companies.

Table 2 displays the summary statistics of the 11 Arab stock market indexes' returns in addition to AMEX. We define returns on day t as $r_t = \ln\left(\frac{p_t}{p_{t-1}}\right)$ where p_t is the value of the stock market index at the close of the day. In addition, Table 2 shows the data sources and period coverage for each market ranging from a minimum of 254 days for Bahrain to a maximum of 4313 days for Saudi Arabia. The returns series clearly show volatility clustering (graphs are not reported), indicating that GARCH models can be used for pricing these series.[3] In addition, we find strong evidence of excess Kurtosis for all markets indicating fat tail distributions. The Jarque-Bera statistic strongly rejects the hypothesis of normal distribution.

Finally, ARCH LM test gives strong evidence for the presence of Autoregressive Conditional Heteroskedasticity (ARCH) in the residuals when specifying a mean equation with simple constant, as shown in Appendix A, which supports the use GARCH models as well. In addition, all series show serial correlation in the residuals as measured by the Ljung-Box Q-statistic and the Breusch–Godfrey serial correlation LM test. This diagnostic suggests that GARCH process coupled with AR specification is appropriate for modeling our stock returns.

3. Methodology and results

3.1. GARCH-M (1,1) estimations

First we use GARCH-M (1,1) (Generalized Autoregressive Conditionally Heteroskedastic in Mean) model allowing the variance of the error term to vary over time, in contrast with classical regressions assuming constant variance. Also GARCH-M allows us to test for the presence of risk premium in the stock markets.[4] Our GARCH-M (1,1) is stated as follows:

$$r_t = \beta_0 + \beta_1 r_{t-1} + \delta h_t + e_t \qquad e_t \sim N(0, h_t) \tag{1}$$

$$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 e_{t-1}^2 \tag{2}$$

In addition to the intercept (β_0) and slope (β_1) in Eq. (1), representing an AR(1) model, δ represents the risk-premium parameter in the conditional model, when tradeoff between volatility and return prevails. Returns volatility is measured by conditional variance h_t, which is described as a function of the squared values of the past residuals (e_{t-1}^2), presenting the ARCH factor, and an auto regressive term (h_{t-1}) reflecting the GARCH character of the model. The sum $\alpha_1 + \alpha_2$ represents the degree of volatility persistence.

Table 2
Returns summary statistics.

	Abu Dhabi	Qatar	Morocco	Tunisia	Bahrain	Egypt	Jordan	Kuwait	Saudi Arabia	Dubai	Oman	AMEX
Mean	0.0002	0.0002	0.00030	0.00067	−0.0022	0.0009	0.0004	0.00076	0.00025	0.00031	0.0003	0.00019
Median	0.0002	0.0003	0.00021	0.0004	−0.0011	0.0012	0.00	0.00105	0.00067	0.0007	0.0008	0.0006
Max	0.0725	0.0942	0.05563	0.0361	0.0262	0.183	0.047	0.05047	0.09391	0.1022	0.0804	0.124
Min	−0.0707	−0.1039	−0.0501	−0.05	−0.037	−0.179	−0.047	−0.047	−0.1032	−0.1215	−0.087	−0.104
Std. dev.	0.0143	0.0180	0.0087	0.0052	0.01	0.0182	0.01	0.01	0.01	0.01994	0.014	0.01
Skewness	−0.0124	−0.5124	−0.133	−0.474	−0.81	−0.353	−0.06	−0.63	−1.02	0.0228	−0.924	−0.5
Kurtosis	7.699	7.9018	8.9713	15.760	5.69	16..32	6.98	7.21	16.71	8.1264	13.65	20.68
Jarque–Bera	1301.35	1347.97	3333.14	8493.29	104.12	13661.4	2756.52	1553.91	34532.1	1545.20	5466.6	30220.5
Prob	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Obs. number	1414	1290	2239	1245	254	1842	4171	1932	4313	1411	1123	2312
Period coverage	1/04/04 to 2/12/09	1/05/04 to 2/16/09	1/18/00 to 1/13/09	2/05/04 to 1/27/09	2/17/08 to 2/26/09	8/19/01 to 1/26/09	1/1/92 to 1/19/09	6/17/01 to 1/12/09	1/26/94 to 1/13/09	1/04/04 to 2/26/09	8/28/04 to 2/26/09	1/3/00 to 2/27/09
Data source	Market's site and Gulfbase.com	Market's site and Gulfbase.com	Market's site	Market's site	Gulfbase.com	Market's site	Market's site	Market's site	Market's site	Market's site and Gulfbase.com	Market's site	Yahoo Finance

[3] For further discussion on application of ARCH and GARCH methodology see Bollerslev, Chou, and Kroner (1992), Poon and Granger (2003), Engle (2001), Andersen, Bollerslev, Diebold, and Labys (2003), and McQueen and Vorkink (2004).

[4] Elyasiani and Mansur (1998) discuss the benefits from the GARCH-M model.

Table 3 shows the estimated GARCH-M (1,1) models for the 12 stock exchanges. First of all, Table 3 tells us that β_0 is insignificant for Morocco, Bahrain, Jordan, Qatar and Oman. However β_0 is shown to be significant at 1% for Dubai, Kuwait and Saudi Arabia, at 5% for AMEX and Egypt, and at 10% for Tunisia and Abu Dhabi.

As for the dependency of the daily returns on their lagged values, β_1 looks very small only in the AMEX case, but still different from zero. In Arab markets, β_1 value ranges from 0.102 in Dubai to 0.323 in Oman, indicating a departure from the weak-form efficiency. The time paths of β_1 are discussed in the next sub-section.

Regarding δ, the risk-premium parameter, the coefficient appears significant at 10% only in the Bahraini case, giving evidence of a negative risk premium, given its short data coverage. Further, GARCH-M (1,1) effects (ARCH and GARCH) are very significant for all markets. All series show high sensitivity to the past shocks except AMEX. α_2 varies between 0.43 for Qatar and 0.084 for Bahrain. This latter is the closest to AMEX for which α_2 equals 0.06 (in Zalewska-Mitura and Hall (1999) α_2 equals 0.05 for FTSE 100 index over 01/02/1991–10/15/1997 period).

Furthermore, the measure of volatility persistence given by $\alpha_1+\alpha_2$ is very close to 1 for all markets indicating that undesirable shocks will persist, except Tunisian market for which the magnitude of persistence is lower (0.94) indicating that undesirable shocks exert their influence for a relatively shorter period.

It is noteworthy that diagnostic statistics based on standardized residuals (Ljung-Box $Q(16)$ and $Q^2(16)$ and ARCH LM(16) test) indicate that serial correlation and heteroskedasticity are dramatically reduced, except in Tunisia and Jordan cases, as expected. Kurtosis and Ljung-Box statistics are much lower, even though normality is not fully satisfied.

Table 3
Estimated GARCH-M (1,1) models.

GARCH-M (1,1) estimations									Diagnostic statistics					
									$\alpha_1+\alpha_2$	$Q(16)$	$Q^2(16)$	ARCH LM(16)	Kurtosis	J–B
Egypt	$r_t=$	0.00098**	+	0.2154***	r_{t-1}	+	−0.08178	h_t		17.86	24.4	1.55	6.04	724.7
		(0.017)		(0.00)			(0.95)			(0.33)	(0.08)	(0.07)		(0.00)
	$h_t=$	0.000005***	+	0.8529***	h_{t-1}	+	0.1369***	e^2_{t-1}	0.99					
		(0.003)		(0.00)			(0.00)							
Morocco	$r_t=$	0.0000363	+	0.3011***	r_{t-1}	+	2.8937	h_t		33.93	6.06	0.37	12.74	9021.8
		(0.82)		(0.00)			(0.32)			(0.006)	(0.98)	(0.98)		(0.00)
	$h_t=$	0.000004***		0.6820***	h_{t-1}	+	0.2887***	e^2_{t-1}	0.97					
		(0.00)		(0.00)			(0.00)							
Bahrain	$r_t=$	−0.000138	+	0.2068***	r_{t-1}	−	21.25502*	h_t		11.5	5.95	0.31	4.63	49.95
		(0.79)		(0.00)			(0.052)			(0.77)	(0.98)	(0.99)		(0.00)
	$h_t=$	0.0000005	+	0.9092***	h_{t-1}	+	0.08490**	e^2_{t-1}	0.99					
		(0.68)		(0.00)			(0.03)							
Jordan	$r_t=$	0.000031	+	0.2428***	r_{t-1}	+	2.6195	h_t		34.83	29.28	1.87	4.85	658.26
		(0.80)		(0.00)			(0.17)			(0.00)	(0.02)	(0.01)		(0.00)
	$h_t=$	0.000003***	+	0.7533***	h_{t-1}	+	0.2294***	e^2_{t-1}	0.98					
		(0.00)		(0.00)			(0.00)							
Abu Dhabi	$r_t=$	0.000578*	+	0.2858***	r_{t-1}	−	0.430585	h_t		25.17	8.36	0.51	6.27	643.05
		(0.0693)		(0.00)			(0.85)			(0.06)	(0.93)	(0.94)		(0.00)
	$h_t=$	0.000006**	+	0.7782***	h_{t-1}	+	0.2023***	e^2_{t-1}	0.98					
		(0.0103)		(0.00)			(0.00)							
Tunisia	$r_t=$	0.000293*	+	0.2636***	r_{t-1}	+	8.4569	h_t		26.27	38.3	2.49	4.48	116.85
		(0.07)		(0.00)			(0.29)			(0.05)	(0.00)	(0.00)		(0.00)
	$h_t=$	0.000001*	+	0.7627***	h_{t-1}	+	0.1823***	e^2_{t-1}	0.94					
		(0.06)		(0.00)			(0.00)							
Saudi Arabia	$r_t=$	0.000355***	+	0.1786***	r_{t-1}	+	0.167723	h_t		76.8	9.1	0.596	8.41	5315.8
		(0.00)		(0.00)			(0.89)			(0.00)	(0.90)	(0.88)		(0.00)
	$h_t=$	0.000002***	+	0.7791***	h_{t-1}	+	0.2281***	e^2_{t-1}	1					
		(0.00)		(0.00)			(0.00)							
Kuwait	$r_t=$	0.001313***	+	0.1560***	r_{t-1}	−	0.828157	h_t		49.03	9.64	0.58	5.19	480.5
		(0.00)		(0.00)			(0.77)			(0.00)	(0.88)	(0.89)		(0.00)
	$h_t=$	0.000002***	+	0.7913***	h_{t-1}	+	0.1993***	e^2_{t-1}	0.99					
		(0.00)		(0.00)			(0.00)							
Qatar	$r_t=$	0.000419	+	0.2933***	r_{t-1}	+	1.418995	h_t		45.663	26.51	1.62	4.65	156.28
		(0.16)		(0.00)			(0.30)			(0.00)	(0.04)	(0.05)		(0.00)
	$h_t=$	0.000011***	+	0.6045***	h_{t-1}	+	0.4304***	e^2_{t-1}	1.03					
		(0.00)		(0.00)			(0.00)							
Dubai	$r_t=$	0.00129***	+	0.1028***	r_{t-1}	+	0.094352	h_t		78.64	18.58	1.109	4.52	146.2
		(0.0001)		(0.002)			(0.94)			(0.00)	(0.29)	(0.34)		(0.00)
	$h_t=$	0.000001***	+	0.6902***	h_{t-1}	+	0.3360***	e^2_{t-1}	1.02					
		(0.00)		(0.00)			(0.00)							
Oman	$r_t=$	0.00039	+	0.3236***	r_{t-1}	+	0.2358	h_t		20.81	11.21	0.67	8.81	1672.8
		(0.104)		(0.00)			(0.92)			(0.18)	(0.79)	(0.82)		(0.00)
	$h_t=$	0.000002***	+	0.833***	h_{t-1}	+	0.1669***	e^2_{t-1}	0.99					
		(0.00)		(0.00)			(0.00)							
AMEX	$r_t=$	0.000646**	+	0.0649***	r_{t-1}	−	1.077997	h_t		10.53	9.97	0.63	6.03	906.2
		(0.03)		(0.00)			(0.75)			(0.83)	(0.87)	(0.86)		(0.00)
	$h_t=$	0.000002	+	0.9097***	h_{t-1}	+	0.0673***	e^2_{t-1}	0.98					
		(0.106)		(0.00)			(0.00)							

P-values of the coefficients are reported in parentheses. $\alpha_1+\alpha_2$ is the sum of ARCH and GARCH coefficients and it is the measure of the volatility persistence. $Q(16)$ and $Q^2(16)$ are Ljung-Box statistics for standardized residuals and squared standardized residuals of order 16. ARCH LM(16) is the heteroskedasticity test *F*-statistic of order 16. J–B refers to Jarque–Bera normality test statistic. ***, ** and * indicate significance levels at 1%, 5% and 10% respectively.

3.2. Kalman filter estimations

Using the GARCH-M (1,1) specification, the state–space model is formulated in order to take not only changing variance structure in stock returns into consideration but also the time-varying dependency of the daily returns on their lagged values as follows:

$$r_t = \beta_0 + \beta_{1t} r_{t-1} + \delta h_t + e_t \qquad e_t \sim N(0, h_t) \tag{3}$$

$$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 e_{t-1}^2 \tag{4}$$

$$\beta_{1t} = \beta_{1t-1} + v_{it} \qquad v_{it} \sim N(0, \sigma_i^2) \tag{5}$$

The β_{1t}, in Eq. (3), is not to be estimated as constant over time like in Eq. (1), but as a time-varying parameter. Eq. (3) is the space or signal equation and Eqs. (4) and (5) the state equations. Eq. (4) describes the behavior of the variance of the residuals as before, and Eq. (5) describes the behavior of β_{1t} following a random walk.

Figs. 1 to 12 in Appendix B show the time paths of β_{1t} coefficient and the 95% confidence interval obtained through Kalman Filter state–space estimations. In the AMEX case, β_{1t} coefficient is very close to zero and goes towards zero, without being sensitive to any of the contemporaneous crises. This is consistent with the weak-form efficiency properties of a developed mature market. In contrast, Arab markets behave differently indicating a clear departure from weak-form efficiency since β_{1t} coefficients are significantly different from zero besides being instable. Nonetheless, some markets are experiencing periods of efficiency improvement. More precisely, stock markets of Saudi Arabia, Egypt and Dubai show a steady improvement of their efficiency till mid 2002, end 2004 and end 2007 respectively. Likewise, Qatar and Jordan stock markets show a decreasing inefficiency over 2005–2008 and 1998–2002 periods. Besides, Kuwait and Abu Dhabi inefficiency decreased dramatically over mid 2005–mid 2007 and 2005–mid 2006 periods, while Bahrain does not show any efficiency improvement. These sub-periods of efficiency improvement are followed by a reversal of β_{1t} time paths indicating that efficiency is redirected in the wrong direction, apparently as a consequence to three major events, 2001 and 2008 global crises in addition to 2006 local crises. For example, Saudi Arabia, Kuwait and Jordan negatively reacted to 2001 and 2006 crises, while Egypt reacted solely to 2006 crises. Besides, Abu Dhabi and Dubai negatively reacted to 2006 and 2008 crises, while Bahrain and Qatar are affected only by the current crises. Regarding Tunisia, Oman and Morocco cases β_{1t} time paths are highly instable without any tendency towards weak-form efficiency.

Overall, all Arab stock markets are found weak-form inefficient and inefficiency does not sufficiently improve towards the first quarter of 2009, except Saudi stock market showing decreasing inefficiency during the current crises. Noteworthy, many markets have experienced sub-periods of efficiency improvement while Tunisia, Oman and Morocco markets' efficiency is highly instable without any tendency towards weak-form efficiency. These findings reveal the ineffectiveness of the reforms so far undertaken and calls for a serious reflection on the way forward to redress the situation. A thorough analysis of the possible explanations that stand behind these findings is, therefore, of key importance not only in gaining a better understanding of the relationship between markets characteristics and efficiency but also in helping to develop recommendations for the relevant authorities.

For instance, the above analysis points the link between efficiency gains and market size and liquidity. Indeed, we noticed that the first group of countries preceded by Saudi Arabia having enjoyed sub-periods of efficiency gains, even though dramatically affected by the contemporaneous crises, stand as the largest and most liquid markets as stressed in Section 2. This concurs with previous findings indicating a positive relationship between markets size and efficiency (in Jeferis and Smith (2005) and Lagoarde-Segot and Lucey (2008) for example). Efforts to expand and deepen these markets should then be seriously intensified especially in Tunisia, Oman and Morocco which are suffering the most from negative effects of thinness. To achieve this end Arab country could for example rely on speeding up the base of privatization, diversifying financial services and improving the investment climate in order to channel more domestic and/or foreign savings to equity markets.

Besides, the lack of liquidity provision and the nature of the traders seem to be broadly similar in all these markets. In fact, the 11 markets are pure order driven markets, which could hamper the liquidity provision function, make them more volatile, especially when dealing with small or illiquid stocks or in periods of information deficiencies and then can be seen as constraint towards more efficiency. It is well documented that order driven market structure fits more with very liquid stocks (Handa & Schwartz, 1996, Seppi, 1997, Revest, 1999 and Demarchi & Foucault, 2000). Huang and Stoll (1996) also found that order book fits more with small or medium orders. Market makers improve liquidity either for less liquid stocks or for big orders. Introducing market makers in Euronext Paris and Stockholm helped these markets in reducing the bid–ask spread and increasing the trade volume (Anand et al., 2006, Venkataraman and Waisburd, 2006 and Bessembinder et al., 2007), which should also be done in Arab stock markets given their thinness. This means that existing brokerage houses would expand their role to act as market makers for a determined number of stocks by quoting bid and ask prices and stand continuously ready to buy or sell stocks using their own inventory. This leads not only to improve liquidity provision function but also to better infer information in prices and then improve the price formation process.

Further subjacent factors lie in the nature of traders in these markets, essentially individuals (88% in Saudi Arabia and more than 60% for others, which is very high internationally), with poor equity investment culture given the short life of these markets. In addition, such traders could not have easy access for high quality and reliable information as institutional traders (such as banks and brokerage houses) can do, even if certain reforms have targeted this concern. In sum, their ability to correctly analyze news may be seriously detrimental, by introducing noise and increasing volatility especially in crisis periods. Thus, the traders' learning process still being in its early stages needs to be improved by better investment culture and spreading institutional trading.

4. Conclusion

Arab countries have shown a growing concern in developing their stock markets since the early 1990s, which explains their number and the many reforms undertaken in order to improve their liquidity and efficiency. These markets have shown a fair development regarding their size and liquidity even though the progress in terms of efficiency remains mixed if one refers to the empirical literature. However, conventional efficiency tests often applied to these emerging markets are considered inadequate since they do not account for non-linear and infrequent trading caused by thinness, lack of liquidity and regulatory changes. In addition, these tests measure the efficiency in a given point of time and do not account for its evolution over time, expected to move towards weak-form efficiency as markets evolve and traders become more sophisticated.

The Evolving Efficiency Test considered in this paper allows us to overcome these two problems. Thus, through this investigation we were able to shed light on the weak-form efficiency dynamics of 11 Arab stock markets besides looking whether reforms and contemporaneous crises affect their efficiency and to what extent.

The results reveal a clear departure from weak-form efficiency. Overall, efficiency paths of the 11 stock markets do not sufficiently improve towards the first quarter of 2009, except Saudi stock market. Besides, their efficiency paths are instable being affected by the contemporaneous crises. In addition these markets are highly sensitive to past shocks indicating that undesirable shocks exert their influence for a long period. Although, many markets have experienced sub-periods of efficiency improvement while Tunisia, Oman and Morocco markets' efficiency is highly instable without any tendency towards weak-form efficiency.

In sum, the results stand in contrast with developed mature markets, represented here by AMEX, and reveal the ineffectiveness of the reforms undertaken during the last decade which could hamper the steady development of the financial systems in these economies. Since efficiency improvements seem to be positively related to market size, efforts to expand and deepen these markets should then be a prime concern. To achieve this end Arab country could for example rely on speeding up the base of privatization, diversifying financial services and improving the investment climate in order to channel more domestic and/or foreign savings to equity markets. In the mean time, liquidity provision function should be improved by introducing market making besides counteracting the shortcomings of the large individual trading by enhancing investment culture and wide spreading institutional trading.

Appendix A. Mean equation estimations

Mean equation regression		T-statistic	Diagnostic statistics DW	Q(16)	$Q^2(16)$	B–G LM(16)	ARCH LM F- stat(16)
Saudi Arabia							
Constant	0.00025	1.236737	1.82	136.34	4395.0	8.62	89.44
				(0.00)	(0.00)	(0.00)	(0.00)
Kuwait							
Constant	0.000756***	3.699065	1.53	229.81	1018.3	11.07	25.5
				(0.00)	(0.00)	(0.00)	(0.00)
Tunisia							
Constant	0.000674***	4.49	1.57	134.95	622.07	8.53	36.09
				(0.00)	(0.00)	(0.00)	(0.00)
Dubai							
Constant	0.00031	0.584761	1.88	80.147	813.85	3.90	24.41
				(0.00)	(0.00)	(0.00)	(0.00)
Egypt							
Constant	0.000999**	2.35453	1.66	82.6	350.04	5.05	17.48
				(0.00)	(0.00)	(0.00)	(0.00)
Qatar							
Constant	0.000227	0.451673	1.45	151.1	1189.2	9.58	29.61
				(0.00)	(0.00)	(0.0027)	(0.00)
Jordan							
Constant	0.00043***	2.77984	1.52	266.00	5178.6	18.92	105.43
				(0.00)	0.00	(0.00)	(0.00)
Abu Dhabi							
Constant	0.000203	0.532	1.40	179.75	760.61	11.89	22.05
				(0.00)	(0.00)	(0.00)	(0.00)
Bahrain							
Constant	−0.00228***	−4.31434	1.43	72.71	133.67	3.85	4.69
				(0.00)	(0.00)	(0.00)	(0.00)
Morocco							
Constant	0.000301	1.629573	1.34	269.27	807.34	18.55	29.22
				(0.00)	(0.00)	(0.00)	(0.00)
Oman							
Constant	0.000299	0.714454	1.47	171.4	1453.1	12.42	38.88
				(0.00)	(0.00)	(0.00)	(0.00)
AMEX							
Constant	0.000185	0.74558	1.92	44.677	2707.8	3.11	69.73
				(0.00)	(0.00)	(0.00)	(0.00)

P-values of the coefficients are reported in parentheses. DW is Durbin–Watson statistic. $Q(16)$ and $Q^2(16)$ are Ljung-Box statistics for standardized residuals and squared standardized residuals of order 16. B–G LM(16) is Breusch–Godfrey serial correlation LM test of order 16. ARCH LM(16) is the heteroskedasticity test F-statistic of order 16. ***, ** and * indicate significance levels at 1%, 5% and 10% respectively.

Appendix B. Efficiency dynamics of Arab stock markets

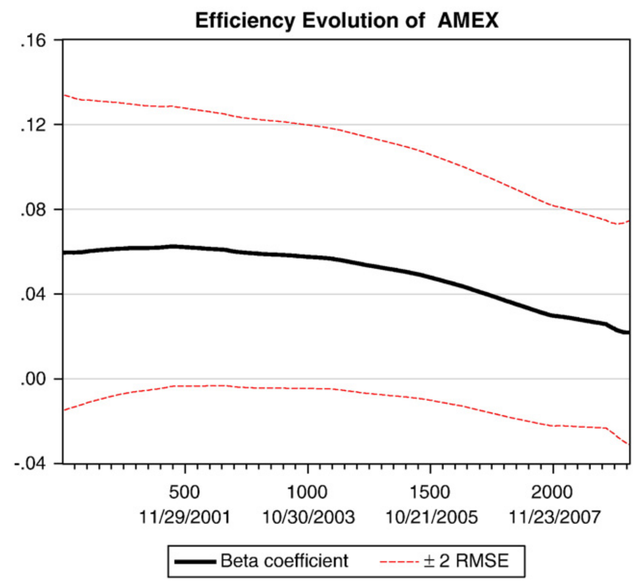

Fig. 1.

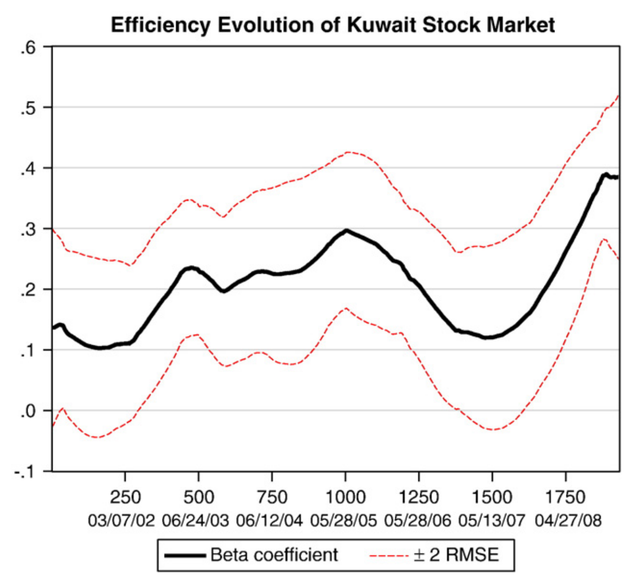

Fig. 2.

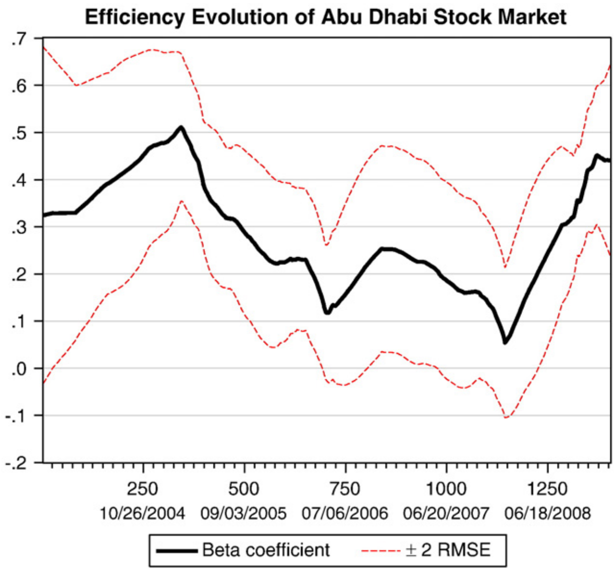

Fig. 3.

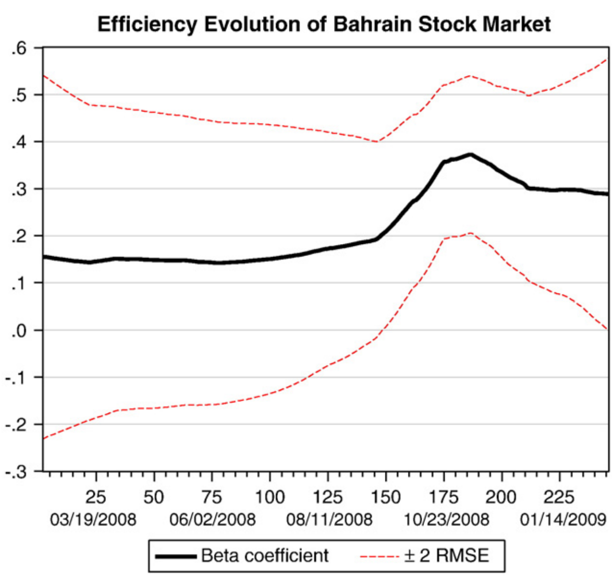

Fig. 4.

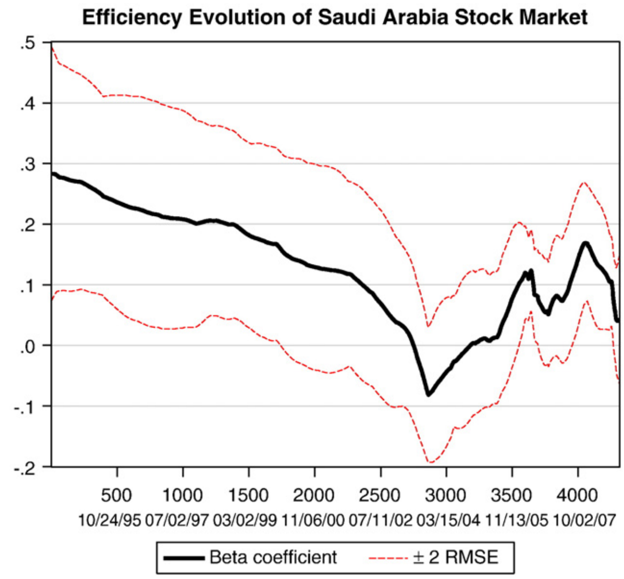

Fig. 5.

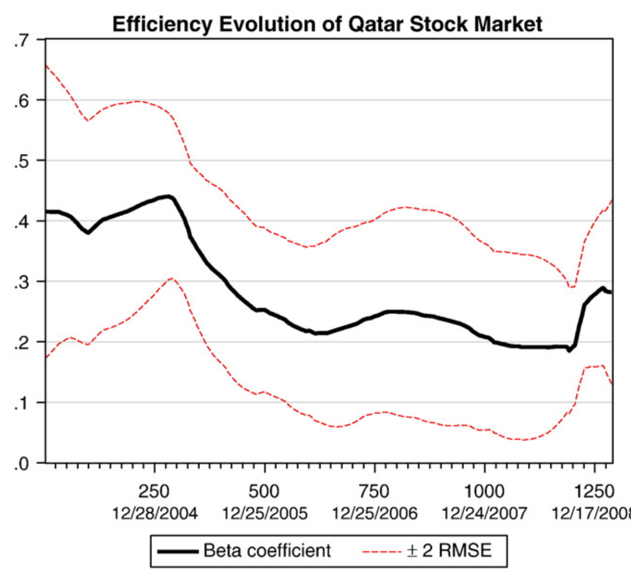

Fig. 6.

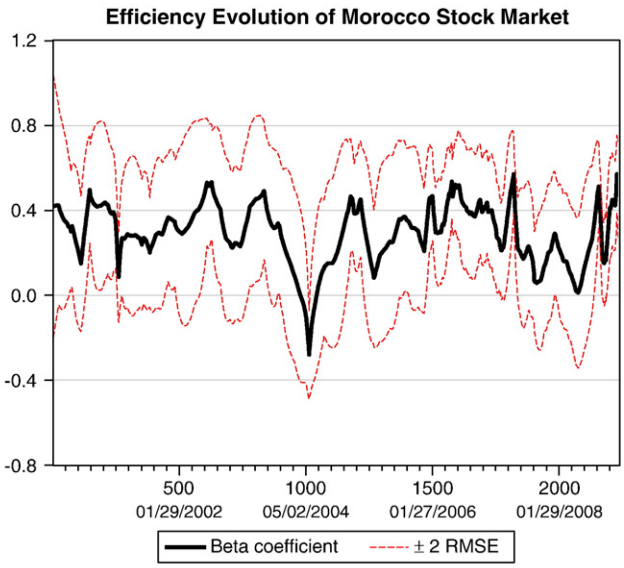

Fig. 7.

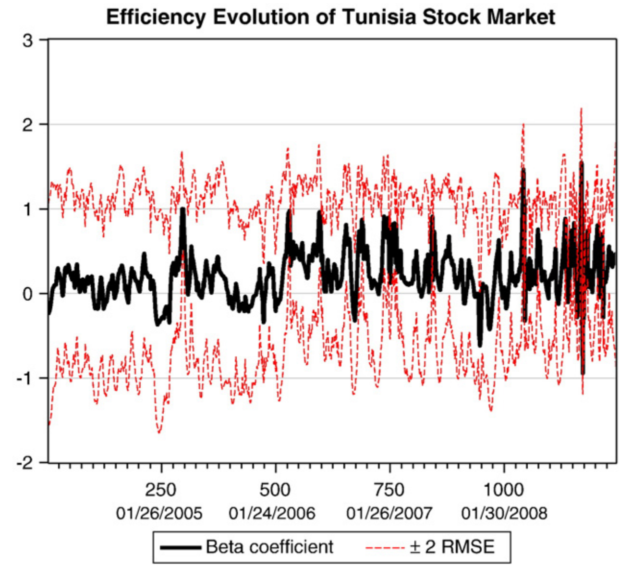

Fig. 9.

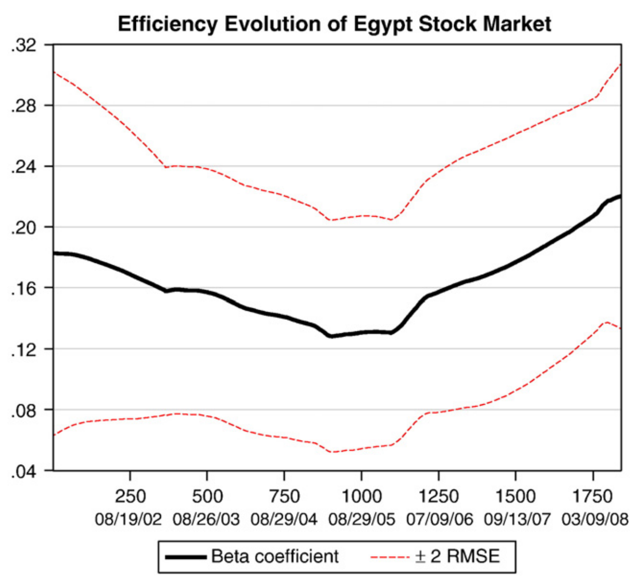

Fig. 8.

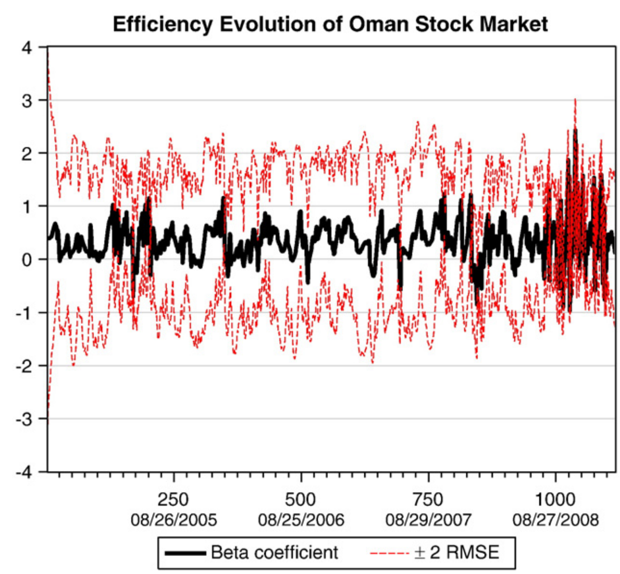

Fig. 10.

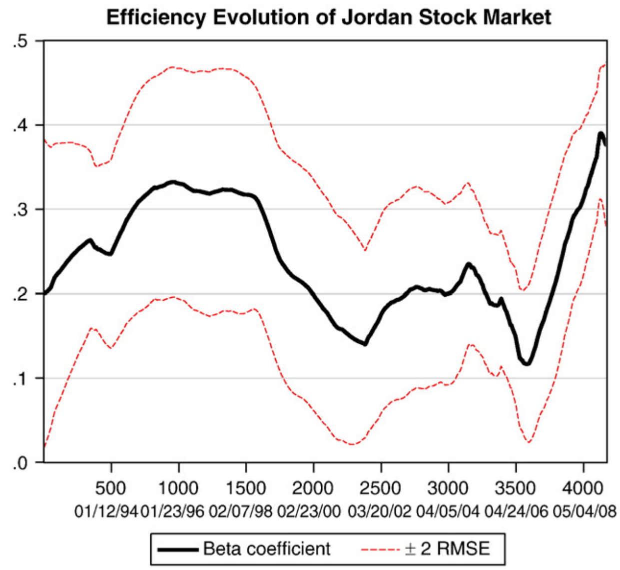

Fig. 11.

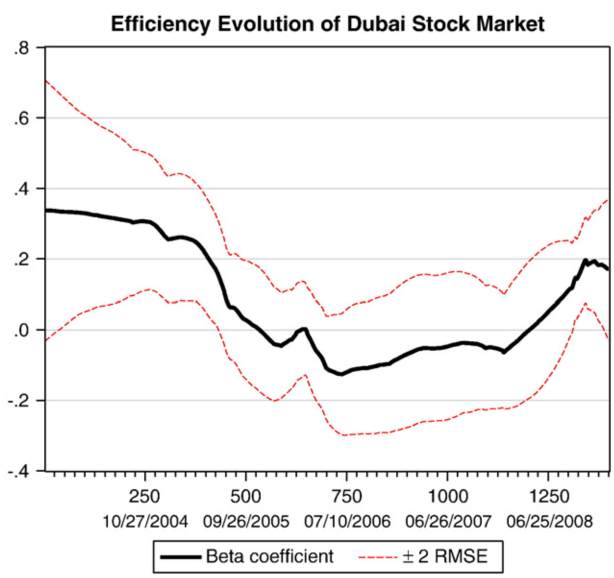

Fig. 12.

References

Abraham, A., Fazal, A. J., & Sulaiman, A. (2002). Testing the random walk behavior and efficiency of the Gulf stock markets. *The Financial Review*, *37*, 469−480.

Abrosimova, N., Dissanaike, G., Linowski, D., 2005, Testing the weak-form efficiency of the Russian Stock Market. Social Science Research Network (SSRN) Working Paper. http://papers.ssrn.com/ sol3/papers.cfm?abstract_id=302287

Alagidede, P., & Panagiotidis, T. (2009). Modelling stock returns in Africa's emerging equity markets. *International Review of Financial Analysis*, *18*, 1−11.

Al-Loughani, N. E. (1995). Random walk in thinly traded stock markets: The case of Kuwait. *Arab Journal of Administration Science*, *3*, 189−209.

Anand, A., C. Tanggaard, C., Weaver, D.G., 2006. Paying for Market Quality. Rutgers University. Working Paper.

Andersen, T. G., Bollerslev, T., Diebold, F., & Labys, P. (2003). Modeling and forecasting realized volatility. *Econometrica*, *71*, 579−625.

Antoniou, A., Ergul, N., & Holmes, P. (1997). Market efficiency, thin trading and non-linear behavior: Evidence from an emerging market. *European Financial Management*, *3*(2), 175−190.

Asal, M. (1998). *Are there trends towards efficiency for the Egyptian stock market. School of Economics and Commercial Low.* Sweden: University of Goteborg.

Asiri, B. (2008). Testing weak-form efficiency in the Bahrain stock market. *International Journal of Emerging Markets*, *3*(1), 38−53.

Awad, I., & Daraghma, Z. (2009). Testing the weak-form efficiency of the Palestinian securities market. *International Research Journal of Finance and Economics*, *32*, 7−17.

Bessembinder, H., Hao, J., Lemmon, M.L., 2007. Why Designate Market Makers? Affirmative Obligations and Market Quality . http://ssrn.com/abstract=989061

Bollerslev, T. (1986). Generalised autoregressive conditional heteroscedasticity. *Journal of Econometrics*, *31*, 307−327.

Bollerslev, T., Chou, R. Y., & Kroner, K. F. (1992). ARCH modeling in finance. *Journal of Econometrics*, *52*, 5−59.

Butler, K. C., & Malaikah, S. J. (1992). Efficiency and inefficiency in thinly traded stock markets: Kuwait and Saudi Arabia. *Journal of Banking and Finance*, *16*, 197−210.

Civelek, M. A. (1991). Stock market efficiency revisited: Evidence from the Amman stock exchange. *The Middle East Business and Economic Review*, *3*, 27−31.

Coronel-Brizio, H. F., Hernandez-Montoya, A. R., Huerta-Quintanilla, R., & Rodriguez-Achach, M. (2007). Evidence of increment of efficiency of the Mexican Stock Market through the analysis of its variations. *Physica A: Statistical mechanics and its applications*, *380*, 391−398.

Demarchi, M., & Foucault, F. (2000). Equity trading systems in Europe. *Annales d' Economie et Statistiques*, *60*, 74−115.

El-Erian, M. A., & Kumar, M. S. (1995). Emerging equity markets in Middle Eastern countries. *IMF Staff Paper*, *42*, 313−343.

Elyasiani, E., & Mansur, I. (1998). Sensitivity of the bank stock returns distribution to changes in the level and volatility of interest rate: A GARCH-M model. *Journal of Banking and Finance*, *22*, 535−563.

Emerson, R., Hall, S. G., & Zalewska-Mitura, A. (1997). Evolving market efficiency with application to some Bulgarian shares. *Economics of Planning*, *30*, 75−90.

Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of UK inflation. *Econometrica*, *50*, 987−1008.

Engle, R. (2001). GARCH 101: The use of ARCH/GARCH models in applied econometrics. *Journal of Economic Perspectives*, *15*(4), 157−168.

Fama, E. (1965). The behavior of stock market prices. *Journal of Business*, *38*, 34−105.

Fama, E. (1970). Efficient capital markets: A review of theory and empirical work. *Journal of Finance*, *25*(2), 383−417.

Hall, S., Urga, G., 2002. Testing for Ongoing Efficiency in the Russian Stock Market. http://www.nes.ru/~agoriaev/Papers/Hall-Urga%20ME%20time-varying%20Russia%2002.pdf

Handa, P., & Schwartz, R. (1996, Winter). How best to supply liquidity to a securities market. *The Journal of Portfolio Management*, 44−51.

Harrison, B., & Paton, D. (2004). Transition, the evolution of stock market efficiency and entry into: The case of Romania. *Economics of Planning*, *37*, 203−223.

Hassan, K. M., Al-Sultan, W. S., & Al-Saleem, J. A. (2003). Stock market efficiency in the gulf cooperation council countries (GCC): The case of Kuwait stock exchange. *Scientific journal of administrative development*, *1*, 1−21.

Huang, R. D., & Stoll, H. R. (1996). Dealer versus auction markets: A paired comparison of execution costs on NASDAQ and the NYSE. *Journal of Financial Economics*, *41*, 313−357.

Jeferis, K., & Smith, G. (2005). The changing efficiency of African Stock Markets. *South African Journal of Economics*, *73*(1), 54−67.

Lagoarde-Segot, T., & Lucey, B. M. (2008). Efficiency in emerging markets — Evidence from the MENA region. *Journal of International Financial Markets, Institutions & Money*, *18*, 94−105.

Li, X. M. (2003). China: Further evidence on the evolution of stock markets in transition economies. *Scottish Journal of Political Economy*, *50*(3), 341−358.

Lim, K. P., & Brooks, D. (2009). Price limits and stock market efficiency: Evidence from rolling bicorrelation test statistic. *Chaos, Solitons & Fractals*, *40*(3), 1271−1276.

Lo, A. W., & Mackinlay, A. C. (1988). Stock market prices do not follow random walks: Evidence from a simple specification test. *Review of Financial Studies*, *1*, 41−66.

Maghyereh, A. I., Omet, G.S., 2003. Electronic Trading and Market Efficiency in an Emerging Market: The Case of the Jordanian Capital Market. Available at SSRN: http://ssrn.com/abstract=364362 or doi:10.2139/ssrn.364362

Marashdeh, H., & Shrestha, M. B. (2008). Efficiency in emerging markets — Evidence from the Emirates Securities Market. *European Journal of Economics, Finance and Administrative Sciences*, *12*, 143−150.

McQueen, G., & Vorkink, K. (2004). Whence GARCH? A preference-based explanation for conditional volatility. *Review of Financial Studies*, *17*, 915−949.

Mecagni, M., Sourial, M., 1999. The Egyptian Stock Market: Efficiency Test and Volatility Effects. IMF Working Paper 48.

Miller, M. H., Kmuthuswamy, J., & Whaley, R. (1994). Mean reversion of standard and poor 500 index basis changes: Arbitrage-induced or statistical illusion. *Journal of Finance*, *49*(2), 479−513.

Moustafa, M. A. (2004). Testing the weak-form efficiency of the United Arab Emirates Stock Market. *International Journal of Business*, *9*, 3 Available at SSRN: http://ssrn.com/abstract=551102

Muslumov, A., Aras, G., & Kurtulus, B. (2003). *Evolving market efficiency in Istanbul Stock Exchange. Istanbul Technical University selected articles.* Available at SSRN: http://ssrn.com/abstract=890077

Nelson, D. (1991). Conditional heteroscedasticity in asset returns: A new approach. *Econometrica*, *59*, 347−370.

Onour, I. A. A. (2004). *Testing weak-form efficiency of Saudi Stock Exchange Market.* Available at SSRN: http://ssrn.com/abstract=611209

Poon, S. H., & Granger, C. W. J. (2003). Forecasting volatility in financial markets: A review. *Journal of Economic Literature*, *41*(2), 478−539.

Posta, V. (2008). Estimating the dynamics of weak efficiency on the Prague stock exchange using the Kalman filter. *Czech Journal of Economics and Finance*, *58*(5–6), 248−260.

Revest, V. (1999). *Structures de marché et évolutions des bourses de valeurs. CREI, document de travail.*

Rockinger, M., & Urga, G. (2000). The evolution of stock markets in transition economies. *Journal of Comparative Economics*, *28*(3), 456−472.
Rockinger, M., & Urga, G. (2001). The time varying parameter model to test for predictability and integration in stock markets of transition economies. *Journal of Business and Economic Statistics*, *19*(1), 73−84.
Seppi, D. (1997). Liquidity provision with limit order and a strategic specialist. *Review of Financial Studies*, *10*(1), 103−150.
Smith, G., 2004. Random Walks in Middle East Stock Markets. University of London. Working Paper.
Squalli, J. (2006). A non-parametric assessment of weak-form efficiency in the UAE financial markets. *Applied Financial Economics*, *16*(18), 1365−1373.
Tooma, E.A., 2003. Modeling and forecasting Egyptian stock market volatility before and after price limits. Working Paper 0310, Economic Research Forum, Cairo, Egypt.
Venkataraman, K., Waisburd, A., 2006. The value of the designated market maker, Journal of Financial and Quantitative Analysis. forthcoming.
Woertz, E. (2006). *GCC stock markets at risk. Gulf Research Center Working Papers. Dubai.*
Wright, J. H. (2000). Alternative variance-ratio tests using ranks and signs. *Journal of Business & Economic Statistics*, *18*(1), 1−9.
Zalewska-Mitura, A., & Hall, S. G. (1999). Examining the first stages of market performance: A test for evolving market efficiency. *Economics Letters*, *64*(1), 1−12.