EMPIRICAL TESTING FOR MARTINGALE PROPERTY: EVIDENCE FROM THE EGYPTIAN AND SOME SELECTED MENA STOCK EXCHANGES

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Dedication

To the absent who is always present in my heart, my father

Your dream has come true

“They said: “Are you indeed Yusuf (Joseph)?” He said “I am Yusuf (Joseph) and this is my brother (Benjamin). Allah has certainly favoured us. Verily, he who fears Allah with obedience to Him, and is patient, then surely, Allah does not allow to be lost the reward of good-doers.” Holly Quran: 12: verse 90.

Abstract

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In the current thesis, the efficiency of the Egyptian and other four MENA exchanges is examined. The first issue of interest is whether market efficiency in Egypt is related to size and regulatory changes. Employing weekly data for the period 1997-2007 and a battery of variance ratio tests (VRs), results indicated that the market was inefficient in pricing all securities during the first sub-period with tight price limits regime, however; it has become efficient in pricing securities, excluding small-capitalized firms, after the expansion of price limits coupled with adopting trading halt for few minutes if prices hit their new limits. The second issue considered is testing for weak-form-efficiency in five MENA exchanges during 1995-2009 using VRs in rolling window estimation to accommodate developments in the underlying exchanges. Results indicate that Turkish and Israeli exchanges are the most efficient throughout the whole period whereas both the Egyptian and Moroccan exchanges moved towards efficiency since late 2002 and the Jordanian exchange experienced inefficiencies during the end of the period. Exchange rates do not matter in determining the dynamics of equity markets examined. The last issue examined is the interdependence and information transmission across super sectors within the same exchange in Egypt, Turkey, and Israel. Multivariate cointegration analysis, which is executed from the domestic investor perspective, indicates the absence of long-term relationship in either exchange. In general, generalised impulse responses indicate that a positive shock in one index in either exchange affects other indexes in the same exchange. However, this impact tapers off quickly. More importantly, most of the impact is on the index experiencing the innovation and the effect on the remaining indexes is relatively small.

List of Abbreviations

Abbreviation	Stands for
ADF	Augmented Dickey Fuller
ADRs	American Depository Receipts
AIC	Akaike Information Criterion
ARCH	Autoregressive Conditional Heteroscedasticity
ASE	Amman Stock Exchange
BAN	Banks
BFRCON	Blaire-Franch and Contreras (2004)
BRES	Basic Resources
CHEM	Chemicals
CHODE	Chow and Denning (1993)
CMA	Capital Market Authority.
CMAI	Capital Market Authority Index
CMAT	Constructions & Materials
CSE	Casablanca Stock Exchange
ECM	Error Correction Mechanism
EFGI	the Egyptian Financial Group Index
EGX	the Egyptian Exchange
EGID	Egypt for Information Dissemination
EMH	Efficient Market Hypothesis
FIN	Financial Services
GARCH	Generalised Autoregressive Conditional Heteroscedasticity
GIRFs	Generalised Impulse Response Functions
HCAR	Health Care
HFI	Hermes Financial Index
J-B	Jarque-Bera
JR_1 and JR_2	joint rank tests
JS_1	Joint sign test.
INDS	Industrial Goods & Services
INSU	Insurance

IPOs	Initial Public Offerings
ISE	Istanbul Stock Exchange
KISH	Kim and Shamisuddin (2008)
KPSS	Kwiatkoski-Phillips-Schmidt-Shin (1992)
LM	Lagrange Multiplier
LOMAC	Lo and MacKinlay (1988)
MCDR	Misr for Central Clearing, Depository, and Registry
MDS	Martingale Difference Sequence
MENA	Middle East and North Africa
MH	Martingale hypothesis
MSCI	Morgan Stanley Capital International
MSCI-Egypt	MSCI-Egypt price index
MSCI-L Cap	MSCI-Egypt Large capitalization price index
MSCI-M Cap	MSCI-Egypt Medium capitalization price index
MSCI-S Cap	MSCI-Egypt Small capitalization price index
MVR	Multiple Variance Ratio
OGAS	Oil & Gas
PHGDS	Personal and Household Goods
PIPO	Prime Initial Public Offerings Index
R_1 and R_2	Single rank tests of Wright (2000)
REST	Real Estate
RW	Random Walk
RW1	Random Walk 1 Model
RW2	Random Walk 2 Model
RW3	Random Walk 3 Model
RWH	Random Walk Hypothesis
S_1	Single Sign Test of Wright (2000)
SIC	Schwarz Information Criterion
SMM	Studentized Maximum Modulus
TASE	Tel Aviv Stock Exchange
TEE	Test of Evolving Efficiency

TELE	Telecommunications
VAR	Vector Autoregression
VR	Variance Ratio
WBCHODE	The Wild Bootstrapped version of CHODE test, robust for heteroscedasticity, introduced by Kim (2006)
WFEMH	Weak Form Efficient Market Hypothesis
UR	Unit Root

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Chapter one

Introduction

1.1. Introduction and Background of the Research Topic:

A stochastic process $\{P_t\}$ satisfying condition 1.1 (or equivalently 1.2) is said to a martingale (Campbell *et. al,* 1997).

$$E[P_{t+1}|P_t, P_{t-1}, P_{t-2}, \ldots..] = P_t \qquad 1.1$$

where E is the expected value operator

$$\text{Or} \quad E[P_{t+1} - P_t|P_{t-1}, P_{t-2}, \ldots..] = 0 \qquad 1.2$$

If P_t represents an asset price at date *t*, then the martingale hypothesis (MH) states that tomorrow's prices is expected to be equal to today's price, given the security's entire price history. In other words, the asset price is likely to rise as it is to fall and, thus, conditioned on its past history, the asset's expected price change is zero. Accordingly, a martingale is considered as a fair game which is neither in one's favour nor in his/her opponent's. Campbell *et. al,* (1997) proposed three versions of the random walk hypothesis (RWH), as development of the MH, as it would be described later. If stock prices of an exchange are found to satisfy the MH (or RWH), then it is said to be informationally efficient in pricing securities since information included in past prices is instantaneously, fully, and continuously incorporated in the securities' current prices.

The stock market is a vital institution in the financial system of any country since its major role is to improve the mobilization of savings, the provision of equity capital to the corporate sector, and the promotion of efficient investment choices via continuous monitoring of equity prices and the possibility of merger and acquisition (Mecagni and Sourial, 1999). Achieving and sustaining high levels of informational efficiency plays a key objective for capital market development for three reasons. The

efficiency of the stock market in allocating capital[1] to the most productive sectors of the economy crucially depends on its informational efficiency[2] [(El-Erian and Kumar, 1995) and (Lagoarde-Segot, 2009)]. Second, by serving as a conduit for improved corporate governance, unbiased market prices may be used as managerial incentives[3]. Third, by conveying information through price signals, public confidence in market mechanisms improves, thereby decreasing risk premia for domestically listed firms (Lagoarde-Segot, 2009). Thus, testing for informational efficiency is still very attractive area for empirical finance.

According to Fama (1970), a market is informationally efficient if relevant information is fully, rapidly, and correctly reflected into securities' prices. The efficient market hypothesis (EMH) is based upon a number of sufficient, but not necessary[4], conditions to achieve this informational efficiency in capital markets. These conditions are the absence of transaction costs, free availability of information to all, and agreement amongst investors on the implication of information on securities' prices. The EMH requires only two necessary conditions. First, it necessitates that the market is

[1] In addition to allocative efficiency, there is another distinctive form of efficiency that is closely related to the informational efficiency that is operational efficiency. Operational efficiency is concerned with costs of conducting transactions on the market.

[2] A well- functioning stock exchange plays an important role for attracting foreign private investments and stimulating domestic savings leading to achieving higher rates of economic growth. If stock markets are characterised by the absence of informational impediments, financial assets prices are likely to adjust rapidly to new information regarding prospects for investment and the business environment. On the other hand, if they are characterised by gradual dissemination of less reliable information regarding companies' performance and policies, market participants may find difficulties in selecting investment opportunities. Such uncertainty results in high levels of volatility and would probably induce potential investors to shorten their investment horizons or to pull out altogether from the market. Likewise, the supply of the investable resources may be shrunk if investors fear being penalized for bearing risk. In addition, excessive volatility may weakness confidence and deters risk-neutral or risk-averse investors (Mecagni and Sourial, 1999).

[3] Note that if a manager fails to fully and credibly reveal information to outside investors and lenders, then the firm is unlikely to be able to raise the outside funds necessary to undertake a worthy investment project.

[4] For the EMH to hold true, it is not necessary for each, or all, of these assumptions to be met. For instance, the market can still be efficient in pricing securities if a sufficient large number of traders have access to the necessary information. What is more, Fama (1991) introduced a weaker definition of the EMH, to take into account information and trading costs, in which a market is described as efficient if securities' prices reflect information up to the point where the marginal benefits of acting on the information (the expected profits to be made) do not exceed the marginal costs of collecting it.

aware of all available and relevant information in the sense that it is not ignored. Formally speaking, this means that the information set employed by the market (Φ_t^m), at time *t*, to determine the price of security is equivalent to the true information set (Φ_t) (Thompson and Lead, 1999). According to the information set available to market participants, Fama (1970) classified market efficiency into three sub-categories: weak−form, semi strong−form and strong−form[1]. In the weak- form EMH [hereafter WFEMH], where current securities' prices fully reflect all what is known from historical prices and trading volumes, Φ_t includes the sequence of price history**.**

The hypothesis to be tested for WFEMH is whether past returns help predicting future returns (Fama, 1991). If this form of the EMH is supported, then technical analysis is ineffective in the sense that information contained in the past history of prices has been already analysed and acted on by the market participants. Thus, securities are not overvalued or undervalued[2] ((Thompson and Lead, 1999).

The second necessary condition required by the EMH, which is often referred as rational expectations element of the EMH, asserts that the market correctly uses the available information in the sense that the expected return can be viewed as a fair game model in which no system of trading rules can reap higher expected returns than the equilibrium expected returns derived by the market. In other words, the actual returns

[1] Both semi and strong-versions of market efficiency are out of the scope of the current study.

[2] In the semi-strong form of the EMH, Φ_t expands to include publicly available information (e.g. earnings announcements, dividends and capitalisation changes). Therefore, the hypothesis of concern is the speed of adjustment to incorporate such announcements into shares' prices (Fama, 1991). The validity of the semi-strong form of EMH implies that both fundamental and technical analysis are useless as all publicly available information has been exhaustively analysed and acted on by an enormous number of specialists (Thompson and Lead, 1999). In the strong form of the EMH, Φ_t encompasses the other two sets of information and privately held information. Such strong form investigates whether any group of investors have private information which is not completely incorporated into market prices (Fama, 1991). Accordingly, if this form holds true, attempts of utilizing monopolistic access to information are unsuccessful because this information has already been reflected in market prices (Thompson and Lead, 1999)

can be randomly greater or lesser than expected returns, but on average, unexpected returns must be zero[1] (Thompson and Lead, 1999).

In principle, the EMH is a joint test of both the fair game property (whether the market efficiently utilizes the information contained in the information set) and the validity of the model of price determination (market equilibrium model) incorporated into the hypothesis. The common equilibrium-pricing model in tests of stock market efficiency is the hypothesis that expected returns are constant over time (Fama, 1991). Thus, the share price in an efficient market, reflecting the share's worth or rather estimate its value, derived under some assumptions[2], changes because of fluctuations in expected fundamentals reflected in changing expectations of future dividends. These fluctuations in expectations are in turn caused by the release of new information that arrives randomly (Thompson and Lead, 1999). In the view of this, the price of a share is comprised solely of a permanent or fundamental component. This permanent component may be represented by a random walk (RW) model with drift, in which the autoregressive root, α, equals one, which is expressed by 1.3.

$$p_t = \mu + \alpha\, p_{t-1} + \varepsilon_t \qquad 1.3$$

Where p_t, p_{t-1}, μ, and ε_t are the natural logarithm of share price at time t, time t+1 the drift parameter, and the error term, respectively. Given that the autoregressive root α equals unity for a RW process, equation 1.3 can be rewritten as follows:

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[1] Under the EMH, the stock price P_t already incorporates all relevant information, and the only reason for prices to change between time *t* and time *t+1* is the arrival of news or unexpected events. Thus, forecast errors (the difference between the expected price at time t+1, $E(P_{t+1})$, and the actual price observed at time t+1, P_{t+1}) should be zero, on average, and should be, according to the orthogonality property, independent of any information Φ_t that was available at the time of the forecast made (Cuthbertson and Nitzsch, 2005).

[2] These assumptions are rationality of all investors who are risk neutrals; dividends growth is not explosive and the transversality condition holds; and all investors have homogenous expectations.

$$p_t - p_{t-1} = \mu + \varepsilon_t \quad \text{Or} \quad a_t = \mu + \varepsilon_t \qquad 1.4$$

Campbell *et.al*, (1997) classified the RW with drift into three models: (1) the strongest version of the RWH, known as Random Walk 1 model or RW1, is the independently and identically distributed (IID) price increments, (2) Random Walk 2 model (RW2), a weaker version of the RWH which includes RW1 as a special case, relaxes the assumption of identical increments but still keeps the assumption of independence, and (3) Random Walk 3 model (RW3), encompassing RW1 and RW2 as special cases, relaxes the independence assumption to accommodate stylized facts of financial series such as volatility clustering by allowing for ARCH effects since the EMH and rational expectations assumptions place restrictions only on the behaviour of the first moment (i.e., expected value of ε_t has to be zero) but they place no restrictions on the form of the second and higher moments of the distribution of ε_t (Cuthbertson and Nitzsch, 2005).

It is worth noting that RW1, RW2, and RW3 are all nonstationary and their conditional means and variances are both linear in time. Given these distinctive features of the RW process, unit root (UR) tests and variance ratio (VR) tests have been widely used by finance scholars to examine any deviation from the RW. The former approach focuses on the nonstationary component of the RW process (i.e. testing whether the autoregressive root, α, equals unity). The latter approach gives attention to stationarity component of the random walk process (i.e. ε_t) by examining whether the variance of the underlying process is linear in time interval.

Lo and MacKinlay (1988) [hereafter LOMAC] utilized the property that the variance of the RW is proportional to time interval and introduced their single VR tests

to test for RW1 and RW3[1]. The intuition behind the VR test is the following: if p_t is a RW then the variance of its q-differences grows proportionally with the difference q. Thus, the variance of *q*-period returns (i.e. $Var(a_t^q)$, where Var is the variance operator) is q times the variance of one period returns (i.e. $Var(a_t)$), which could be expressed in 1.5. Accordingly, the VR for lag q, VR(q) expressed in 1.6, could be defined as the ratio of the variance of q-period return to q times the variance of one-period return, should be equal unity for any holding period q.

$$\frac{Var(a_t^q)}{Var(a_t)} = q \qquad 1.5$$

$$VR(q) = \frac{1}{q}\frac{Var(a_t^q)}{Var(a_t)} = 1 \qquad 1.6$$

LOMAC (1988) proposed two test statistics, which are asymptotically standard normal, under the assumption of homoscedasticity and heteroscedasticity to test for RW1 and RW3, respectively. In empirical work, it is customary to investigate whether the VRs for several pre-determined holding periods are equal to unity [for weekly and monthly data, widely-used holding periods are q=2, 4, 8, and 16 (see for example (LOMAC, 1988). For daily data, commonly-used time intervals are q=2, 5, 10, 20 and 40 [see, for example, Kim and Shamisuddin (2008) [hereafter KISH]]. LOMAC approach focuses on testing individual VRs for a specific aggregation interval, q, however; the RWH requires that VRs for all aggregation intervals selected should equal

[1] Testing for independence without assuming identical distributions is quite problematic for time series data. If no restrictions are imposed on how the marginal distributions of the underlying data can vary through time, it would be almost impossible to perform statistical inferences because the sample distributions of even the most elementary statistics cannot be derived. Two branches of empirical research, namely; filter rules and technical analysis could be viewed as economic tests of RW2, however; neither of these approaches makes much use of statistical inference (Campbell *et.al*, 1997). Empirical testing for RW2 is out of the scope of the current study.

unity. Hence, testing for RWH necessitates conducting a joint test in which a multiple comparison of VRs over a set of different time intervals is made; thereby using LOMAC tests is misleading as it tends to overreject the null hypothesis of a joint test. The multiple VR (MVR) tests of Chow and Denning (1993) [hereafter CHODE] provides a joint test through controlling the size of the test. By treating the LOMAC test statistics as Studentized Maximum Modulus (SMM) variates, they developed their joint test which is able to reduce the Type I error and control the size of a MVR. Yet, both LOMAC and CHODE tests are asymptotic tests whose sampling distributions are approximated by their limiting distribution and, therefore, may show small sample deficiencies. Hence, literature proceeds in two directions: (1) Wright (2000) introduced a new VR test based on ranks and signs (R_1, R_2, S_1 and S_2 where R_1 and R_2 are exact under assumption of homoscedasticity and the two latter are exact under assumption of heteroscedasticity)[1] which are exact tests whose sampling distribution do not resort to asymptotic approximation and are more powerful than the conventional VR when returns are highly nonnormal, (2) Kim (2006) introduced a wild bootstrap version of CHODE [henceforth WBCHODE] which is applicable to data with unknown forms of conditional and unconditional heteroscedasticity. What is more, Blaire-Franch and Contreras (2004) [henceforth BFRCON] and KISH (2008), independently, proposed joint ranks (JR_1 and JR_2) and joint sign (JS_1) VR tests as refinements of exact single rank and sign VR tests of Wright (2000).

UR tests [e.g. ADF and KPSS tests] have been widely employed by researchers to test for nonstationarity feature (Lim and Brooks, 2011). If price series is found to contain UR, then, a shock to the series has a permanent effect and, thus, there is no tendency to

[1] It is worth mentioning that Wright's (2000) S_2 is not considered here, as Monte Carlo simulation performed by him indicated that its size and power properties are quite inferior to those of S_1.

revert to its mean[1]. The finance literature employs cointegration analysis to addresses the WFEMH through testing for information transmission across international (regional) exchanges [e.g. Kasa (1992), Chan *et. al,* (1997), and Phengpis and Apilado (2004)] or across sector (industry) indexes in a single market (Berument *et.al,* 2005). The rationale behind employing cointegration approach in testing for WFEMH is that: if two price series are found to be cointegrated, then there must be Granger causality, at least in one direction, between them which raise the possibility of using information content in one series to help forecasting the other, implying violation of the WFEMH. The main idea behind cointegration is that if two variables say x_t and y_t are individually integrated of order one and have a long-run equilibrium relationship, then they are said to be cointegrated. If shocks in the short-run disturb this relationship causing disequilibrium, there must exist an Error Correction Mechanism (ECM) tries to restore the equilibrium relationship between these two variables. The main idea of the ECM is that "a proportion of the disequilibrium from one period is corrected in the next period". Accordingly, changes in one variables are related to past changes in both variables and to past equilibrium error. To illustrate how the existence of cointegration between two nonstationary variables violates the WFEMH, consider a system of two variables x_t, y_t which are individually integrated of order one, then Δx_t and Δy_t are stationary, depending on that, a simple form of ECM can be (Marashdeh, 2006):

$$\Delta x_t = a_1 + \beta_1\left(x_t - \delta\, y_t\right) + a_{1x}\Delta x_{t-1} + a_{2x}\Delta y_{t-1} + \varepsilon_{x,t} \qquad (1.7)$$

$$\Delta y_t = a_2 + \beta_2\left(x_t - \delta\, y_t\right) + a_{1y}\Delta x_{t-1} + a_{2y}\Delta y_{t-1} + \varepsilon_{y,t} \qquad (1.8)$$

[1] Campbell *et.al* (1997) differentiated between UR tests and RWH tests (i.e., tests of return's predictability based on their own history). They argued that the focus of UR tests is not on the predictability of stock returns which is the concern under the RWH. They pointed out that while the RWH is encompassed in the UR hypothesis, it is the permanent (or transitory) nature of the shock to p_t series that concerns UR tests. Thus, by construction, tests of UR are not designed to test for predictability implied by the RWH.

Where $\varepsilon_{x,t}$ and $\varepsilon_{y,t} \sim IN(0,\sigma^2), (x_t - \delta\, y_t)$ is the error correction term which measures past equilibrium error, β represents the speed with which the model adjusted itself to its equilibrium level. The coefficients a_{2x} and a_{2y} represent the short-term linear causality from y_t to x_t, and from x_t, to y_t, respectively. Hence, any deviation from long-run equilibrium relationship is corrected to keep the stability of the system as a whole. For a speculative market with constant expected equilibrium returns, equations 1.7 and 1.8 represent a manifest violation of WFEMH since information contained in past prices could be employed to improve the forecast of the current prices.

A relatively less explored area of research has been the linkage between sector indexes within the same exchange, with a handful number of studies undertaken to date [e.g. (Ewing, 2002) and (Berument *et.al*, 2005)]. This branch of studies is quite important from the point of view of both domestic investors who are interested in diversifying their portfolios across industries in their local exchanges and policymakers concerned with designing policies to prevent the potential negative transmission of shocks from the influential sector, if any, to others (Wang *et.al*, 2005).

1.2. Motivation and Objectives of the Current Research

The current research is motivated by the inconclusive conclusion regarding testing for own-history-return-predictability in Egypt and other Middle East and North Africa (MENA) countries, namely; Jordan, Morocco, Turkey and Israel, and the rare investigation of information transmission across sector indexes within the same exchange as shown in table A.1.1 in Appendix (1). These countries have been involving in economic reform policies since late 1980s and early 1990s. Waves of privatizations and regulatory improvements yielded significant results. For example, market capitalization represents 31% of GDP in MENA for 2003 compared to 24% and 26% in

Latin America and Eastern Europe in the same year, respectively (Lagoarde-Segot and Lucey, 2007b). In contrast to emerging equity markets of Latin America and Asia, which have received extensive empirical analysis, equity markets in MENA have not been attracted enough attention by scholars as noticed by Smith (2007) and Lagoarde-Segot and Lucey (2008a). Lagoarde-Segot and Lucey (2007a, b) has suggested that the stock markets of this group (the five markets mentioned above in addition to Tunisia and Lebanon) are partially segmented from world and regional influences; thereby they offer alternative opportunities for international portfolio diversifications.

From table A.1.1, one could address three features that motivate the current empirical work as follows. First, although Al-Khazali *et.al* (2007) Lagoarde-Segot and Lucey (2008a), and Smith (2008) investigated the issue of WFEMH in the Egyptian Exchange (EGX) during the period 1994−2003, 1998−2004, and 2000-2006, respectively, they did not capture the effect of changes in price limits imposed on the daily movements of listed shares during their study periods by means of non-overlapping sub-samples. In addition, whether the EGX's efficiency is related to firm size has not been highlighted by any study. Scholars addressed the issue of price limits on the dynamics of EGX focused on their impact on conditional volatility [e.g. Tooma (2003), and Tooma and Sourial (2004)].

Second, the study conducted by Lagoarde-Segot and Lucey (2008a) is the only one to investigate the issue of WFEMH in MENA countries under investigation as a group. More importantly, with the exception of three studies [i.e. Yilmaz (1999), Jefferis and Smith (2004), and Maghyereh (2005)], all studies addressed whether the market(s) under examination is (are) in agreement with WFEMH in an absolute sense, with an implicit assumption that the level of market efficiency remains unchanged throughout the entire period of estimation. In addition, the impact of the recent financial

crisis on testing for WFEMH has not been highlighted for this group of countries. Third, the area of information transmission between sectors in the same exchange has been only highlighted for Turkey (employed old and limited dataset covering only three sectors) and Jordan.

Thus, the objective of the first empirical chapter (chapter three) is to address the issue of whether the efficiency of the EGX is related to size and regulatory changes. This objective is achieved through (i) employing eight indexes tracking the performance of different assets (e.g. large, medium, and small-capitalized firms), and

(ii) dividing the period under consideration into two non-overlapping periods: the first one, in which narrow price limits of ±5% imposed on daily movements of listed shares, extends from 2nd of February 1997 to 21st of July 2002, whereas the second period stretches from 22nd of July 2002 to 29th of June 2007 where the price boundaries were expanded and accompanied by applying trading halt for a period of 30 minutes, 45 minutes or until the end of the trading session if the weighted average price of stocks hit the limits of ±10%, ±15% or ±20% respectively, when compared to their opening prices[1].

Imposition of price limits is thought to hinder price discovery as equity prices are prevented from efficiently reaching to their equilibrium levels (the delayed price discovery hypothesis). The adverse effect of tight price limits on stock market efficiency has been confirmed for other exchanges such as Korea (Ryoo and Smith, 2002) and Taiwan (Chen and Ting, 2000). In addition the relation between efficiency

[1] The period before imposing the price limits on 2nd of February 1997 is not included in the analysis because data of MSCI indexes tracking the performance of small, medium, and large-cap firms are available from June, 1996. Using weekly data, as recommended by LOMAC (1988) to avoid bias inherent in daily data, few number of observations would be available for this period.

and firm size is well documented in literature even for developed exchanges such as Tokyo and London exchanges (Hung *et.al*, 2009). In this regard, the argument is that: large-capitalised stocks, with the availability of more information, tend to follow RW (Ryoo and Smith, 2002) whereas small- capitalised stocks require more time to incorporate new information into prices inducing strong positive autocorrelation in small-sorted portfolios (LOMAC, 1988). Conventional VR tests (i.e. LOMAC and CHODE) and the other sophisticated tests (WBCHODE, JR_1, JR_2, and JS_1) are employed to compare their inferential outcomes.

Campbell *et.al*, (1997) debated that perfect efficiency is an unrealistic benchmark that is unlikely to be attainable in practice or in theory. They emphasised that, by citing the work of Grossman and Stiglitz (1980), if markets are perfectly efficient in the sense that investors are not compensated for the cost of information gathering and processing, then there will no incentive to trade and, hence, markets will eventually collapse. For this reason, Campbell *et.al*, (1997) proposed the concept of relative efficiency, which is the efficiency of one market measured against another. They indicated that relative efficiency may be a more useful concept than all-or-none view investigated by bulk of market efficiency literature. In addition, it is sensible to expect the evolution of market efficiency over time due to changes in macro-institutions, market regulations and information technologies (Lim and Brooks, 2011). For this reason, Emerson *et.al* (1997), when testing for WFEMH in Central and Eastern Europe transition economies, claimed that a more relevant hypothesis to be tested is how such embryonic markets move towards efficiency since it takes time for the price discovery process to become known. Employing VR tests in overlapping sub-samples is advocated in this regard since the main objective of rolling window estimation is to gauge how frequent the RW is rejected during the entire sample period. Accordingly, a suitable measure of

constructing efficiency ranking is the percent of sub-samples in which the null of RW has to be rejected, where a larger percent implies an inferior degree of informational efficiency (Lim and Brooks, 2011). In addition, rolling window procedure, by tracking the evolution of market efficiency through time, can be used to identify the factors that lead markets to become efficient (e.g. the introduction of electronic trading system) and events that coincide with those times when underlying stock price series deviate from a RW such as financial crisis (KISH, 2008).

Thus, the objective of the second empirical chapter (chapter four) is to re-examine the issue of WFEMH for Egypt, Jordan, Morocco, Turkey and Israel[1] during the period 1995-2009, employing multiple VR tests [WBCHODE, JR_1, JR_2 and JS_1] in rolling window procedure. Following Kim (2004), the rolling procedure is applied in a fixed window size of 260 observations (equivalent to 5 year of employed weekly data)[2]. By doing this, the issue of evolving market efficiency across time and relative efficiency of the employed countries are addressed. In this framework, factors leading to achieve market efficiency and/or events coincide with observable inefficiencies could be identified and, therefore, the issue of whether the recent American mortgage crisis [hitting the international financial markets by the second half of 2007] affect the efficiency of employed countries could be addressed. Financial crises characterized by panic and high levels of volatility and uncertainty are likely to adversely affect the ability of investors to efficiently price securities (Lim and Brooks, 2011). The analysis

[1] In addition to these five countries, Lagoarde-Segot and Lucey (2008a) examined the issue of WFEMH, in its absolute sense, for Tunisia and Lebanon. The seven countries are members of the Euro-Mediterranean partnership. In order to keep homogeneity of the data, Tunisia and Lebanon are not considered since their performance is not tracked by any international institution (e.g. MSCI).The use of a single provider for the indices is generally recommended for cross-market comparisons since it provides a homogenized framework.

[2] Kim (2004) employed three sizes of the fixed window corresponding to 5, 10, and 15 years because he employed large period compared to that considered here. However, his findings showed insensitivity of results to the size of the window.

will be executed using weekly MSCI (Morgan Stanley Capital International) data denominated in both local and US dollar to introduce results from the perspective of local and international investors.

The objective of the third empirical chapter (chapter five) is to investigate information transmission across super sector indexes within the same market. In other words, the chapter is concerned with exploring long and short-term interdependence between sub-indexes within the same exchange via answering the following questions: Do sub-indexes within the same exchange share common stochastic trends? Do they influence each other in the short-run? What is the speed of adjustment to their own shocks and shocks from other sectors?

DataStream categorizes industries, as defined by the Financial Times classification, into 19 super sectors. However, due to lack of sectoral diversification in MENA exchanges as recognized by other studies (Bennacuer *et.al*, 2009), daily data of six super sector indexes are employed for each exchange. The employed indexes account for approximately 85%, 80%, and 72% of total market capitalization during the period 2003-2007 in the Egyptian, Turkish, and Israeli exchanges, respectively. Due to unavailability of data for Morocco and Jordan, they are excluded from the analysis. Following other paper cited in information transmission literature (e.g. Wang *et.al*, 2005), the multivariate cointegration approach of Johansen's is going to be employed. It has been argued that macroeconomic shocks [e.g. a sudden monetary tightening or rise in expected inflation] would affect all economy sectors and, thus, different sectors will move together in responding to such shocks. On the other hand, some shocks are related to specific sectors within the market. Therefore, if the shocks are not common across sectors, it is unlikely that these sectors would co-move. Particularly, if aggregate unit roots are generated by technology, it is not likely that growth innovations will be

common across sectors. For example, improved technology in service quality in tourism may not be helpful in the home equipment sector [(Ewing, 2002) and (Berument *et.al*, 2005)]. Other tools employed in the chapter to address the issues of interdependence between super sectors include Granger causality tests and generalised impulse response functions.

1.3. Contribution of the Research

The current thesis contributes to the debate regarding the efficiency of stock markets in five MENA countries, namely Egypt, Jordan, Morocco, Turkey, and Israel. Distinguished from previous work [e.g. Smith *et.al*, (2002) and Lagoarde-Segot and Lucey (2008a)] studied these exchanges, the current work highlighted three issues have not been addressed when studying WFEMH in these countries. These three issues are:

(1) The impact of firm size and regulatory changes on the efficiency of the EGX.
(2) Evolving efficiency over time, the impact of American subprime crisis on their informational efficiency, and relative efficiency of employed exchanges.
(3) The issue of information transmission across sub-indexes within the same exchange is addresses for the Egyptian and Israeli exchanges for the first time and re-examined for Turkey using a recent period and a different dataset with wider sectoral coverage.

Main findings of the research could be summarized as follows:

(1) It seems that the relaxation of price limits, accompanied with improvements in the trading infrastructure and environment, has had a positive impact on the efficiency of the EGX. The claim that prices of large-capitalized firms tend to follow martingale property has been demonstrated in the second sub-period

when price boundaries were expanded where prices of small- capitalized firms are found in disagreement with WFEMH in the two sub-periods.

(2) For the Egyptian, Moroccan, and Jordanian exchange, the degree of efficiency varies across time. The Israeli and Turkish exchanges were found efficient through all subsamples and, thus, they are ranked as the most efficient among employed exchanges. Generally speaking, exchange rates do not matter in determining the dynamics of equity markets examined here. The recent financial crisis seems not to have significant influence on employed markets. However, the Jordanian exchange experienced inefficiencies at the end of the study period, overvaluation of the Jordanian equities stems from the spillover effects from neighbouring oil-producing countries that experienced sharp increase in oil prices. A process of price correction took place when Arab investors withdrew considerable funds from the Jordanian market and thus it restored its efficiency.

(3) No cointegrating vectors are detected between sub-indexes in either exchange, indicating the possibility of domestic portfolio diversification among these indexes in long run. In the short-term, the results of generalized impulse response functions, generally, indicate that the a positive shock in one index has positive impact on other indexes, however, most of the impact is on the index experiencing the innovation and the effect on the remaining indexes is relatively small and taper off after few days.

1.4. Structure of the Research

The thesis is going to be presented in six chapters. This current chapter has introduced an overview of the research area, motivation, objectives and significance of the thesis. The second chapter is concerned with reviewing some recent studies testing for WFEMH with reference to issues related to information efficiency in the stock markets

under investigation. The third Chapter investigates whether the issue of WFEMH in the EGX is linked to regulatory changes and firm size. Chapter four addresses the issue of evolving efficiency over time and the relative efficiency of employed exchanges. Chapter five highlights the issue of information transmission between super-sector indexes within the same exchange. Finally, Chapter six concludes.

Appendix 1:

Table A.1.1: Empirical research on WFEMH of MENA stock markets employed in the current research

Study	data	Methodology	Market	Main findings
Mecagni and Sourial (1999)	D: 1994 to1997	AR(1)-GARCH(p,q)-M	EGY	The significance of the AR(1) coefficient indicates departures from efficiency.
Smith *et.al*, (2002)	W: 1990-1998	CHODE	EGY, MOR among other MENA counties	EGY and MOR are not efficient.
Maghyereh (2005)	D: 1/1/1999 to 30/8/2002	GARCH approach with time-varying parameters.	JOR	Efficiency of the Jordanian exchange has not been affected by introducing the new electronic trading system in 2000.
Omet *et.al*, (2002)	D: 1992-2000	AR(1)-GARCH(1,1)-M model	JOR	Significant departure from WFEMH.
Yilmaz (1999)	W: 1998-1998 Local-currency based data set.	CHODE in rolling window estimation.	TUR, ISR, JOR	Moves towards efficiency by the end of the period
Al-Khazali *et. al*, (2007)	W:1994 to 2003, US dollar-based dataset	R_1, R_2, S_1	EGY, JOR, MOR among other counties	Raw data for all countries were found violating the RW behaviour. However, they were found consistent with it after correcting for thin trading.
Bugak and Brorsen (2003)	W:1992 to 1999	LOMAC, R_1, R_2, S_1	TUR	LOMAC could not reject the null hypothesis whereas other tests reject the RW behaviour.
Jefferis and Smith (2005)	W:1993-2001 for EGY and 1990-2001 for MOR Local currency based data	GARCH approach with time-varying parameters.	EGY, MOR among other African counties	EGY and MOR moved towards efficiency at the end of the period (since 1999)

Haque *et.al* (2004)	W: 1988-2002	LB-Q, LOMAC, runs	EGY, JOR, MOR, ISR, among 10 MENA counties	EGY and MOR are predictable whereas JOR and ISR are not.
Lagoarde-Segot and Lucey (2008a)	D: 1998 to 2004- local and US dollar datasets were employed	LOMAC, CHODE, WBCHODE, R_1, R_2	EGY, JOR, MOR, TUR ISR	According to LOMAC, CHODE, WBCHODE, the WFEMH has to be rejected for Egypt and Morocco but not for Jordan, Israel and Turkey, irrespective of the currency used. Reject the null for Egypt and Morocco when WBCHODE is employed. When R_1, R_2 were employed, the RW has to be rejected for Egypt, Jordan, Morocco, for both currencies and for Israel when series expressed in US dollar is employed.
Smith (2008)	W and M: 2000-2006	WBCHODE, JR_1, JR_2, JS_1	EGY, MOR, among 11 African exchanges	EGY is efficient but MOR is not.
Berument *et.al*, (2005)	D:1/2/1997 to 24/9/2003 3 Sector indexes: Service, Industrial and Financials	UR and cointegration tests	TUR	Sector indexes do not share a common stochastic trend.
Al-Fayoumi *et al.*, (2009)	D:3/9/2000 to 30/8/2007, three sector indexes (Service, Industrial and Financials) and the general index.	UR and cointegration tests	JOR	The four indexes are related in the long-run via one cointegrating vector. In the short-run, sector returns reflect information from other sectors, and there are significant information flows within the Jordanian exchange.

D= daily, W=weekly, M= monthly, LB-Q Ljung‑Box Q statistic R_1, R_2, S_1 are rank, rank score, and sign tests of Wright (2000), WBCHODE=the wild bootstrapped version of CHODE test introduced by Kim (2006), JR_1 and JR_1 are joint rank tests of BFRCON (2004), JS_1 = joint signs test of KISH (2008) EGY=Egypt, JOR=Jordan, MOR=Morocco, TUR=Turkey, ISR=Israel.

Chapter Two

Testing for WFEMH for Stock Markets: Review and Special Reference to Related Issues in MENA Exchanges

2.1. Introduction:

If share prices do obey the RWH, the market is said to be informationally efficient in the weak sense since securities prices reflect all available information that is relevant to their valuation[1]**.** The RWH has three testable implications. First, securities' prices increments are serially uncorrelated [the least restrictive version of RWH, i.e., RW3]. Second, the variance of returns is a linear function of the time interval over which they are computed. Third, price series are nonstationary.

The first feature of uncorrelated price increments has been investigated by the examination of correlation structure of financial returns [e.g. Fama (1965), Claessens *et. al*, (1995) and Haque *et. al*, (2004)] or in a regression-based methodology where the mean and variance equations of return series are, respectively, modelled employing AR (or ARMA) process and the ARCH class models[2] [e.g. Mecagni and Sourial (1999), Harrison and Paton (2007) Panaiotdis (2010)]. The second feature has been investigated using VR tests first introduced by LOMAC (1988) and its recent refinements proposed by CHODE (1993), Wright (2000), BFRCON (2004), Kim (2006), and KISH (2008).

Finally, the third feature of nonstationarity of price series has been tested by UR tests and extended to include cointegration analysis to address the issue of interdependence between international financial markets, an area that has been

[1] It is worth mentioning that if equity prices are found to follow RW, then it followed that (1) they do not exhibit any patterns at specific dates and (2) it should be impossible for any trader to reap abnormal returns. Thus, two branches of literature investigate the WFEMH by means of (1) testing for seasonalities through examining the calendar patterns such as January effect [see for example, (Brown *et.al,* 1983), Maghyereh (2002) and (Choudhry, 2001)] and (2) examining the profitability of trading strategies based on past returns such as momentum and contrarian strategies (see, for example, Chou *et. al*, 2007). These two approaches are not considered in the current study.

[2] This traditional framework is extended by Zalewska-Mitur and Hall (1999) who applied GARCH-M model with time-varying parameters to capture smooth changes in the level of efficiency over time instead of assuming this level to be constant during estimation period.

extensively explored[1]. The main contribution of this stream of literature is providing useful information for portfolio diversification purposes. A relatively less investigated area is the information transmission across sub-indexes (e.g. sector or industry indexes) in a single country with handful number of studies conducted to the date [e.g. Wang *et.al* (2005) and Squalli (2005)].

The present chapter aims at reviewing some empirical findings of own –history returns' predictability literature (i.e. empirical work concerned with testing for the first and second features of RW) and information transmission literature (i.e. testing for the third feature of RW by means of cointegration technique). Given the voluminous literature covering both areas, the current chapter is restricted to review those studies questioned the issue of short-horizon predictability of stock returns on the basis of past price changes and those addressed the issue of information transmission across sub-indexes within the same country. In addition, it concerns with addressing issues related to market efficiency in exchanges under consideration. Related issues to information efficiency, as recognised by other researchers, include accounting standards, market size, liquidity, market microstructure, and financial liberalisation, [(Jefferris and Smith, 2004), Yilmaz (1999), Smith (2009), and (Füss, 2005)].

This chapter is organised as follows: section 2 reviews empirical work on returns-own-history predictability whereas section 3 focuses in empirical work related to information flows across sectors (industries) within the same market. Section 4

[1] See for example, Kanas (1988) Kasa (1992), Jeon and Chang (1991), Arshanapalli and Doukas (1993), Arshanapalli *et al*. (1995) who investigated interdependence between international exchanges mainly between US market and other European and/ or Asian markets. In addition, comovements between regional markets [Gunduz and Omran (2000) for Middle East and North Africa markets, Assaf (2003) for Gulf Corporation Countries, Chen *et .al,* (2002) for Latin America, Deffusco *et.al* (1996), Serletis and King (1997) and Horobet and Lupu (2009) for European countries] have also been widely addressed by scholars.

highlights issues linked to market efficiency in MENA exchanges under examination. Finally, section 4 concludes.

2.2. WFEMH: Own-history Returns' Predictability

The literature investigating the RWH based on returns-own-history predictability is voluminous, and, thus, trying to cover it is infeasible. Thus, the current study mainly focuses on recent empirical findings concerned with testing for serial linear dependence in the mean of return series. The first generation of studies on WFEMH during 1960s [Fama (1965 and 1970)[1]] provided an overwhelming support for the WFEMH since no evidence of autocorrelation in return series was found. However, literature emerged since the second half of 1980s, employing more sophisticated econometric methodologies compared to those of the first generation studies, did provide support in favour of return predictability. LOMAC (1988) presented evidence that the WFEMH is robustly rejected for the New York Stock Exchange. Since this seminal work, a variety of papers applying LOMAC VR tests have found mixed evidence for a number of countries and sample periods [e.g. Squalli (2006) for the two exchanges of United Arab Emirates, Dockery and Vergari (1997) for the Budapest Stock Exchange, Ma (2004) for the two equity markets of China, Urrutia (1994) for Argentina, Brazil, Mexico and Chile]. Similarly, for predictability of international equity markets [Claessens *et.al*, (1995), Haque *et.al*, (2004) and Parto and Wu (2004)], the conclusion is not definite.

Given the misleading nature of LOMAC tests as pointed out by CHODE (1993), scholars applying CHODE tests [Karemera *et.al* (1999) for 15 of emerging equity

[1] Fama (1991) conducted a second review of market efficiency, in which WFEMH tests are named tests of return predictability enlarging the information set to include other economic variables, and concluded that returns are predictable from past returns and other economic variables but he claimed that apparent return predictability could be spurious due to data dredging and specific conditions of employed samples.

markets, Smith *et.al* (2002) for eight African exchanges, Jefferis and Smith (2004) for the South African Exchange, Smith (2007) for five MENA exchanges] found evidence of returns' predictability-based on past history. Other recent improvements to VR methodology (e.g. WBCHODE and joint rank and sign tests) motivated scholars to re-visit the WFEMH for different countries [Smith (2009) for 10 European emerging markets, Al-Khazali *et al.*, (2007) for seven of MENA exchanges, Smith (2008) for some African markets, Charles and Darńe (2009) for Latin American exchanges, and Lagoarde-Segot and Lucey (2008a) for seven MENA exchanges].To conclude, the evidence of testing for WFEMH is still inconclusive and yields some contradictory conclusions even for the same country [e.g. results of Al-Khazali *et al.*, (2007), Smith (2008) and Lagoarde-Segot and Lucey (2008a) for the Egyptian exchange)]. This could be attributed to the different frequencies employed and the period covered by the study. More importantly, all above mentioned studies addressed the issue of WFEMH in an absolute sense assuming, implicitly, that the level of market efficiency remains unchanged during the entire sample employed.

Another strand of literature concerned with factors affecting the market (in)efficiency addresses the issue by means of non-overlapping subsamples. Implementation of price limit system and financial crisis are among those factors that might hurt market efficiency. Price limits delay full incorporation of information into prices (price discovery mechanism is delayed to the following days when prices hit their lower or upper limits) and, thus, prevent prices from reaching their equilibrium levels (Tooma, 2005). Chang and Ting (2000) and Ryoo and Smith (2002) concluded that price limits adversely affect market efficiency in Taiwan and South Korea, respectively. The occurrence of financial crisis is likely to negatively affect market

efficiency since, in times of financial turmoil characterized by panic, investors are probably unable to price securities efficiently [(Yilmaz, 1999) and (Lim and Brooks, 2011). This concern motivated Hoque *et al*. (2007) and KISH (2008) to explore the impact of the 1997 financial crisis on efficiency of eight emerging Asian equity exchanges and Auer and Schuster (2011) to investigate the impact of the recent U.S. subprime mortgage crisis on international markets. Hoque *et al*. (2007) found that the crisis has not significant effect on the degree of efficiency since six of employed exchanges showed signs of inefficiency in the pre- and post-crisis periods. KISH (2008) found that the multiple VR tests employed agreed that the stock markets of Taiwan, Hong Kong, and Japan were efficient in the pre- and post-crisis periods, yet, for the other six exchanges, the effect of the financial turmoil is difficult to identify given that no agreement could be reached by the three tests employed. Auer and Schuster (2011), applying a battery of MVR tests for data of 55 countries (23 developed, 21 emerging and 11 frontier equity markets), concluded that the majority of developed and emerging markets were found to be efficient before and during the crisis whereas most of the frontier markets are not during the aforementioned periods.

Among factors thought to positively influence market efficiency are opening the domestic markets to foreign investors and the adoption of an electronic trading system. It is argued that the liberalization of a stock market improves the conditions for market efficiency since the number of market participants increases resulting in higher trading volumes and values which reflects greater tendency for securities' prices to incorporate important market information (Füss, 2005). Given that the majority of foreign investors are institutional investors with large portfolios, the cost of purchasing information is low relative to the sums they invest in these markets, thereby the equity portfolio

inflows to emerging markets would result in an increase in demand for information. In response to this, brokerage firms would be keen to allocate more resources to information gathering and processing. This, in turn, would increase the availability of information regarding individual stocks, sectors, and the whole economy to both international and local investors bringing the exchange closer to efficiency (Yilmaz, 1999). Kim and Singal (2000a, b) and Füss (2005) concluded that stock markets, in general, become efficient after allowing the participation of foreign investors. However, findings of Kawakatsu and Morey (1999a, b) revealed that employed emerging markets were consistent with WFEMH even before the actual market opening date. Proponents of the positive impact of automation on market efficiency advocate that the execution process of trades becomes faster and less costly. Additionally, traders have access to broader information including bid and ask prices, and trading activities occur at lower costs due to the existence of a limit order book. In Such computerized system, it is expected to attract more investors, boost trading volume and liquidity and improve the price discovery process (Maghyereh, 2005). Naidu and Rozeff (1994) found positive impact of automating the Singaporean Stock Exchange on its efficiency whereas Sioud and Hmaied (2003) and Maghyereh (2005) found no evidence that automation has led the Tunisian or the Jordanian exchanges, respectively, to become efficient.

However, it may be more reasonable to expect market efficiency to evolve over time in a dynamic manner that is likely not to be captured by an arbitrarily breakpoint as assumed by the approach of non-overlapping sub-periods (Lim and Brooks, 2011). To capture the possibility of smooth changes in market efficiency, Zalewska-Mitura and Hall (1999) developed the "test of evolving efficiency" (TEE) that extends the classical test for autocorrelation of returns by applying GARCH-M model with time-

varying parameters. The changing degree of predictability (and therefore weak-form-efficiency) is captured by the time-varying autocorrelation coefficients. If the estimates of time-varying autocorrelation coefficient smoothly converge toward zero until it becomes insignificant, then the market under examination is said to move towards efficiency. This approach has been applied to Budapest exchange (Zalewska-Mitura and Hall, 1999), Jordanian exchange (Maghyereh, 2005), and to seven African exchanges (Jeffris and Smith, 2005). Results revealed that either the Budapest or the Jordanian exchanges moved towards efficiency whereas Jeffris and Smith (2005) found that three markets (Egypt, Morocco and Nigeria) moved towards efficiency by the end of estimation period and that the South African exchange remained efficient throughout the whole period.

Another approach to track the evolving efficiency over time is employing VR tests in a rolling window framework [Yilmaz (1999), Kim (2004), KISH (2008), Zulfadin (2008) and Hung *et.al* (2009)]. Apart from their findings, which are summarized in table A.2.1 in appendix (2), Lim and Brooks (2011) pointed out that the application of a rolling window essentially helps in (1) capturing the persistence of stock price departures from a random walk benchmark over time, (2) allowing to assess the relative weak-form efficiency of stock markets where the market with lowest percentage of rejecting WFEMH is ranked as the most efficient, (3) identifying the events that coincide with periods of information inefficiency (e.g. financial crisis), and (4) determining the impact of postulated factors on the degree of market efficiency (e.g. financial liberalization).

2.3. WFEMH: Information Flows across sub-indexes Within the Same Country

Cointegration analysis, considered to be a sound technique for modelling both short- and long-term dynamics, has been used by a handful number of empiricists to investigate interdependence between sub-indexes within the same country. This branch of studies address the following questions: Do sector indexes of certain exchange share common stochastic trends? Do exist Granger causality amongst them? If, any, in which direction? How does an index respond to its own shock and to shock from other sectors? What is the speed of adjustments to these shocks? To answer these questions, scholars utilize a package of econometric techniques, includes cointegration, Granger-causality, impulse response functions and variance decomposition. Raising these issues is quite important from the point of view of both domestic investors who are interested in diversifying their portfolios in their local exchanges and policymakers concerned with designing policies to prevent the potential negative transmission of shocks from the influential sector to others as such transmission might create financial instability during a crisis, which could further spread to the production side of the economy (Wang *et.al*, 2005).

Ewing (2002) employed the generalised forecast error decomposition to examine the interrelationships among the five major S&P stock indexes over the post-1987 crash period. He indicated that shocks to an index of the five major S&P stock indexes can account for much of the fluctuation in other indexes. Arbeláez *et.al*, (2001) found that daily movement of sector indexes in the Colombian exchange share a common stochastic trend. In the short-term, the indexes exhibit Granger causality in about 50% of the cases. Results also indicated that a high percentage of error variance

is accounted for by the innovations in the same index and that the responses to innovations in other indexes are rapid and persistent. For the two exchanges in the United Arab Emirates, Squalli (2005) identified a long-run equilibrium relationship between the banking, services, and the general index across the two markets. General and banking indexes of Abu Dhabi Securities Market were found Granger-cause their corresponding Dubai Financial Market indices. Given the existence of one cointegrating vector between daily movements of the 12 sector indexes in Cyprus, Constantinou *et.al,* (2008) examined all bivariate systems of cointegration among employed indexes where they were unable to reject the null hypothesis of no cointegration in most bivariate cases and, thus domestic investors could construct portfolios to include stocks from the sectors which are not cointegrated.

Berument *et.al* (2005) found no evidence of cointegration between daily movements of three sector indexes in Istanbul Stock Exchange. Similarly, Wang *et.al*, (2005) found no evidence of cointegration between sector indexes in the two Chinese stock exchanges in Shanghai and Shenzhen. In the short-run, sector returns reflect information from other sectors, and there are strong information flows, not only within each exchange, but also across both Shanghai and Shenzhen markets. Hence, potential diversification benefits from sector-level investment may be relatively limited given the significant linkages and high contemporaneous correlations found among sector returns.

Patraa and Poshakwaleb (2008) tested for information transmission across main six sectors accounting for more than 63% of the total market capitalization in the Athens Stock Exchange. Using daily data for the period 1996-2003, they concluded that, with the exception of Banking and Construction sectors, long-term relationship

among the Athens sectoral indexes is not statistically significant. In line with this, the variance of returns for most sectors is largely influenced by their own innovations, with the ability of banking sector to explain around 15% to 25% of the variance of other sectors. Thus, banking sector index could be potentially used in predicting short term movements in other sector indexes.

Gee and Abd-Karim (2005) examined interactions between Malaysian sector indexes during 1994-2002, which was divided, based on the currency crisis occurred on 1997, into pre-crisis, crisis and post-crisis periods. According to the multivariate cointegration, common stochastic trends are only detected for the pre-crisis period for both daily and weekly data. The construction sector led other sectors during tranquil periods whereas the financial sector led other sectors during the turmoil period. The causal relationship seems to be more observable when daily data are employed indicating that the effects of shocks tap off quickly. Al-Fayoumi *et.al*, (2009) found that daily increments of Jordanian sector indexes are related in the long-run via one cointegrating vector. They reported that, in the short-run, sector returns reflect information from other sectors, and there are significant information flows within the Jordanian exchange.

2.4. MENA Exchanges: Special Reference to Informational Efficiency Related Issues:

Literature identifies some factors that are likely to influence the informational efficiency of stock markets. These factors include accounting standards, market size (measured by the absolute value of market capitalization and/or its ratio to gross domestic product (GDP)), liquidity, financial liberalisation, improvements in

microstructure (e.g. adopting automated trading system), quality of information and the speed it made available to market participants, and the enforcement of insider trading regulations [(Jefferris and Smith, 2004), Yilmaz (1999), Smith (2009), and (Füss, 2005)]. For example, Yilmaz (1999) concluded that emerging markets converge towards RW behaviour as they evolve through time from small, shallow and segmented markets into sizeable and liquid markets integrated with the world financial system. Disclosure of relevant information is a prerequisite for achieving reasonable degree of market efficiency (Füss, 2005). More importantly, the quality of disclosed information, and, hence, the market efficiency, depends on sound accounting laws and practices. Market liquidity could be viewed as the degree to which large transactions can occur in a timely fashion with minimal impact on prices. Market liquidity and size are of crucial importance to an investor's decision to invest in a particular market. Foreign and institutional investors are attracted to larger and more liquid stock markets since this ensures easy entry and exit from the market (Bakry, 2006). Liquidity facilitates the price formation process; with more frequent trading, prices are likely to respond to new information quickly and, consequently, the market is more likely to be in agreement with WFEMH (Smith, 2009). Thus, the current section introduces a brief description of MENA exchanges with special reference to informational-efficiency related issues.

Israel was the first among MENA countries to launch its economic reform programmes in 1985 followed by Turkey and Morocco (1989), Egypt (1992), and Jordan (1995). They have adopted several sound macroeconomic policies with the aim to overcome some macroeconomic imbalances and to achieve higher economic growth rates. These reforms include economic liberalization policies (e.g. fiscal, monetary and foreign trade policies, and relaxation of restrictions imposed on the flows of foreign

direct investments), and deregulation and privatization policies. Making major changes in the operation of MENA stock markets was one of the main objectives of reform policies. Since privatization lies in the heart of these programmes, stock markets are channels for divesting state-owned enterprises through public stock offering and as a venue enabling the private sector to raise capital [(Ghyselse and Cherkaoui, 2003), (Marashdeh, 2006) and (Lagoarde-Segot and Lucey, 2007b)]. After adopting privatization policies to some of their manufacturing industries and financial sector, MENA countries went ahead with the privatization of major infrastructure industries [e.g. telecommunications, electricity, gas, water and transport] which is a more recent phenomenon (Gentzoglanis, 2007)

The oldest stock markets in MENA are those of Egypt (Alexandria Stock Exchange was established on 1880 and Cairo Stock Exchange was established on 1903), Turkey (1929), and Morocco (1929). The relatively newly established exchanges in MENA countries under investigation are those of Israel (created on 1953) and Jordan (established on 1976). However, old MENA exchanges have experienced stagnation for more than 50 years (Marashdeh, 2006). For example, the Egyptian exchange witnessed a remarkable reduction in its activity due to nationalisation of industry and the adoption of central planning policies in 1950s [(Marashdeh, 2006) and (Mecagni and Sourial, 1999)]. MENA countries, as mentioned earlier, have undertaken economic reform policies that aim at enhancing the role of stock markets. To enhance this role and attract foreign investors, MENA countries under investigation took considerable actions to liberalize and improve the trading environment, as shown in table A.2.2 in appendix (2). Among these procedures and actions are: (1) relaxation (removal) of restrictions imposed on access of foreign investors to capital markets, (2) the

introduction of American depository receipts (ADRs)[1], (3) adopting automated trading systems, and (4) regulatory reforms that include establishment of regulatory bodies to ensure shareholders' protection and to monitor market activities.

To achieve international comparability in accounting disclosure, MENA countries have amended their national accounting standards to converge with the international set of financial reporting and accounting standards. Thus, all countries, currently, pass the transparency criteria and other criteria of market quality set by FTSE, as shown in table A.2.2 in Appendix 2. Regulatory framework that maximises equality among stock market shareholders is important to minimise the asymmetric information and, thus, to ensure market efficiency (Zulfadin, 2008). The principle of equitable treatment of shareholders (e.g. prohibition of market manipulation and insider dealing) is partially implemented in Turkey[2] (OECD, 2006), partially observed in Egypt, largely observed in Jordan and materially not observed in Morocco[3] (Harabi, 2007) whereas it has been successfully implemented in Israel (Israel Securities Authority, 2008)

Table A.2.3 in appendix (2) presents main financial indicators for MENA exchanges considered here. Market capitalization of exchanges under investigation

[1] ADRs are certificates issued by a US bank representing a particular number of stocks of a foreign exchange traded on a US stock exchange. Due to the availability of dollar-denominated price information, low transaction costs, and timely dividend distribution, it is expected that such certificates would make it easier for American investors to invest in foreign corporations (Marashdeh, 2006).

[2] It has been assessed as Partly Implemented, primarily for the following reasons: the definition of insider trading is relatively narrow, it is difficult to prove some elements (OECD, 2006)

[3] According to OECD assessment of corporate governance principles, largely observed= only minor shortcomings are observed, which do not raise questions about the authorities' ability and intend to achieve full observance in the short term, Partially observed= while the legal and regulatory framework complies with the principle, practices and enforcement diverge., and Materially not observed= it means that, despite progress, shortcomings are sufficient to raise doubts about the authorities' ability to achieve observance.

continued to grow during 1995−2007, and then it sharply dropped in 2008 influenced by the American subprime mortgage crisis. Istanbul Stock Exchange (ISE) of Turkey and Tel Aviv Stock Exchange (TASE) of Israel have the biggest markets sizes in terms of absolute market capitalization. In 2004, for example, market capitalization of ISE and TASE were US $ 98.3 billion and US $ 95.05 billion, respectively, which is approximately more than twice that of EGX, three times that of Casablanca Stock Exchange (CSE of Morocco) and five times that of Amman Stock Exchange (ASE of Jordan). The ratio of market capitalization to GDP, which reflects the stock market size as a percentage of the country's economic activity, provides deep insight into capital market size. Generally speaking, Jordan has the highest ratio of market capitalization to GDP through the whole period reaching its peak (232%) in 2007 whereas Turkey has the lowest percent of financial depth during the period under examination. The rank of Egypt and Morocco is approximately the same during the period under examination with Israel ranked the second. In 2006, for example, market capitalization to GDP ratio reached 118.83%, 86.97%, 75.2% and 30.59% for Israel, Egypt, Morocco and Turkey, respectively. Regarding the number of listed companies, Egypt has the largest number in 2002 (1148) which declined significantly to reach 305 in 2009. This could be explained by the fact that the number of companies that were de-listed, because they did not comply with the new listing requirements of 2002, exceeded the number of the new listed companies. It is worth mentioning that the large number of listed companies in the EGX up to 2002, most of them were infrequently traded, could be attributed to the tax advantages of being listed in the stock exchange as listed companies benefited from tax exemption equivalent to the value of paid-in capital times by interest rate determined by the Central Bank of Egypt (Bakry, 2006). By the end of 2009, Israel

ranked first with 609 listed companies, followed by Turkey (315), Egypt (305), Jordan (272) and Morocco (78), respectively.

Market liquidity could be measured by value traded, the ratio of value traded to GDP, and turnover ratio (the value of share traded/market capitalization) that measures the activity of market relative to its size. A small but active stock market will have a high turnover ratio whereas a large, but less liquid stock market will have a low turnover ratio (Bakry, 2006). Exchanges under examination have experienced booms in their activities which are reflected in the exponential increase in values of traded stocks by approximately 7666%, 2523%, 1110.7%, 373.8%, 863.9% for Egypt, Jordan, Morocco, Turkey, and Israel, respectively. With regard to the percent of value traded to GDP, it witnessed improvements for all countries during the study period with Turkey and Israel ranked the first and the second until 2001when the Jordanian exchange percent starts to have three-digit. According to turnover ratio, ISE is the most liquid exchange during the whole period with three-digit percent, TASE ranked second whereas other exchanges lack behind them, however, their liquidity has significantly increased from 12.33%, 28.89% and 6.38% in 2003 to 60.07%, 40.3%, and 45.73% in 2009 for Egypt, Jordan and Morocco, respectively.

2.5. Conclusion:

The current chapter aimed at (1) reviewing some recent empirical research tested for WFEMH through exploring short-horizon returns' predictability based on their past history and information flows across sector indexes within the same market, and (2) addressing issues related to market efficiency in MENA exchanges under examination. The handful number of studies concerned with interdependence among sub-indexes within the same exchange employed cointegration analysis as a sound technique for

modelling both short- and long-term dynamics. Studies interested with predictability of equity returns based on their own past, extensively used the VR tests, could be divided into three strands: (1) first strand questioned whether markets under examination are efficient or not in an absolute sense, assuming that the level of efficiency remains unchanged during the estimation period reached conflicting results even for the same country (2) second strand questioned the factors affecting market efficiency (e.g. financial liberalization and the introduction of automated trading system) by means of non-overlapping sub-periods, and (3) third strand explored the issue of smooth evolving of market efficiency over time by means of VR ratio in rolling window estimation and GARCH models with time varying parameters. The importance of applying VR tests in rolling procedure essentially stems from capturing the persistence of stock price departures from a random walk benchmark across time and allowing assessing the relative weak-form efficiency of stock markets.

Economic reform policies adopted by MENA countries in late 1980s and early 1990s focused on enhancing the role of their financial markets in economic activities. To improve the performance of their capital markets, MENA countries under investigation have undertaken considerable actions to liberalize their capital markets and to improve the trading environment. In addition, all countries have adopted international accounting standards; thereby they pass the transparency criteria and other criteria of market quality set by FTSE. However, more efforts are needed to ensure equitable treatment between shareholders.

Financial indicators for MENA exchanges indicated that ISE and TASE have the biggest markets sizes in terms of absolute market capitalization and Jordan has the highest ratio of market capitalization to GDP, and ISE is the most liquid exchange

during the whole period with three-digit percent, TASE ranked the second while other exchanges lack behind them, however, their liquidity has significantly improved during the period 2003−2009.

Appendix 2:

Table A.2.1: Some Selected Studies on WFEMH: Test for Own-history Returns' Predictability

Study	data	Type of the analysis	Methodology	Market	Main findings
LOMAC (1988)	W: 1965-1985	Absolute market efficiency	LOMAC	New York Stock Exchange	Reject MDS for returns of aggregate indexes and size-sorted portfolios, for the entire period and all sub-periods. Rejections cannot be explained by infrequent trading or time-varying volatilities.
Squalli (2006)	D: 30/9/2001 to17-9/2005	Absolute market efficiency	LOMAC and runs	United Arab Emirates: Abu Dhabi and Dubai stock markets.	RW1 and RW3 have to be rejected for all sector indexes in the two exchanges except for banking index of Abu Dhabi stock market.
Lock (2007)	W: 1997-2006	Non-overlapping sub-sampling	LOMAC	Taiwan	Reject WFEMH for the period 1977-1989 Do not reject WFEMH for the period 1990-2006 since the market become bigger and more liquid.
Ma (2004)	D, W, M	Absolute market efficiency	LOMAC, runs, serial correlation	China : Shanghai and Shenzhen stock markets	The three tests were not completely consistent in rejection (acceptance) of the null
Urrutia (1994)	M:1975:12 to 1991:3	Absolute market efficiency	LOMAC	Argentina, Brazil, Chile, Mexico	The null could not be rejected for Argentina, Brazil, Chile for investment horizon larger than 4 months
Dockery and Vergari (1997)	W: Janury-1991 to May-1995	Absolute market efficiency	LOMAC	Budapest Stock Exchange	Obeys martingale property.
Claessense *et. al*, (1995)	M	Absolute market efficiency	LOMAC, L-B (Q)	20 stock exchanges	Seven countries exhibit positive serial correlation.
Haque *et. al*,	W	Absolute	LOMAC,	Some selected	The three tests gave different results.

(2004)		market efficiency	runs, autocorrelation coefficient	countries in MENA	
Parto and Wu (2004)	D, W, M (1979-1998)			18 developed countries	Inference of martingale testing is sensitive to horizon, frequency, and currency domination (local and US$ currencies were used).
Karemera *et.al*, (1999)	M: 1987:12-1997:5 for 11 countries and 1986:1-1995:4 for 4 countries	Absolute market efficiency	LOMAC CHODE	15 emerging equity markets	Most countries were found to be consistent with the martingale hypothesis. Exchange rates matter in determining the dynamics of share returns in some of the examined countries that have had suffered from unsettled exchange rate regime (Argentina, Brazil, Hong Kong, Indonesia Mexico, the Philippines and Turkey) and countries that have had strict monetary and exchange rate controls (Singapore and Taiwan). They highlighted the misleading nature of LOMAC when investigating the martingale hypothesis.
Ryoo and Smith (2002)	D: March-1988 to December-1998	Non-overlapping Sub-samples	CHODE	Korea	When price limits imposed on daily movements of equity prices were relaxed, the market approached randomness
Füss (2005)	W	Non-overlapping sub-sampling	LOMAC CHODE, runs	Seven Asian emerging markets	Returns did not satisfy MDS. However, MDS has to be accepted, except for small markets of Indonesia and Thailand, in the post-liberalization period.
Hoque *et.al*, (2007)	W: April 1990 to February 2004	Non-overlapping sub-periods	LOMAC CHODE, R_1, R_2, S_1	eight emerging markets in Asia	The 1997 financial crisis does not have significant impact on the degree of efficiency with six of the employed markets found inefficient in the pre and post-crisis periods.
KISH (2008)	D, W 1990 to 2005	Non-overlapping sub-periods for weekly data and rolling window estimation	CHODE, WBCHODE, JS_1	Nine Asian equity markets	For weekly data, the sample is divided to pre-crisis (1990-1996) and post-crisis (1998-2005). Japan, Taiwan and Hong Kong were found efficient in the pre- and post- crisis periods. For the other six markets, the conclusion is indefinite since the three tests do not agree in the rejection/acceptance of WFEMH. Results from rolling window procedure indicated that level of market efficiency varies across time and across countries with Japan, and Hong Kong are ranked as the most efficient. Market

		for daily data			efficiency may depend on level of equity market development and regulatory framework.
Zulfadin (2008)	D: 1/11/1998 to 29/12/05 General index and ten sector indexes	Rolling window procedure	CHODE, WBCHODE, JS_1	Indonesia	Level of efficiency varies across time, general index mask (in)efficiency of sector indexes. Generally speaking, the Indonesia exchange is not efficient in pricing securities in most overlapping sub-samples.
Smith (2009)	W: 1988-2007	Absolute sense efficiency	WBCHODE, JS_1	12 equity markets (10 emerging European equities, UK and USA were included for comparative purposes)	Returns of UK, USA, Turkey, and Poland obeyed MDS. On the other hand, other markets violated the martingale hypothesis. He interpreted these results in terms of size, liquidity and market quality as markets for which MDS is rejected are small, illiquid and do not meet most of the 22 criteria set by FTSE for a stock market to be classified as developed.
Hung *et.al*, (2009)		Rolling window	CHODE, JR1, JR2, JS1	UK and Japan	WFEMH is supported for large-capitalised indices but not for small-capitalised firms.
Yilmaz (1999)	D and W: 1988 to 1998 – local currency based dataset	Rolling window procedure	CHODE	18 countries (12 emerging ones and 9 mature ones)	Emerging markets move towards RW behaviour as they evolve through time from small, illiquid, and segmented markets into sizeable and liquid markets integrated into the international financial system. For mature markets (e.g. USA and Japan) and those emerging markets with similar features to mature exchanges, equity prices appeared to satisfy martingale property. In addition, financial crises (e.g. Mexican and East Asian crises) adversely affected the ability of emerging markets to price equities efficiently.
Kim (2004)	W 1975:5 to 2002:7	Rolling window procedure	WBCHODE	Five Asian equity markets	MDS could not be rejected for returns of Japan, Hong Kong, and Korea but it has been soundly rejected for Taiwanese and Thai exchanges. Results were found insensitive to the size of the fixed window (5, 10, 15 years)

D= daily, W=weekly, M= monthly, LB-Q Ljung–Box Q statistic R_1, R_2, S_1 are rank, rank score, and sign tests of Wright (2000), WBCHODE=the wild bootstrapped version of CHODE test introduced by Kim (2006), JR_1 and JR_1 are joint rank tests of BFRCON (2004), JS_1 = joint signs test of KISH (2008)

Table 2.2.A: Overview of MEMA's stock markets

	Egypt	Jordan	Morocco	Turkey	Israel
Name of the exchange	The Egyptian Exchange (EGX) is previously known as Cairo and Alexandria Stock Exchanges	Amman Stock Exchange (ASE)	Casablanca Stock Exchange (CSE)	Istanbul Stock Exchange (ISE)	Tel Aviv Stock Exchange (TASE)
Date of establishment	Alexandria Stock Exchange was established on 1880 and Cairo Stock Exchange was established on 1903	1976	1929	1929	1953
Financial liberalization	1992	1995	1988	1989	1985
	No restrictions are imposed on foreign ownership of companies or remitting of profits. Taxes on capital gains and dividends were eliminated.	The ASE allows foreign investors to hold majority stakes in all sectors except construction, mining and commercial service companies.	Foreign investors have complete access to the CSE, unrestricted repatriation of capital and income from investment.	Foreign investors can purchase listed securities without restrictions and pay no tax.	Foreign investors are allowed to purchase any listed securities or mutual fund. Taxation burden on dividends is lower for investors of those countries that have tax treaties with Israel.
Introducing ADRs	1996, November	1997, December	1996, April	1990, July	1990
Trading System	Electronic, 2001	Electronic, 2000	Electronic, 1997	Electronic, 1993	Electronic, 1997 .
Accounting Standards	International	International	International	International	International
FTSE classification	Secondary Emerging	Frontier	Secondary Emerging	Developed	Developed

Transparency - market depth information / visibility and timely trade reporting process(1)	Pass	Pass	Pass	Pass	Pass
Transaction costs - implicit and explicit costs to be reasonable and competitive(1)	Pass	Pass	Pass	Pass	Pass
Regulator	The Capital market law No.95/1992 defined the regulatory framework for financial intermediaries, established Capital Market Authority as an independent regulatory agency for the securities industry.	In1997, the Jordan Securities Commission was created which is entrusted with the supervisory and legislative functions.	In 1993, the securities commission (known as Conseil De´ontologique des Valeurs Mobilie`res or CDVM) was established with the role of insuring shareholders protection, to monitor market activity and to help the government in the regulation of the stock exchange	The Capital Markets Board, established on 1982, is the regulatory and supervisory authority for the securities markets and institutions. It is responsible for the protection of the rights and interests of investors.	The Israel Securities Authority, the stock market regulator, was established under the Securities Law issued on 1968 and its mandate is to protect the interests of the investing public.
Formal stock market regulatory authorities actively monitor Market(1)	Pass	Pass	Pass	Pass	Pass
Clearing and Settlement(1)	T+3	T+3	T+3	T+2	T+2

Source: Ghyselse and Cherkaoui (2003), Marashdeh (2006), Shachmurove (2003), Gentzoglanis (2007), Jefferis and Smith (2005), Budak, (2008), UNCTAD (2008), Saadi-Sedik and Petri (2006), Smith (2007), Bakry (2006), Eldor and Melnick (2004), Smith (2007), Israel Securities Authority (2008), http://www.adoptifrs.org, http://www.ftse.com/Indices/Country_Classification/

(1) FTSE quality of markets criteria

Table 2.3.A: Main Financial Indicators in MENA Countries

year	Market Capitalization US $ billion					(Market Capitalization/GDP)%					(value of stock traded/GDP)%					Turnover ratio%				
	EGY	JOR	MOR	TUR	ISR	EGY	JOR	MOR	TUR	ISR	EGY	JOR	MOR	TUR	ISR	EGY	JOR	MOR	TUR	ISR
1995	8.09	4.67	5.59	20.77	36.4	13.44	69.42	18.04	12.26	37.89	1.13	7.68	7.35	30.32	9.53	10.97	11.17	46.97	242.58	26.5
1996	14.17	4.55	8.71	30.02	35.93	20.96	65.69	23.76	16.54	34.1	3.64	4.29	1.18	20.3	7.63	22.13	6.44	5.9	145.03	26.38
1997	20.83	5.45	12.18	61.09	45.27	26.56	75.14	36.44	32.18	41.76	7.47	6.91	3.14	31.14	9.88	33.48	10.02	10.04	129.74	26.54
1998	24.38	5.84	15.68	33.65	39.63	28.74	73.77	39.17	12.49	36.06	5.93	8.25	3.47	25.42	10.25	22.24	11.57	9.98	144.53	29.89
1999	32.84	5.83	13.96	112.72	63.82	36.2	71.48	34.47	45.13	57.6	9.96	6.72	6.37	32.54	13.96	31.59	9.39	17.23	111.06	36.58
2000	28.74	4.94	10.89	69.66	64.08	28.79	58.4	29.44	26.13	51.37	11.14	4.91	2.95	67.23	18.75	36.12	7.72	8.89	196.53	44.35
2001	24.34	6.32	9.09	47.15	70.27	24.93	70.33	24.09	24.06	57.1	3.99	10.39	2.58	39.76	24.21	14.69	16.58	9.74	133.44	95.55
2002	26.1	7.09	8.59	33.96	45.37	29.7	73.94	21.26	14.6	40.15	2.91	13.96	1.45	30.39	48.89	10.14	19.97	6.64	174.25	68.64
2003	27.03	10.96	13.15	68.38	75.72	32.65	107.5	26.4	22.57	63.68	3.95	25.56	1.39	32.87	34.95	12.33	28.89	6.38	194.67	54
2004	38.52	18.83	25.06	98.30	95.05	48.85	161.1	44.01	25.07	75.29	7.11	46.69	2.95	37.59	36.45	17.1	36.31	8.78	176.9	55.55
2005	79.67	37.64	27.22	161.54	120.11	88.83	298.99	45.73	33.45	89.47	28.31	189.11	6.97	41.67	44.61	42.97	84.99	15.86	154.91	60.51
2006	93.47	29.73	49.36	162.4	173.31	86.97	190.02	75.2	30.59	118.83	44.16	128.16	20.57	42.87	60.87	54.82	59.53	35.26	140.53	55.39
2007	139.29	41.22	75.49	286.6	236.36	106.76	232	100.36	44.28	141.54	40.68	98.1	34.93	46.73	67.94	45.61	49.13	42.09	134.71	58.87
2008	85.89	35.85	65.74	117.93	134.46	52.74	157.94	73.97	16.15	66.53	42.77	123.4	24.67	32.82	54.01	61.85	72.69	31.05	118.52	55.78
2009	89.95	31.86	62.91	225.74	142.1	47.6	126.99	68.85	36.73	93.2	27.95	54.38	32.19	39.63	45.19	60.07	40.3	45.73	141.72	66.66
	Trading value (US $ billion)					Listed companies														
	EGY	JOR	MOR	TUR	ISR	EGY	JOR	MOR	TUR	ISR										
1995	0.68	0.52	2.43	51.4	9.16	746	97	44	205	654										
1996	2.46	0.30	0.43	36.83	8.05	649	98	47	228	655										
1997	5.86	0.50	1.05	59.2	10.71	654	139	49	258	640										
1998	5.028	0.65	1.39	68.46	11.26	861	150	53	277	650										
1999	9.04	0.55	2.53	81.28	15.46	1033	152	55	285	644										
2000	11.1	0.42	1.09	179.21	23.39	1076	163	53	315	654										
2001	3.89	0.93	0.973	77.94	29.79	1110	161	55	310	636										
2002	2.26	1.34	0.587	70.67	55.25	1148	158	55	288	615										
2003	3.28	2.61	0.693	99.61	41.55	967	161	53	284	576										
2004	5.60	5.33	1.68	147.43	46.23	792	192	52	296	571										
2005	25.4	23.81	4.15	201.26	59.88	744	201	56	304	572										
2006	47.46	20.05	13.52	227.62	88.77	603	227	65	314	612										
2007	53.08	17.43	26.28	302.4	113.46	435	245	74	319	654										
2008	69.64	28	21.93	239.7	109.16	373	262	77	284	630										
2009	52.81	13.64	29.42	243.53	88.29	305	272	78	315	609										

Source: http://data.worldbank.org/, and World Development Indicators (WDI, 2011)

Chapter Three

Testing for WFEMH in the EGX: Do Size and Regulatory Changes Matter?

3.1. Introduction:

The current chapter aims at investigating whether weekly returns of the EGX do obey WFEMH during the period February 1997−June, 2007. Using a battery of VR tests will make it possible to compare their inferential outcomes. The chapter employs eight value-weighted indexes, adjusted for free-float, tracking the performance of the whole exchange, large, medium, small capitalized firms, and privatized companies through initial public offerings (IPOs)[1]. The inclusion of indexes tracking the performance of large, medium, and small firms will be beneficial in testing for the martingale as it enables testing the claim that prices of large- capitalized shares, with availability of more information, tend to follow a martingale process [(Ryoo and Smith, 2002) and (Jefferis and Smith, 2004)] whereas small stocks require more time to incorporate new information into prices inducing strong positive autocorrelation in small-sorted portfolios (LOMAC, 1988). This claim has been approved for developed stock markets of Japan and the UK (Hung *et.al*, 2009) and South Africa (Jefferis and Smith, 2004).

In order to capture the effect of the change of regulatory policies on market efficiency, the study period has been divided into two sub-periods: the first starts on 2nd of February, 1997 and ends on 17th of July, 2002; and the second stretches from 24th of July, 2002 to 29th of June, 2007. In the first sub-period, narrow price limits have been imposed on share price movements in the EGX where their daily movements are allowed to fluctuate within ±5% of their closing prices in the previous day, otherwise trading would be suspended until the next

[1] IPOs of the state-owned enterprises were the main method of recovering the stock market. By the end of 1998, the value of traded shares of privatized companies represented 38% of the total market capitalization of the Egyptian stock market (USAID, 2004).

day when a new limit is launched based on the closing price of the current day. In the second sub-period, a new price ceiling system was set on 21st of July 2002 in place, whereby the price boundaries were expanded to ±20%. The new price ceiling system stipulated the halting of trade on stock for a period of thirty minutes, forty-five minutes or till the end of the trading session if their prevailing weighted average price hit ±10%, ±15% or ±20% respectively, when compared to their opening prices (Bakry, 2006). The target of adopting price limits is to control daily volatilities of stock price movements via imposing price constraints in order to provide a cool-off period for rational reappraisal of investment decisions during times of overreaction and panic trading. Therefore, the main task of circuit breaker is to re-inform market participants, thereby facilitating price discovery mechanism (Tooma and Sourial, 2004). However, opponents of price limits assert that they are ineffective since they (1) are likely to cause volatility to spread out over a longer period of time since boundaries prevent big one-day price increments and prevent immediate corrections in order imbalance (spill-over hypothesis), (2) interrupt incorporation of information into prices preventing them from adjusting to their new equilibrium levels, thereby the price discovery mechanism is delayed to the following days (delay price discovery hypothesis), and (3) interfere with trading causing either: (i) intensive trading activities on subsequent days after prices hitting their limits since stocks become illiquid once the limits are hit or (ii) intensive trading prior to limit hit days because investors are anticipating a limit hit and are advancing their transactions to avoid being locked into an investment positions (trading inference hypothesis) [Kim and Rhee (1997), Tooma (2005) and Tooma (2011)].

The adverse effects of price limits on market efficiency on other stock markets have been confirmed. For example, Ryoo and Smith (2002) concluded that the Korean stock market was inefficient in pricing securities during periods of tight price limits and moved towards efficiency as these limits were relaxed. Similarly, Chen and Ting (2000) found that the increase in price limits is inversely related to the magnitude of the first order autocorrelation for Taiwan stock market.

The objective of the current chapter is to examine the efficiency of the EGX in pricing equities during the period 1997 -2007, and whether it is related to firm size and changes in regulatory policies. The remainder of the chapter is structured as follows. Section 2 presents the employed methodology while data and empirical results are introduced in sections 3 and 4 respectively. Finally, section 5 concludes.

3.2. Methodology:

As mentioned earlier, LOMAC (1988) utilized the property of RW process that its increments must be a linear function of the time interval and introduced their single VR methodology that has received significant modifications. Among these refinements are CHODE (1993), Wright (2000), Kim (2006), BFRCON (2004) and KISH (2008) methodologies, which are described below [for other VR methodologies proposed in the literature, refer to (Charles and Darnè, 2009)].

3.2.1. LOMAC's (1988) Single VR test:

Recall that the RW with drift model could be expressed as follows:

$$p_t - p_{t-1} = \mu + \varepsilon_t \quad \text{Or} \quad a_t = \mu + \varepsilon_t \qquad 3.1$$

Where μ is the drift parameter, $\mathrm{E}\left[\varepsilon_t\right]=0$, $\mathrm{E}\left[\varepsilon_t.\varepsilon_{t-g}\right]=0$ for $g \neq 0$ for all *t*. For RW1, $\{\varepsilon_t\}$ is IID, and therefore, conditional heteroscedasticity is not allowed. Consider a time series with asset returns, a_t, where *t=1,2,...,T,* the VR of LOMAC (1988), using overlapping q-differences, is given by 3−2

$$VR(q)=\left\{\frac{1}{Tq}\sum_{t=q}^{T}(a_t+a_{t-1}+...+a_{t-q+1}-q\hat{\mu})^2\right\}\div\left\{\frac{1}{T}\sum_{t=1}^{T}(a_t-\hat{\mu})^2\right\} \qquad 3.2$$

Where $\hat{\mu}=T^{-1}\sum_{t=1}^{T}a_t$

Campbell *et.al*, (1997) showed that the $VR(q)$, where q is any integer greater than one, satisfies the following relation.:

$$VR(q)=\frac{Var(a_t^q)}{q.Var(a_t)}=1+2\sum_{k=1}^{q-1}(1-\frac{k}{q}).\hat{\rho}(k) \qquad 3.3$$

Where $VR\left(a_t^q\right)$ and $VR\left(a_t\right)$ are the variance of q-period return and the variance of one-period return respectively. The continuously compounded q-period return is $a_t^q \equiv a_t+a_{t+1}+...+a_{t-q+1}$ and $\hat{\rho}(k)$ is the estimator of kth serial correlation coefficient. Equation 3.3 shows that $VR(q)$ is a linear combination of the first $q-1$ autocorrelation coefficients of $\{a_t\}$, with linearly declining weights. The null hypothesis is that VR*(q)*=1, and the alternative hypothesis is *VR(q)*≠1. If the null of RW is rejected and VR*(q)*>1, then $\hat{\rho}(k)\succ 0$, hence variances of returns grow faster than linearly (mean aversion). If the null is rejected and VR*(q)*<1, then $\hat{\rho}(k)\prec 0$, hence variances of returns grow slower than linearly (mean reversion) [Campbell *et.al*, (1997) and (Füss, 2005)].

LOMAC (1988) introduced the test statistics, expressed in 3.4 which is asymptotically distributed as standard normal, under assumptions of homoscedasticity (i.e. for IID price increments)

$$Z_1(q) = [VR(q) - 1]\left[\frac{2(2q-1)(q-1)}{3q(Tq)}\right]^{-1/2} \sim \text{N}(0, 1), \qquad 3.4$$

Under Assumption H* of LOMAC[1] (1988) where the innovations in returns have zero mean, are uncorrelated at all leads and lags, while general forms of heteroscedasticity including GARCH-type are allowed (i.e. return series for martingale sequence difference (MDS), they proposed the test statistic expressed by 3.5 which is asymptotically distributed as standard normal.

$$Z_2(q) = [VR(q) - 1]\left[4\sum_{j=1}^{q=4}\left(1 - \frac{j}{q}\right)^2 \delta_j\right]^{-1/2} \sim \text{N}(0, 1) \qquad 3.5$$

$$\text{Where } \hat{\delta}_j = \frac{\sum_{t=j+1}^{T}(a_t - \hat{\mu})^2 (a_{t-j} - \hat{\mu})^2}{\left[\sum_{t=1}^{T}(a_t - \hat{\mu})^2\right]^2} \qquad 3.6$$

LOMAC approach has two shortcomings. First, it is customary in empirical applications to conduct separate individual tests for a number of q holding periods. However, RWH requires that $VR(q_i) = 1$ for all values of q_i. Therefore, LOMAC approach may be misleading as it tends to overreject the null hypothesis of a joint test. It may involve much larger Type I error than the nominal level of significance. Namely, the probability of incorrect rejection of the

[1] Refer to Appendix 3, attached to the current chapter, that shows Assumption H* of LOMAC (1988).

true null hypothesis can be quite larger than the chosen level of significance. Second, the sampling distribution of the test statistics was found to be far from normal in finite samples, showing severe bias and right skew. These finite sample deficiencies may give rise to serious size distortions or lower power, which can lead to misleading inferences. This is especially true when the sample size is not large enough to justify asymptotic approximations (Charles and Darne, 2009).

The remedy for the first shortcoming is proposed by CHODE (1993) whereas the remedy of the second weakness is introduced by Wright (2000), described below.

3.2.2. CHODE (1993) MVR test:

CHODE (1993) developed a joint VR test that extends LOMAC methodology through proposing multiple comparison framework based on treating the LOMAC test statistics as SMM variates, which is able to reduce the Type I error and control the size of a multiple variance ratio. By conducting a Monte Carlo simulation, they found that the power of their MVR test is comparable to that of DF and the PP unit root tests against a stationary AR(1) alternative and is more powerful than these tests against two unit root alternatives, an ARIMA(1,1,1) and an ARIMA(1,1,0).

For time series to satisfy a RW, according to CHODE (1993), any VR must be equal to unity, so that a more powerful approach is a comparison of all selected VRs with unity. In other words, the null hypothesis to be tested is $MVR(q_i) = 1 \text{for } i = 1,...,m$ against the alternative hypothesises that $MVR(q_i) \neq 1$

for some i. Accordingly, the null of RW should be rejected if the MVR is significantly different from one for some i (Füss, 2005).

Under Assumption H* of LOMAC (1988), the null that returns form an IID sequence (or MDS) is rejected if any of the estimated VRs differ significantly from unity when compared with SMM critical values. CHODE (1993) defined their test statistics as follows:

$$MZ_1 = \max_{1\le i\le m}\left|Z_1(q_i)\right| \qquad 3.7$$

$$MZ_2 = \max_{1\le i\le m}\left|Z_2(q_i)\right| \qquad 3.8$$

Where MZ_1 and MZ_2 are CHODE test statistics under the assumption of IID and heteroscedasticity respectively, and $Z_1(q_i)$ and $Z_2(q_i)$ are defined in 3.4 and 3.5, respectively. In order to control the joint test size, the confidence interval of at least $100(1-\alpha)$ percent of these extreme statistics, $Z_1(q_i)$ and $Z_2(q_i)$ can be defined as $Z_1(q_i) \pm \mathrm{SMM}(\alpha, m, \infty)$ and $Z_2(q_i) \pm \mathrm{SMM}(\alpha, m, \infty)$ where $\pm \mathrm{SMM}(\alpha, m, \infty)$ is the asymptotic critical values of the upper α point of the SMM distribution with parameter *m* (the number of aggregation intervals of q) and ∞ degrees of freedom. Asymptotically, if MZ_1 (or MZ_2) are greater than the $[1-(\alpha^*/2)]th$ percentile of the standard normal distribution, where $\alpha^* = 1-(1-\alpha)^{1/m}$, the null hypothesis of IID price increments (MDS price changes) has to be rejected at α level of significance (Zulfadin, 2008).

3.2.3. VR based on ranks and signs of Wright (2000)

As mentioned earlier, LOMAC approach as well as that of CHODE, possess asymptotic test statistics whose sampling distributions are approximated based on their limiting distribution. To deal with this problem, Wright (2000) introduced exact nonparametric tests, which are based on ranks and signs of returns, have two advantages over LOMAC and CHODE tests when the sample size is relatively small. First, as the sign and rank tests have exact sampling distribution, there is no need to resort to asymptotic approximation. Second, these tests may be more powerful than the conventional VR tests when the data are highly nonnormal. Wright (2000) asserted that his tests are robust to many forms of conditional heteroscedasticity and have power against a wide range of models of serial correlation such as autoregressive moving average and fractionally integrated alternatives with heavy tailed innovations. Tests based on ranks are exact under the independence and identical distribution assumption, whereas the tests based on signs are exact even under conditional heteroscedasticity. Moreover, Wright (2000) showed that ranks-based tests display low size distortion, under conditional heteroscedasticity.

Given T observations of asset returns $\{a_1, a_2, ..., a_T\}$ and that $r(a_t)$ is the rank of a_t among a_t's, Wright (2000) defined two standardised random variables r_{1t} and r_{2t} as follows:

$$r_{1t} = [r(a_t) - 0.5(T+1)/\sqrt{[(T-1)(T+1)/12]}] \qquad 3.9$$

$$r_{2t} = \Phi^{-1}[r(a_t)/(T+1)]$$
where Φ is the standard normal cumulative distribution function $\qquad 3.10$

The series r_{1t} is a simple linear transformation with a sample mean of zero and a sample variance of unity whereas the series r_{2t}, known as the inverse normal, has zero mean and approximately unit variance. Wright (2000) derived VR- based rank test statistics by replacing these transformations of the ranks in the expression of VR(q) given in 3.2 , and, thus, the tests statistic $Z_1(q)$ given in 3−4 can be expressed as follows:

$$R_1(q) = \left(\frac{(Tq)^{-1} \sum_{t=q}^{T} (r_{1t} + r_{1t-1} + \ldots + r_{1t-q+1})^2}{T^{-1} \sum_{t=1}^{T} r_{1t}^2} - 1 \right) \left(\frac{2(2q-1)(q-1)}{3qT} \right)^{-1/2} \quad 3.11$$

$$R_2(q) = \left(\frac{(Tq)^{-1} \sum_{t=q}^{T} (r_{2t} + r_{2t-1} + \ldots + r_{2t-q+1})^2}{T^{-1} \sum_{t=1}^{T} r_{2t}^2} - 1 \right) \left(\frac{2(2q-1)(q-1)}{3qT} \right)^{-1/2} \quad 3.12$$

Under the null hypothesis that a_t is generated from and IID sequence [Assumption A_0 in (Wright, 2000)][1], $r(a_t)$ is a random permutation of numbers of 1,2,..., T with equal probability, thus, the exact sampling distributions of R_1 and R_2, given by 3.13and 3.14 respectively, may easily be simulated to an arbitrary degree of accuracy. In other words, the process involves computing $R_1(q)$ and $R_2(q)$ for a large number of permutations of $r(a_t)$, say 10000, and observing the empirical distribution of the obtained series to compute *p*-value for two-tailed test.

[1] Refer to Appendix 3, attached to the current chapter, for illustration of assumptions of Wright (2000).

$$\left(\frac{(Tq)^{-1}\sum_{t=q}^{T}(r_{1t}^{*}+r_{1t-1}^{*}+\ldots+r_{1t-q+1}^{*})^{2}}{T^{-1}\sum_{t=1}^{T}r_{1t}^{*2}}-1\right)\left(\frac{2(2q-1)(q-1)}{3qT}\right)^{-1/2} \qquad 3.13$$

$$\left(\frac{(Tq)^{-1}\sum_{t=q}^{T}(r_{2t}^{*}+r_{2t-1}^{*}+\ldots+r_{2t-q+1}^{*})^{2}}{T^{-1}\sum_{t=1}^{T}r_{2t}^{*2}}-1\right)\left(\frac{2(2q-1)(q-1)}{3qT}\right)^{-1/2} \qquad 3.14$$

Where:

$$r_{1t}^{*}=[r^{*}(a_t)-0.5(T+1)/\sqrt{[(T-1)(T+1)/12]}],\quad r_{2t}^{*}=\Phi^{-1}[r^{*}(a_t)/(T+1)],$$

and $\{r^{*}(a_t)\}_{t=1}^{T}$ is any permutation of 1, 2, …, T each with equal probability.

Wright (2000) derived a sign-based test statistic S_1, given in 3.15, under the assumption of MDS returns permitting conditional heteroscedasticity [Assumptions A_1 and A_2 in (Wright, 2000) and that the drift parameter μ =0]. This is based on the IID series S_t which has mean zero and variance one. If returns, a_t, are positive then each S_t is equal to 1 with probability 0.5 otherwise S_t equals -1 with probability 0.5 as well.

$$S_1(q)=\left(\frac{(Tq)^{-1}\sum_{t=q}^{T}(s_t+s_{t-1}+\ldots+s_{t-q+1})^{2}}{T^{-1}\sum_{t=1}^{T}s_t^{2}}-1\right)\left(\frac{2(2q-1)(q-1)}{3qT}\right)^{-1/2} \qquad 3.15$$

The exact sampling distribution of S_1 is given by 3.16, and the critical values of the test can be obtained by simulating its sampling distribution. The null hypothesis is rejected if observed R_1, R_2 and S_1 are greater than their corresponding values obtained from simulation.

$$\left(\frac{(Tq)^{-1}\sum_{t=q}^{T}(s_t^* + s_{t-1}^* + ... + s_{t-q+1}^*)^2}{T^{-1}\sum_{t=1}^{T} s_t^{*2}} - 1 \right) \left(\frac{2(2q-1)(q-1)}{3qT} \right)^{-1/2} \qquad 3.16$$

Where $\{s_t^*\}_{t=1}^{T}$ is an IID sequence, each element of which is with probability 0.5 and −1 otherwise.

3.2.4. WBCHODE test of Kim (2006)

Kim (2006) employed the wild bootstrap of Mammen (1993), which is applicable to data with unknown form of unconditional and conditional heteroscedasticity, to approximate the sampling distribution of MZ_2 given in 3.8. The wild bootstrap test based on MZ_2 can be conducted in three steps as below:

(1) Generate a bootstrap sample of T observations $a_t^* = \eta_t . a_t (t = 1,..., T)$ where η_t is a random sequence with zero mean and unit variance.

(2) Calculate MZ_2^* that is the MZ_2 statistic in 3−8 obtained from the wild bootsrap sample generated in stage (1).

(3) Repeat steps (1) and (2) sufficiently many, say *m*, times to creat the wild bootsrap distribution of the test statistic $\{MZ_2^*(j)\}_{j=1}^{m}$.

The wild bootstrap distribution $\{MZ_2^*(j)\}_{j=1}^{m}$ is used to approximate the sampling distribution of the MZ_2 statistic. The *p*-value of the test is estimated as the proportion of $\{MZ_2^*(j)\}_{j=1}^{m}$ greater than MZ_2 statistic calculated from the original data. In implementing the wild bootstrap test, a specific form of η_t should be chosen. In the current research, the standard normal distribution for η_t is used

as Kim (2006) reported that other choices provide qualitatively similar small samples results.

Condition on a_t, a_t^* is serially uncorrelated sequence with zero mean and variance a_t^2, which is a special case of Assumption H* of LOMAC (1988). As such, MZ_2^* has the same asymptotic distribution as MZ_2. As a_t^* is serially uncorrelated, the wild bootstrapping approximates the sampling distributions under the null hypothesis, which is a desirable property for a bootstrap test. It is worth mentioning that the wild bootstrap is valid and the test statistic being bootstrapped are pivotal asymptotically, under the condition that a_t form MDS satisfying Assumption H* of LOMAC (1988).

When he examined the small sample properties of his new test, Kim (2006) found wild bootstrap test is superior alternative to the conventional VR tests over a wide range of sample sizes and error terms considered.

3.2.5. Multiple VR tests based of ranks and signs:

In the spirit of CHODE (1993) methodology, BFRCON (2004) and KISH (2008) extended single rank and sign tests of Wright (2000) to the multiple rank and sign tests. Thus, applying the procedure proposed by CHODE (1993), individual rank and sign test statistics expressed in 3.11, 3.12 and 3.15 could extended to joint tests (JR_1, JR_2 and JS_1 respectively) by computing each test statistic for m different values of q and selecting the one with the maximum absolute value as follows:

$$JR_1 = \max_{1\le i\le m} \left| R_1(q_i) \right| \qquad 3.17$$

$$JR_2 = \max_{1\le i\le m}\left|R_2(q_i)\right| \qquad 3.18$$

$$JS_1 = \max_{1\le i\le m}\left|S_1(q_i)\right| \qquad 3.19$$

The ranks-based procedures are exact under the IID assumption whereas the signs-based procedures are exact under both the IID and MDS assumptions (Charles and Darńe, 2009). The exact sampling distributions of JR_1, JR_2 and JS_1 are given by 3−20, 3−21, and 3−22 respectively.

$$\max\left\{\left|R_1^*(q_1)\right|,\left|R_1^*(q_2)\right|...\left|R_1^*(q_m)\right|\right\} \qquad 3.20$$

$$\max\left\{\left|R_2^*(q_1)\right|,\left|R_2^*(q_2)\right|...\left|R_2^*(q_m)\right|\right\} \qquad 3.21$$

$$\max\left\{\left|S_1^*(q_1)\right|,\left|S_1^*(q_2)\right|...\left|S_1^*(q_m)\right|\right\} \qquad 3.22$$

To study the unknown power properties of JS_1 test; KISH (2008) conducted a Monte Carlo simulation to compare its power properties with MZ_2 and MZ_2^*. Their Monte Carlo results indicated that MZ_2^* and JS_1 tests are good alternatives in testing for the MDS of a financial return. They found that both tests maintain desirable power properties with longer holding periods, although there is tendency that the power of the tests gets, to a degree, lower with longer holding periods. According to their Monte Carlo results, these new VR tests have superior small sample properties to MZ_2. It is worth mentioning that MZ_2^* has higher power than JS_1 particularly when the underlying return series follows an

AR(1) or long memory model with GARCH(1,1) errors; relative power is reversed when the underlying return series has a stochastic volatility term.

When both MZ_2^* and JS_1 tests are carried out on one series there are four possible outcomes (Smith, 2008): (1) neither test rejects its null hypothesis, in which case it is inferred that the returns series is an MDS; (2) both tests reject the null and, thus, the series of returns is not an MDS; (3) JS_1 rejects and MZ_2^* does not reject; the series is an MDS satisfying Assumption H* of LOMAC (1988); and (4) JS_1 does not reject and MZ_2^* rejects; the returns series is an MDS satisfying Assumptions A1 and A2 (Wright, 2000).

3.3. Data:

To avoid biases inherent in daily data, weekly data of eight indexes, all value-weighted, tracking the performance of the EGX is used. Local indexes are CMAI, HFI, EFGI, and PIPO. CMAI can be viewed as an All-Share index as it includes all companies listed on the EGX. HFI, calculated by the Egyptian Financial Group (EFG)-Hermes Corporation, tracks the movement of the most active registered stocks and it is rebalanced quarterly (Bakry, 2006). EFGI, considered as a subset of the HFI, tracks the movement of the most actively registered large-capitalised companies. The privatisation process of the state-owned enterprises, starting in 1990s, was conducted mostly through IPOs. In response to this, the Prime Group introduced its PIPO index in 1994 to provide a definitive standard for measuring IPO equity performance on a general basis. As of December 2005, the PIPO index consisted of 64 companies (Bakry, 2006).

International indexes employed are MSCI-Egypt, MSCI-L Cap, MSCI-M Cap, and MSCI-S Cap, all are adjusted for free-float market capitalization. MSCI-Egypt with a base date of 30th of December, 1994, aims at an inclusion of stocks accounting for approximately 85% of the free-float adjusted market capitalization. There is no target regarding the specific number of stocks that should be included in the index. By the end of July 2004, seventeen Egyptian companies were included in the MSCI Egypt Index (Bakry, 2006). MSCI-L Cap, started at 29th of November 1996, aims at tracking the performance of Large-cap companies in the EGX. It included only one company in its inception date and as no stock was eligible for the inclusion in this index for a relatively long period, data of this index is reliable since the end of December 2004. MSCI-M Cap and MSCI-S Cap, with the same base date of 31st of May, 1996, aim at tracking the performance of medium and small-sized firms in the EGX respectively.

Accordingly, the sample period for all series, except MSCI-L Cap and PIPO, starts at 3rd of February, 1997 and ends at 25th of July, 2007 compromising of 543 weekly observations. Due to missing data, MSCI-L Cap comprises 213 observations starting in 1st of December, 2004 and ends as other series whereas PIPO has the same starting date 3rd of February, 1997 but ends by 21st of February, 2007[1]. Returns are constructed as the first difference of natural logarithm of share prices.

[1] PIPO index increased from 6080 points in 14/2/2007 to 59421 in 21/2/2007, an increase of 877.3% and maintained this suspicious high level until 9/5/2007.

3.4. Empirical Results:

Table (3.1: panels A and B) present descriptive statistics for weekly returns of employed indexes. With the exception of PIPO, all returns are insignificantly different from zero in sub-period II whereas, in sub-period I, CMAI is the only index exhibiting positive significant returns. The All-Share CMAI displays the lowest levels of volatilities, measured by the standard deviation, in the two samples reflecting infrequent trading of many listed shares. For all returns series in the two samples, skewness, kurtosis, or both indicate that the rates of return are not likely drawn from normal distributions. The J-B statistics confirm that all returns deviate from normality as the null hypothesis of unconditional normality is rejected for all indices beyond the 1% level of significance. Figure 3.1 displays the time plots of log returns of employed indexes. The above and bottom horizontal lines in each graph show (Q1−3IQR) and (Q3+3IQR) respectively, where Q1 is the first quartile, Q3 is the third quartile, and IQR is the inter quartile range (the difference between Q3 and Q1). This criterion is commonly used to identify extreme outliers based in box plot (KISH, 2008). From these graphs, the phenomenon of volatility clustering where large (small) price changes are followed by large (small) price movements of either sign is evident for all series.

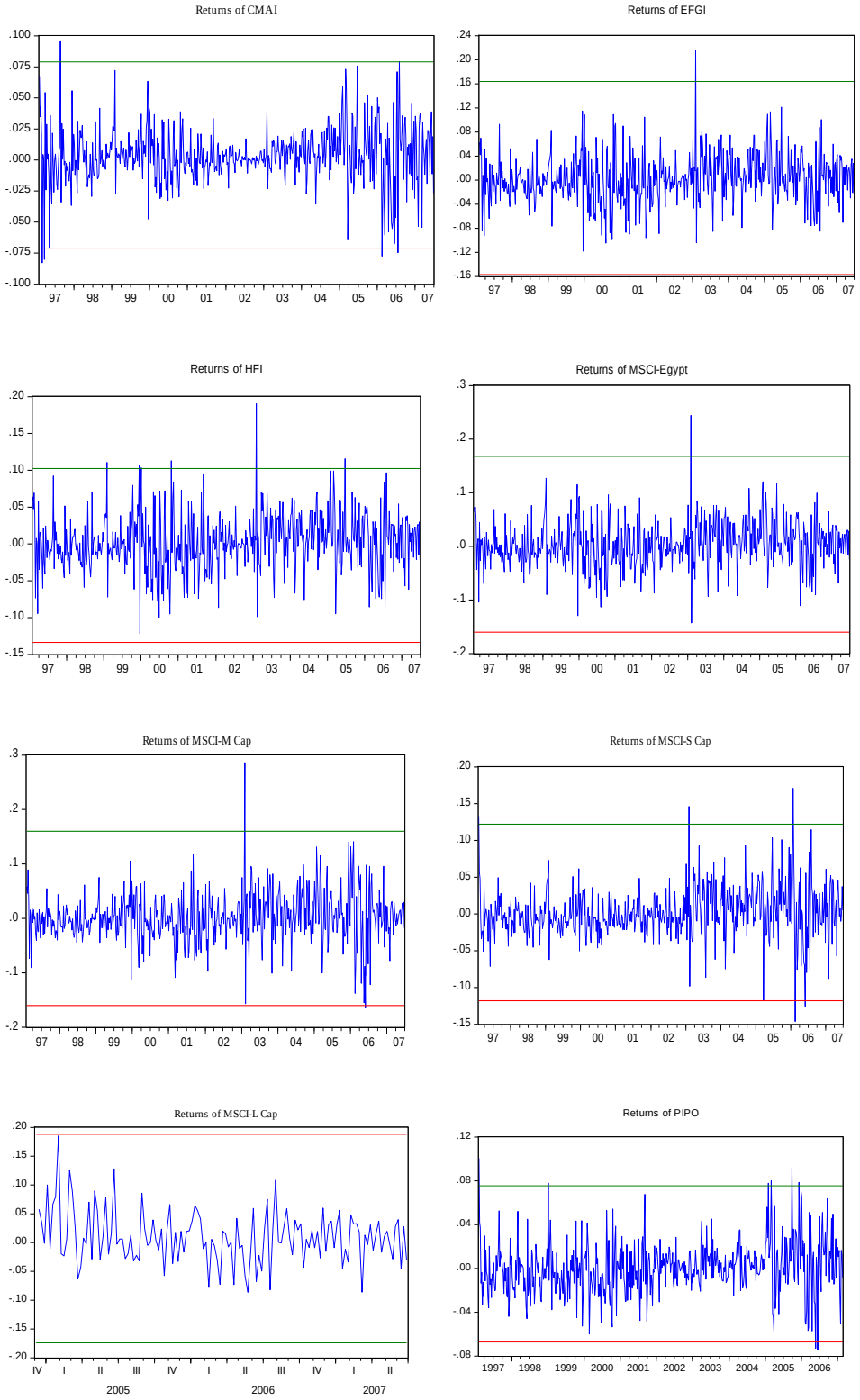
Table 3.1: Descriptive statistics for weekly returns of indices employed in the study in the two sub-periods

Descriptive statistics	**Panel A: Sub-period I**							
	CMAI	**HFI**	**MSCI-Egypt**	**MSCI-L Cap**	**MSCI-M Cap**	**MSCI-S Cap**	**EFGI**	**PIPO**
Mean (1) t-statistic	0.0035* (3.2901)	-0.0007 (-0.3623)	0.0000 (0.0000)	------	-0.0010* (-5.0740)	-0.0008 (-0.5761)	-0.0006 (-0.2967)	-0.0001 (-0.0731)
Std.Dev.	0.0190	0.0345	0.0375	------	0.0352	0.0248	0.0360	0.0244
Skewness(2) t-statistic	1.0656* (7.769)	0.2007 (1.4634)	0.3058 ** (2.2297)	-------	-0.0518 (-0.3777)	1.4176* (10.3364)	0.0907 (0.6613)	0.8356* (6.0928)
Kurtosis (3) t-statistic	6.2093* (11.700)	4.2334 * (4.4966)	4.1274* (4.1102)	------	5.1695* (7.9095)	7.8213* (17.5773)	4.1387* (4.1514)	4.9758* (7.2033)
J-B statistic (p-value)	197.277* (0.0000)	22.2961* (0.000)	21.8685* (0.0000)	------	62.7056* (0.0000)	415.8256* (0.0000)	17.6729* (0.0001)	89.1016* (0.0000)
Descriptive statistics	**Panel B: Sub-period II**							
	CMAI	**HFI**	**MSCI-Egypt**	**MSCI-L Cap**	**MSCI-M Cap**	**MSCI-S Cap**	**EFGI**	**PIPO**
Mean(1) t-statistic	0.0057 (0.0140)	0.0099 (0.0156)	0.0107 (0.0160)	0.0040 (1.1183)	0.0096 (0.0113)	0.0086 (0.0138)	0.0106 (0.0168)	0.0052 * (3.2285)
Std.Dev.	0.0241	0.0392	0.0412	0.0522	0.0524	0.0385	0.0389	0.0249
Skewness (2) t-statistic	-0.793* (-5.230)	-0.120 (-0.791)	-0. 271 (-1.787)	-0.977* (-5.822)	-0.373 (-2.460)	-0.2287 (-1.893)	-0.169 (-1.114)	0.1500 (0.9467)

Kurtosis (3) t-statistic	7.665* (15.385)	5.132* (7.031)	4.391* (4.587)	6.686* (10.982)	5.703* (8.914)	5.547* (8.400)	4.284* (4.234)	4.818* (5.7395)
J-B statistic (p-value)	264.132* (0.0000)	50.096* (0.0000)	24.277* (0.000)	154.522* (0.0000)	85.559* (0.0000)	72.833* (0.0000)	19.259* (0.0000)	33.842* (0.0000)

Notes: (1) t-statistic, between parentheses, is calculated as t = mean return/(standard deviation * square root of the sample size). (2)t-statistic, between parentheses, is calculated as $t = (S' - 0) / SE(S')$, where S' is value of skewness coefficient of certain index, 0 is the value of skewness coefficient for a normal distribution, and $SE(S')$ is the standard error of the estimated skewness coefficient which calculated as the square root of 6/n, where n is the number of observations. (3) t-statistic, between parentheses, is calculated as $t = (K' - 3) / SE(K')$, where K' is value of kurtosis coefficient of certain index, 3 is the value of kurtosis coefficient for a normal distribution, and $SE(K')$ is the standard error of the estimated kurtosis coefficient which calculated as the square root of 24/n, where n is the number of observations. * , ** indicate that the null hypothesis should be rejected at 1% or less and 5% or less level of significance respectively. ----indicates unavailability of data for MSCI-L cap in sub-period I.

Figure3.1: plot of log returns of employed indexes



The above and the bottom horizontal lines in each graph represent (Q1-3IQR) and (Q3+3IQR) respectively, where Q1 is the first quartile, Q3 is the third quartile and IQR (Interquartile range) = Q3−Q1

3.4.1. VR Results for the First Sub-period:

The results of LOMAC tests on weekly returns of employed indexes during the first sub-sample, for intervals 2, 4, 8, and 16, with the base of one week are presented in Table 3.2. Computations of larger variance ratios (32 or higher) are improper and would result in spurious results due the changing nature of the emerging markets (Haque *et. al.*, 2004).

Table 3.2: LOMAC VR tests for intervals 2, 4, 8, and 16 on weekly returns during sub-period I

Index	Holding period			
	q = 2	**q = 4**	**q = 8**	**q = 16**
CMAI	VR(q)= 1.249	VR(q)=1.684	VR(q)=2.1655	VR(q)= 2.7548
	Z_1(q)=4.4635* [√]	Z_1(q)=6.5334 *[√]	Z_1(q)=7.0373*[√]	Z_1(q)=7.1203*[√]
	Z_2 (q)=3.000*[√]	Z_2 (q)=4.287* [√]	Z_2(q)=4.782*[√]	Z_2(q)=5.085* [√]
HFI	VR(q)= 1.1255	VR(q)= 1.3386	VR(q)=1.5452	VR(q)=1.997
	Z_1 (q)=2.238** [×]	Z_1 (q)=3.227*[√]	Z_1 (q)=3.2706*[√]	Z_1 (q)=4.042* [√]
	Z_2 (q)=1.730	Z_2(q)=2.565**[√]	Z_2 (q)=2.659* [√]	Z_2 (q)=3.369* [√]
MSCI-Egypt	VR(q)= 1.115	VR(q)=1.3226	VR(q)=1.5447	VR(q)=2.0316
	Z_1 (q)=2.0591**[×]	Z_1 (q)=3.080* [√]	Z_1 (q)= 3.289* [√]	Z_1 (q)=4.1861* [√]
	Z_2 (q)=1.7165	Z_2 (q)=2.585* [√]	Z_2 (q)=2.814* [√]	Z_2 (q)=3.6952* [√]
MSCI-M-Cap	VR(q)= 1.087	VR(q)=1.3115	VR(q)= 1.5222	VR(q)= 2.0317
	Z_1 (q)= 1.5704	Z_1 (q)=2.974 *[√]	Z_1 (q)=3.153* [√]	Z_1 (q)= 4.186* [√]
	Z_2 (q)=1.3746	Z_2 (q)=2.470**[×]	Z_2 (q)=2.601 * [√]	Z_2 (q)=3.507* [√]
MSCI-S Cap	VR(q)=1.2542	VR(q)=1.7395	VR(q)=2.3042	VR(q)=3.1625
	Z_1 (q)=4.5417 * [√]	Z_1 (q)=7.060 * [√]	Z_1 (q)=7.875* [√]	Z_1 (q)= 8.7749* [√]
	Z_2 (q)=2.496** [√]	Z_2 (q)=4.086* [√]	Z_2 (q)=4.929* [√]	Z_2 (q)=6.086* [√]
EFGI	VR(q)= 1.1085	VR(q)=1.2862	VR(q)=1.4317	VR(q)= 1.8353
	Z_1 (q)=1.9388	Z_1 (q)=2.732* [√]	Z_1 (q)=2.6070*[√]	Z_1 (q)=3.839* [√]
	Z_2 (q)=1.481	Z_2 (q)=2.15** [×]	Z_2 (q)=2.128**[×]	Z_2 (q)=2.840* [√]
PIPO	VR(q)= 1.1713	VR(q)= 1.5329	VR(q)= 1.9715	VR(q)= 2.6738
	Z_1 (q)=3.059* [√]	Z_1 (q)=5.0882*[√]	Z_1 (q)=5.866* [√]	Z_1 (q)=6.810*[√]
	Z_2 (q)=2.3356**[×]	Z_2 (q)=3.836* [√]	Z_2 (q)=4.736* [√]	Z_2 (q)=5.810* [√]

*, ** indicate significance at 1% and 5% when compared with critical values of 2.576 and 1.96 (of the standard normal distribution) respectively. The symbol [√] indicates that the VR is statistically different from unity at the 5% level of significance when compared with the SMM critical value of 2.491. The symbol [×] indicates an inferential error in which the variance ratios are separately statistically different from unity according to the standard normal distribution critical values, however; they are insignificant compared with the SMM distribution critical values.

From table 3.2, the weekly behaviour of returns of all indices, except for MSCI-M-Cap and EFGI in intervals 2, under the assumptions homoscedasticity deviates markedly from randomness. All the test statistics of Z_1(q) reject the null at either 1% or 5% level of significance. What is more, the rejections of the null

hypothesis are robust in to the presence of heteroscedasticity. However, the rejections of the null under the presence of heteroscedasticity are weaker than under the assumption of homoscedasticity as every $Z_2(q)$ is smaller than the corresponding $Z_1(q)$. Therefore, the rejection of the null hypothesises are attributed partially to the variance changes, but there is little doubt that the objections are mainly due to the violation of randomness. All VRs exceed one for all cases, in which the test statistic is significant, and most of them are relatively large. All rejections occur in the right tail indicating the presence of positive serial correlation in return series. Thus, employed indexes are inconsistent with RW1 or RW3 during the period February-1997 to July-2002, according to LOMAC methodology.

The VR in interval q of 2 is approximately equal to one plus the first order serial correlation coefficient estimator (Campbell *et.al*, 1997). Therefore, the significant variance ratio of 1.2499 of CMAI for interval q of 2 implies that the positive first order serial correlation for weekly returns of that index is approximately 25%. Similarly, the positive first order autocorrelation for weekly returns of MSCI-S Cap and PIPO are 25.42% and 17.13% respectively. The VR of all return series increases successively as the length of the interval q increases[1]. Campbell *et.al*, (1997) indicated that the increase of the VRs following the enlarging of the interval length of q implies positive serial correlation in multiple period returns[2]. This feature, that VRs are over one and increasing with interval

[1] For example, the VR of weekly returns of MSCI-S Cap climbed from 1.2542 in interval 2 to 3.1625 in interval 16, and similar patterns can be found in the tests of the other indices.

[2] For instance, by using the VRs of HFI we get VR(8)/VR(4)= 1.5452/1.3386= 1.1543, which implies that four-week returns of HFI have a first order serial correlation coefficient of approximately 15.43%.

length of q enlarging, conforms to studies by LOMAC (1988), Campbell *et.al* (1997) and Ma (2004).

Taking into account the joint nature of the VR approach to testing the RWH, I employ CHODE methodology which compares LOMAC test statistics with the SMM distribution critical value of 2.491 (corresponding to a 5% level and m=4). For returns of CMAI and MSCI-S Cap, both LOMAC and CHODE tests agree in rejecting the RW1 and RW3 hypothesises. For returns of other indices, the CHODE test highlights inferential errors arisen from using the single LOMAC tests and ignoring the joint nature of the VR approach to testing the RWH. For example, when the critical value of 1.96 for the 5% significance level of the standard normal distribution are employed, two out of three heteroscedasticity- robust $Z_2(q)$ statistics for returns of EFGI indicate an (incorrect) rejection of the null as the RW3 should not be rejected at 5% level of significance according to the critical value of SMM distribution.

Results of multiple VR tests for returns of employed indexes are presented in table 3.3. The *p*-value of MZ_2^* is based on 10000 wild bootstrap replications and *p*-values of JR_1, JR_2, and JS_1 are computed based on 10000 Monte Carlo trials for a vector of holding period q=2,4,8, and 16. The strong random walk model RW1 is soundly rejected beyond 1% by JR_1 and JR_2 for all indexes and, thus, returns of the EGX do not form IID sequence. Similarly, the weak random walk model RW3 is rejected for all indexes, including EFGI tracking the performance of large-capitalized firms, by MZ_2, MZ_2*, and JS_1 and, hence EGX's returns do not obey MDS.

Table 3.3: Multiple VR results for weekly returns during sub-period I

Index	Test				
	MZ_2 m=4	MZ_2*	JR1	JR2	JS_1
CMAI	5.0857*	0.0002*	4.7173* (0.0001)	5.2529* (0.0.0001)	4.4996** (0.0112)
HFI	3.3690*	0.0074*	3.7009* (0.0011)	3.5662* (0.0012)	2.8475** (0.0128)
MSCI-Egypt	3.6952*	0.0042*	3.2561* (0.0025)	3.3340* (0.0021)	3.6212* (0.0021)
MSCI-M Cap	3.5070*	0.0061*	2.9501* (0.0063)	3.4492* (0.0013)	2.7161** (0.0214)
MSCI-S Cap	6.0861*	0.0000*	5.1293* (0.0000)	5.4370* (0.0000)	4.2548* (0.0008)
EFGI	2.8405*	0.0209*	3.5247* (0.0012)	3.0620* (0.0055)	3.4715* (0.0020)
PIPO	5.8101*	0.0000*	5.2528* (0.0000)	4.9546* (0.0000)	5.2851* (0.0000)

The critical values for $MZ_2$for m=4 are 3.022(1%), 2.491(5%). p-values of JR_1, JR_2, and JS_1 are based on 10000 Monte Carlo trials for q=(2,4,8,16) and p-value of from the wild bootstrap MZ_2* is calculated based on 10000 replication for the same vector of holding periods. *,** indicate significance at 1% and 5% respectively.

The departure of the EGX from efficient pricing of securities is robust across all indexes tracking the performance of the whole market (CMAI) and MSCI-Egypt, highly liquid shares (HFI and EFGI), and large-capitalized firms (EFGI) and that index measuring the performance of partially and wholly privatized companies (PIPO). Therefore, the claim that prices of large firms tend to follow martingale process has not been approved for the EGX during the period February-1997 to July-2002.

Possible explanations for EGX not satisfying WFEMH during the period 1997 to 2002 include nonsynchronous trading which hold true especially for CMAI[1], limited role of mutual funds and professionally managed financial intermediaries[2], narrow price limits imposed on daily price movements of listed

[1] EFGI and HFI indexes consist of highly liquid assets and presumably have no thin trading problems.

[2] The mutual fund industry, newly established in Egypt in 1994 with three local funds, accounted for 7% of total market capitalization in 1997 (Mecagni and Sourial, 1999) and less than 3% in 2002 (CBE, 2002/2003).

shares, dissemination of limited information for market participants on corporate development because of noncompliance with mandatory disclosure requirements, and information asymmetry induced by the presence of selective disclosure[1]. The issue of nonsynchronous trading is prominent reason for the CMAI, including all listed shares irrespective of liquidity, not obeying martingale property. Companies listed on the EGX can be segmented into actively traded firms and rarely traded ones. For the former companies, they are listed on the EGX for capital raising purposes whereas most companies, which rarely traded[2], are listed to benefit from a special tax deduction that is allowed by the Egyptian tax law. The tax deduction is equivalent to the value of paid-in capital times by the Central Bank of Egypt's deposit rate [(Dahawy, 2009); (Bakry, 2006) and (Fawzy, 2003)].

The adverse effects of narrow price boundaries on the performance of the EGX have been recognised by other research. Tooma (2011) confirmed the presence of magnet effect in the EGX where price limits act as a magnet that attracts equity prices closer to their limits. This can be explained by traders' fears

[1] Selective disclosure takes place when corporate insiders provide some important information to selected group of people (e.g. certain investors or analysts) without making this information available to the public, which creates potential insider trading. Consequently, informed investors are likely using such information in trading at the expense of less informed investors (Aly, 2008)

[2] In most cases, rarely traded companies are joint stock companies in name but in reality they are owned by members of the same family or friends (Abdelsalam and Weetman, 2007). The delisting rules, before those in August 2002, required only one transaction per year allow for infrequent trading indicating that if the listed stocks are not traded for six months in row, the closing price of these stocks is to be cancelled. Then, these securities are to be delisted if not traded for a period of one year (Mecagni and Sourial, 1999). The average of traded companies per month during the period 1996-2002 range between a minimum of 129 in 1996 (representing 18.9% of listed companies) and maximum of 243 in 1999 (representing 23.5% of listed companies). Additionally, trading remained highly concentrated in a little number of stocks. In 1997, more than two-thirds of trading value was in 25 stocks (representing less than 5% of listed stocks) whereas the 30 most heavily traded shares (represent 2.8% of listed companies) accounted for 73.87 of value traded in 2000.

of illiquidity or of being locked into an investment position, caused by price hitting their ceilings/floors, motivated them to accelerate trading and, thereby creating large price variation and heavy trading volume. What is more, Tooma (2005) asserted that the narrow price limits, imposed on EGX's shares' movements during the period 1997−2002, were source of higher volatility on subsequent trading days, delaying full incorporation of information into prices, and interfering with trading activities of investors. Tooma and Sourial (2004) found that price limits contributed on increasing investors' risk aversion which adds distortion to the market making it difficult for efficient pricing[1]. Information asymmetries among market participants in the EGX, due to abusive practice of insider trading and self-dealing (World Bank, 2004)[2], has probably caused the market respond to new information with lag as well-informed traders initially react to the arrival of new information and, then, less-informed traders respond to such information. Thus, relevant information was only gradually reflected in equity price movements. In addition, limited information regarding the performance of corporations was only disseminated to market participants. However, International Accounting Standards are mandated by CMA, results of Dahway *et.al,* (2002) and Dahway (2009) indicated that most of the companies studied during 1997 to 2002 did not comply with disclosure requirements.

[1] Tooma and Sourial (2004) found that symmetric GARCH is adequate to model conditional volatility in the pre-implementation period where asymmetric GARCH models are the most appropriate in the post-implementation of symmetric tight price limits. Accordingly, negative shocks were found to have deeper influence on conditional volatility than positive shocks on the post-implementation period. By hitting its upper/ lower limits, trading on this stock is on halt until next day and, consequently, exiting from the market is probably a difficult task especially when prices are in the downward trend. For this reason, traders react aggressively towards adverse shocks with the aim of reducing losses through exiting the market as fast as possible.

[2] Insider trading and self-dealing was not specifically addressed in the Capital Market Law no. 95 of 1992 but article no 64 can be used to sanction insider trading (World Bank, 2004).

3.4.2. VR Results for the Second Sub-period:

Results of LOMAC test on returns of EGX indexes, in sub-period II, for intervals 2, 4, 8, and 16, with the base of one week are provided in table 3.4. According to $Z_2(q)$, the RW3 could not be rejected for all indexes in interval 2 which indicate that the first order autocorrelation is insignificantly different from zero. In addition, the null that returns of MSCI-L Cap and MSCI-M-Cap form an MDS could not be rejected for all holding periods, however; it has to be rejected for all intervals for PIPO returns. For HFI, MSCI-Egypt and EFGI, the null has to be rejected only in lag 16. Again, the employment of CHODE test highlights inferential errors arisen from using the single LOMAC tests and ignoring the joint nature of the VR approach to testing the martingale.

From table 3.5 displaying results of joint VR tests; all VR tests could not reject the null for HFI, MSCI-L Cap, MSCI-M Cap. The MDS null has to be rejected by MZ_2, MZ_2^* and JS_1 for the index covering performance of small-size firms, MSCI-S Cap whereas the null of MDS could not be rejected by MZ_2^* and JS_1 for MSCI-Egypt at 5% level of significance. CMAI and PIPO are found to satisfy MDS null under Assumptions A_1 and A_2 of Wright (2000) since the null could not rejected by JS_1 only, at 5% level of significance. Accordingly, the EGX behaviour, excluding small-cap firms covered by MSCI-S Cap, is consistent with WFEMH.

Table 3.4: LOMAC VR tests for intervals 2, 4, 8, and 16 on weekly returns during sub-period II

	q = 2	q = 4	q = 8	q = 16
CMAI	VR(q)= 1.0829	VR(q)=1.2005	VR(q)=1.6145	VR(q)=2.2571
	Z_1 (q)=1.5211	Z_1(q)=1.9651**[×]	Z_1 (q)=3.8083*[√]	Z_1 (q)=5.2352 * [√]
	Z_2 (q)=1.3703	Z_2 (q)=1.3732	Z_2 (q)= 2.4136**[×]	Z_2 (q)=3.3641*[√]
HFI	VR(q)=0.9926	VR(q)=1.0402	VR(q)=1.2937	VR(q)=1.6740
	Z_1 (q)= −0.1339	Z_1 (q)=0.3941	Z_1 (q)= 1.8204	Z_1 (q)= 2.8069* [√]
	Z_2 (q)= − 0.1111	Z_2 (q)=0.2977	Z_2 (q)=1.3313	Z_2 (q)=2.1184 * [×]
MSCI-Egypt	VR(q)=1.0330	VR(q)=1.1140	VR(q)=1.3427	VR(q)=1.7179
	Z_1 (q)=0.6053	Z_1 (q)=1.1172	Z_1 (q)=2.1241 [×]	Z_1 (q)=2.9899* [√]
	Z_2 (q)=0.5092	Z_2 (q)=0.8642	Z_2 (q)=1.5649	Z_2 (q)=2.2494** [×]
MSCI-L-Cap	VR(q)= 1.0082	VR(q)=1.0816	VR(q)=1.3436	VR(q)=1.6748
	Z_1 (q)=0.1207	Z_1 (q)=0.6372	Z_1 (q)=1.6956	Z_1 (q)=2.2377 [×]
	Z_2 (q)=0.1010	Z_2 (q)=0.4969	Z_2 (q)= 1.2581	Z_2 (q)=1.6990
MSCI-M Cap	VR(q)= 1.1088	VR(q)=1.1927	VR(q)=1.3974	VR(q)=1.6195
	Z_1 (q)=1.9946	Z_1 (q)=1.8889	Z_1 (q)= 2.4629 [×]	Z_1 (q)=2.5799 *[√]
	Z_2 (q)=1.6914	Z_2 (q)=1.5310	Z_2 (q)=1.8744	Z_2 (q)= 1.9585
MSCI-S Cap	VR(q)= 1.0867	VR(q)=1.2558	VR(q)=1.5866	VR(q)=2.0512
	Z_1 (q)=1.5900	Z_1 (q)=2.5067[√]	Z_1 (q)=3.6353* [√]	Z_1 (q)=4.3779 *[√]
	Z_2 (q)= 1.4503	Z_2 (q)=1.9003	Z_2 (q)=2.6263* [√]	Z_2 (q)=3.2687* [√]
EFGI	VR(q)= 1.0122	VR(q)=1.0910	VR(q)=1.3467	VR(q)=1.7900
	Z_1 (q)= 0.2254	Z_1 (q)=0.8918	Z_1 (q)= 2.1488*[×]	Z_1 (q)=3.2898* [√]
	Z_2 (q)=0.1893	Z_2 (q)=0.6659	Z_2 (q)=1.5303	Z_2 (q)=2.3921 **[×]
PIPO	VR(q)= 1.1763	VR(q)= 1.4319	VR(q)= 1.8785	VR(q)= 2.1901
	Z_1 (q)= 2.7259* [√]	Z_1(q)= 3.5694* [√]	Z_1 (q)=4.5917 * [√]	Z_1 (q)= 4.1800* [√]
	Z_2 (q)=2.1642*[×]	Z_2 (q)=2.8430* [√]	Z_2 (q)= 3.5658* [√]	Z_2 (q)=3.2409* [√]

Notes: same as those of table (3.2).

Table 3.5: Multiple VR results for weekly returns during sub-period II

Index	Test				
	MZ_2 m=4	MZ_2* p-values from wild bootstrap	JR1	JR2	JS_1
CMAI	3.3641*	0.0046*	1.4959 (0.2991)	2.2245 (0.0623)	3.6902 (0.1805)
HFI	2.1184	0.0720	0.8967 (0.6839)	1.4229 (0.3461)	3.4362 (0.1677)
MSCI-Egypt	2.2494*	0.0596	0.8106 (0.7437)	1.5103 (0.2871)	4.0652 (0.0646)
MSCI-L Cap	1.6990	0.2032	0.3342 (0.9802)	0.8195 (0.7528)	0.6166 (0.9556)
MSCI-M Cap	1.9585	0.1301	1.4344 (0.3363)	1.7276 (0.1923)	15275 (0.3792)
MSCI-S Cap	3.2687*	0.0062*	2.2058 (0.0577)	2.4737** (0.0279)	4.8491** (0.0270)
EFGI	2.3921	0.0527	0.8590 (0.7075)	1.5942 (0.2464)	3.7212 (0.0873)
PIPO	3.5658*	0.0062*	3.1026* (0.0051)	3.4658** (0.0026)	2.8031 (0.0678)

Notes: Same as those of table (3.3).

It is more likely that coincide of significant developments of the EGX and expansion in price limits (and using trading halts if the price fluctuations hit the relaxed price limits) have led the EGX to follow the RW3 model during the second sub-period. The positive impact of relaxing price limits on market efficiency is confirmed by other studies [(Ryoo and Smith (2002) and Chan and Ting (2000)]. It seems that the new circuit breaker regime facilitate the price discovery process as information is efficiently incorporated into equity prices once trading is resumed after trading suspended (for 30, 45 minutes or till the end of the session if they hit ±10%, ±15% or ±20% of their opening prices). Thus, during the halt period, investors are given the chance to adjust their positions and to react to the new information arrived to the exchange.

The EGX witnessed significant developments in the field of disclosure, information dissemination and trading infrastructure. Some of these developments actually took place in the end of sub-period I but their influences have been enhanced in the second sub-period. For example, EGID[1] began exclusively providing EGX data to all local and international recipients, as of 1st January 2002. In order to increase the transparency and disclosure on the EGX, the listing rules have been adjusted in August 2002 with focus on information disclosure, corporate governance, penalising insider trading and encouraging firms to conform to internationally accepted accounting standards. These new rules stipulate that some fines, varying between imposing money charges and the delisting of companies, are to be levied on companies that do not meet the listing and disclosure requirements (Bakry, 2006), thereby the number of listed

[1] Egypt for Information Dissemination (EGID) is subsidiary company launched, on 1999, by the EGX and is fully owned by it.

companies significantly decreased from 1148 in the end of 2002 to in 435 by the end of 2007. More importantly, disclosure requirements are currently linked to the number of shareholders, whereby companies with more than 100 shareholders have stricter disclosure standards and must publish annual and quarterly reports (World Bank, 2004). In addition, the new listing rules emphasize that listed companies should have an Investor Relations Officer who would be responsible for contacting the EGX in order to answer inquiries of shareholders and investors. Interestingly, the 100 most actively traded companies, in terms of value and volume traded, established their own websites as a means of voluntary disclosure[1] to meet the increasing stakeholders' demands for greater speed, transparent and timely financial information[2] (Aly, 2008).

In order to enhance market efficiency, several remarkable improvements in the infrastructure of the market have been made such the new automated trading system which was initiated in May, 2001, including the installation of a network through which all market entities are linked to the exchange, and improving the settlement, clearing, and registry of publicly traded securities [(ERF, 2004), and (USAID, 2004)]. An important aspect of this new trading system is the pre-opening session which allows for price discovery (Bakry, 2006). The capacity of trading and surveillance systems have been upgraded to match up with the

[1] Voluntary disclosure can be defined as that type of disclosure primarily made outside financial statements and not required by law. Firms utilize voluntary disclosures in order to distinguish themselves through improving information about their businesses, thereby providing more transparency to investors and creditors (Aly, 2008).

[2] English language is used to disclose information for all companies' websites whereas only 29 companies employed both English and Arabic to disclose their information. Employing English language reflects companies' desires to be global through selling their products abroad or raising their capital by selling the companies' shares to foreigners.

increasing trading volumes executed on board[1]. In addition, the new phase of the trading system, introduced on the 20th of July 2006, permits for online trading to boost the market liquidity and facilitate the trading activity (CASE, 2006). To increase the liquidity of the exchange, trading on margin (on credit)[2] and adding the market maker activity[3] to the activities of securities companies have been recently approved. Thus, the exchange witnessed a boom in its activity in sub-period II compared with sub-period I[4].

For small-capitalised firms not obeying a random walk can be explained by the fact that these firms are listed in Unofficial Schedule (2), where they are subject to the minimum requirements of disclosure. They are required to introduce their financial statements on a yearly base, thereby little information are available about their developments.

[1] The new trading system has 18 times capacity of the old trading system (USAID, 2004).

[2] The Minister of Investment issued decree no 314 for 2006 in which securities brokerage companies are required to raise the minimum issued and paid-in capital in order to ensure that they have sufficient liquid net worth to fulfil unanticipated urgent financial obligations on a timely basis, to meet their obligations resulting from margin purchases. It is noteworthy that the CMA agreed to license the Arab African International Bank to practise margin trading, a major instrument for activation of trading and attraction of more investment flows to the market.

[3] To improve the depth of the exchange via providing more liquidity, the Minister of Investment issued a decree adding the market maker activity to the activities of securities companies. Therefore, some securities companies licensed by the CMA, has to provide permanent liquidity for certain securities by meeting the orders of purchasing or selling such securities continuously during the trading.

[4] The EGX has grown in size as the market capitalisation has increased by 534.7% from L.E (Egyptian Pound) 121 billion (represent 36% of GDP) in 2000 to L.E 768 billion (105% of GDP) in 2007. The exponential growth in EGX's activity is reflected by the bulky increase in volume traded, value traded, and the number of transactions. Daily average volume and value traded rose from 4 million securities and L.E 181.8 million in 2000 to 48.9 million securities and L.E 1141.4 million in 2007, an increase of 1122.5% and 1092.5% respectively. Furthermore, the number of transactions boosted from 1.2 million in 2000 to 9.01 million in 2007, representing a boost of 650.83%. Therefore, it is reasonable to infer that increase of maturity has made the market more random in terms of price movements.

3.5. Conclusion

The current chapter examined the information efficiency of the EGX during 1997 to 2007 through employing eight local and international indexes tracking the performance of the EGX. Conventional and sophisticated VR tests have been employed to detect departure from WFEMH. Regarding comparing inferential outcomes of employed tests, the misleading inferences drawn from employing single VR of LOMAC, when testing for martingale, has been highlighted. In addition, JS_1 is more robust than MZ_2^*, and of course the asymptotic CHODE, in testing for martingale property specifically in the presence of extreme outliers (i.e. PIPO returns in the second sub-period).

During the first sub-period, the EGX was found to be inefficient in pricing securities and the claim that large-capitalized firms satisfying martingale property has not been demonstrated. Reasons behind the deviation from WFEMH include: (1) nonsynchronous trading which hold true specifically for CMAI including many inactive stocks that are listed in the EGX to benefit from the tax deduction advantage, (2) tight symmetric price limits of ±5% imposed on daily movements of stock prices as they delay price discovery process, (3) limited information available to market participants about corporations' development due noncompliance with mandatory disclosure requirements, (4)information asymmetry among market participants because of selective disclosure and self-dealing, and (5) limited role played by specialists and financial intermediaries.

For the second sub-period, weekly movements of the EGX's returns, with the exception of MSCI-S-Cap, are found to satisfy MDS. Possible explanations for satisfying MDS include: (1) relaxation of price limits, (2) improving

information dissemination, (3) applying new listing rules to increase the transparency and disclosure on the EGX and the initiative taken by the most active companies to establish their own websites for voluntary disclosure purposes, (4) remarkable improvements in the infrastructure and environment of trading such the new automated trading system, shortening the duration of financial settlements, and allowing for trading on margin and market maker activities.

To conclude, it is more likely that the change in policy regulation (i.e. shift from narrow price boundaries to wide ones coupled with trading halt for few minutes) and improvements in the trading infrastructure and environment has led the exchange, as a whole, to be more liquid and efficient. The claim that prices of large-capitalized firms tend to follow martingale property whereas those of small-capitalized firm do not has been demonstrated in the second sub-period.

Appendix 3:

Assumptions of VR tests

The LOMAC (1988), CHODE (1993) and Kim (2006) tests are driven by Assumption H* of LOMAC (1988) which assumes the following [LOMAC (1988), Wright (2000) and Charles and Darnè (2009)]:

H*1: For all *t*, $E(\varepsilon_t) = 0$ and $E(\varepsilon_t.\varepsilon_{t-k}) = 0$ for any $k \neq 0$;

H*2: $\{\varepsilon_t\}$ is a $\phi-$mixing sequence with coefficient $\phi(m)$ of size $r/(2r-1)$ or is $\alpha-$mixing with coefficient $\alpha(m)$ of $r/(r-1)$, where $r \succ 1$, for all *t* and for $k \neq 0$, there exist some $\delta \succ 0$ for which $E\left|\varepsilon_t.\varepsilon_{t-k}\right|^{2(r+\delta)} \prec \infty$;

H*3: $\lim_{T\to\infty} \frac{1}{T} \sum E(\varepsilon_t^2) \prec \infty$;

H*4: For all *t*, $E(\varepsilon_t\varepsilon_{t-j}.\varepsilon_t\varepsilon_{t-k}) = 0$ for all nonzero *j* and *k* where $j \neq k$.

Assumption H*1 is the essential property of the RW1 model (i.e. IID price increments). Assumptions H*2 and H*3 are restrictions on the degree of dependence and heterogeneity, which are allowed and yet still permit some form of law of large numbers and central limit theorem to obtain. This allows for a variety of forms of heteroscedasticity, including GARCH-type variances and variances with deterministic changes. Assumption H*4implies that the sample autocorrelations of ε_t are asymptotically uncorrelated.

Rank and signs tests of Wright (2000) are driven by Assumption A in which it is considered that asset returns x_t is generated by $x_t = \mu + z_t$ and $z_t = \sigma_t . \varepsilon_t$. Allowing $I_t = \{x_t, x_{t-1}, x_{t-2}, ...\}$, Wright (2000) proposed the following assumptions:

Assumption A_0 : z_t is an IID sequence,

Assumption A_1 : σ_t and ε_t are independent conditional on information set available at *t−1*, I_{t-1}., and

Assumption A_2 : $E(\varepsilon_t | I_{t-1}) = 0$ or one ($\varepsilon_t \succ 0$) is an IID binomial variable that is one with probability 0.5 and zero otherwise.

Assumption A_0 is the strongest possible assumption, stipulating that asset returns are IID, ruling out any conditional heteroscedasticity. If Assumption A_1 and Assumption A_2 hold, then $E(x_t | I_{t-1}) = \mu$, so x_t is an MDS with respect to I_t and may be therefore conditionally heteroscedastic. Likewise the Assumption H^* of LOMAC (1988), the combinations of the last two assumptions are sufficient but not necessary for x_t to be a MDS. Furthermore, Assumption A_1 is satisfied in a GARCH model and also by a stochastic volatility model in which the innovations to volatility are independent of ε_t . Assumption A_2 allows ε_t being *t*-distributed with time-varying degrees of freedom. The rank-based tests of Wright (2000) and Belaire-Franch and Contreras (2004) are based on Assumption A_0 while sign-based test of Kim and Shamsuddin (2008) is based on Assumptions A_1 and A_2.

Chapter Four

Evolving and Relative Efficiency of MENA Exchanges: Evidence from Rolling Joint Variance Ratio Tests.

4.1. Introduction:

As mentioned in chapter one, empirical research examined weak-form-efficiency in Egypt, Jordan, Morocco, Turkey and Israel reached mixed conclusions. Mean reasons behind that include using different data frequencies, different tests and, more importantly, testing for WFEMH in an absolute sense with an implicit assumption of efficiency being steady during the period under estimation. However, it is reasonable to expect market efficiency to evolve over time due to changes in macro-institutions, stock market regulations and technological advances (Lim and Brooks, 2011). Yilmaz (1999) debated that emerging markets examined in his study moved towards efficiency as they evolve through time from small, shallow and segmented markets into sizeable and liquid markets integrated with the world financial system. In addition, Emerson *et.al* (1997) contended that a more relevant hypothesis to be tested, especially in the case of markets under economic transition, is how such infant markets converge towards efficiency since it takes time for the price discovery process to become known. Campbell *et.al*, (1997) proposed the concept of relative efficiency, which is the efficiency of one market measured against another, indicating that it may be a more useful concept than all-or-none view investigated by majority of market efficiency literature.

Lim and Brooks (2011) support using VR methodology in overlapping sub-samples when testing for WFEMH since (1) it captures the gradual change in the level of efficiency through time; thereby it would be useful in identifying factors that lead markets to become (in)efficient, and (2) it may serve as a measure of constructing efficiency ranking because the main purpose of rolling

window estimation is to measure how frequent the WFEMH is rejected during the whole sample period where large percentage of rejections interpreted as an inferior degree of informational efficiency.

The present chapter aims at addressing the WFEMH using multiple VR tests in rolling window framework to investigate how equity prices behave across time and across countries. In other words, issues of evolving and relative efficiency of MENA countries are going to be addressed. By tracking the evolving of efficiency through time, it would be possible to detect factors leading the market to become efficient and identify any coincidence between the recent American subprime mortgage crisis, hitting international financial markets in the second half of 2007, and informational inefficiencies in these markets. To examine the presence of exchange rate effects on test of financial asset dynamics, data denominated in domestic and US$ currencies is employed to introduce results from the perspective of domestic and international investors. From the perspective of foreign investors, the performance of stock markets using common currency is what matters since foreign stocks are assets comprise both the local currency stock index and the dollar/local currency exchange rate. This combination, thus, accounts for any stock market changes that are in fact induced by exchange rate movements, which would be important to foreign investors. In other words, some movements of the equity price indexes are likely to be reflection of the foreign exchange exposure of listed firms. Stock prices denominated in the common currency implicitly represent the sum of the returns on two assets: the domestic stock index and the domestic currency (Saadi-Sedik and Petri, 2006).

The current chapter structured as follows. Section 2 introduces brief description of data and methodology since VR tests have been introduced in details in Chapter three. Section 3 presents discussion of empirical results. Finally, section 4 concludes.

4.2. Data and Methodology:

The current empirical work employs weekly data of MSCI price indexes, denominated in domestic and US$ currencies, for five MENA countries; namely, Egypt, Jordan, Morocco, Turkey, and Israel for the period starts from 4th of January, 1995 to 9th of December, 2009. MSCI price indexes are value-weighted targeting 85% of adjusted free-float market capitalization in a particular country. The data points are associated with Wednesdays, however; those associated with Tuesdays are employed if the exchanges under consideration are closed in Wednesdays. Following Kim (2004), the rolling window procedure is applied in a fixed window size of 260 observations (equivalent to 5 year of employed weekly data, assuming each year has, on average, 52 weeks). The multiple VR analysis is conducted using the first 260 observations corresponding to the first sub-period; then the sample is rolled 4 points forward, eliminating the first 4 observations, performing the VR tests for the new window and repeat this procedure until the end of the series. For the sample period considered here, return series for an index a_t includes 780 observations. Thus,

Sub-period 1: $a_1,\ a_2,\ a_3,...,a_{260}$

Sub-period 2: $a_5,\ a_6,\ a_7,...,a_{264}$

$\vdots$

Sub-period 131: $a_{521},\ a_{522},\ a_{523},...,a_{780}$

Accordingly, there are 131 overlapping sub-samples for each index. The RW behaviour of each index is tracked across these sub-periods and the market with the highest percentage of rejecting WFEMH would be classified as the least efficient, in contrast to, the market with the lowest percentage of rejections would be ranked as the most efficient.

4.3. Empirical Results

Table 4.1 presents statistical descriptions of local and US dollar-based data in panels A and B respectively. For of local-currency based data, the average weekly return in Turkey is more than twice that of Egypt, around four times that of Israel and Morocco, and more than ten times that of Jordan. For measure of risk, Turkey has the highest sample standard deviation which is around one and half, twice, more than twice, and three times as that of its counterparts in Egypt, Israel, Jordan and Morocco respectively. Accordingly, Turkey has the highest approximate Sharpe ratio, a measure of risk-adjusted performance, followed by Egypt, Morocco, Israel, and Jordan. The relative ranking of mean returns is not maintained for exchange rate-adjusted data as Egypt comes with the highest mean return followed by Turkey, Morocco, Israel, and Jordan. On a risk-adjusted basis, Morocco has the largest Sharpe ratio followed by Egypt, Israel, Turkey and Jordan. Domestic investors, with the exception of Morocco, would obtain higher risk-adjusted returns than would international investors.

All return series denominated in both local and US dollar currencies are significantly left-skewed and exhibit excess kurtosis. Therefore, the unconditional normality is soundly rejected by JB statistics beyond 1% level of significance.

From Figure 4.1, displaying graphs of log price indexes and return series in both local and US dollar currencies, it is clear that return series exhibit volatility pooling confirming deviation from normality.

Table 4.1: Descriptive statistics of local and US dollar-based weekly equity returns of MENA countries

Descriptive statistics	Panel (A): statistical description for the local currency-based data				
	Egypt	Jordan	Morocco	Turkey	Israel
Mean	0.00325	0.00063	0.00162	0.00664	0.00183
Std.Dev.	0.0411	0.0271	0.0223	0.0640	0.0313
Skewness t-statistic(1)	-0.5415 [-6.2487]	-0.5924 [-6.8362]	-0.3482 [-4.0182]	-0.2377 [-2.743]	-0.3352 [-3.8681]
Kurtosis t-statistic(2)	6.5694 [20.595]	8.9492 [34.3262]	8.3526 [30.8839]	5.0457 [11.8035]	5.0482 [11.8179]
J-B statistic [p-value]	451.6391 [0.0000]	1194.655 [0.0000]	945.714 [0.0000]	143.1843 [0.0000]	150.764 [0.0000]
Standardised returns(3)	0.0790	0.0232	0.0726	0.1037	0.0584
Descriptive statistics	Panel (B): statistical description for the US dollar-based data				
	Egypt	Jordan	Morocco	Turkey	Israel
Mean	0.00264	0.00062	0.00181	0.00199	0.00162
Std.Dev.	0.0418	0.0268	0.0247	0.0723	0.0335
Skewness t-statistic(1)	-0.5851 [-6.7519]	-0.6299 [-7.2689]	-0.3022 [-3.4873]	-0.5280 [-6.093]	-0.3494 [-4.032]
Kurtosis t-statistic(2)	6.6186 [20.878]	8.6756 [32.7476]	7.9311 [28.4519]	4.8166 [10.4816]	5.0765 [11.981]
J-B statistic [p-value]	469.4847 [0.0000]	1097.113 [0.0000]	801.139 [0.0000]	143.315 [0.0000]	155.827 [0.0000]
Standardised returns(3)	0.0631	0.0231	0.0732	0.0275	0.0483

Notes: (1)t-statistic, between parentheses, is calculated as $t = (S' - 0) / SE(S')$, where S' is value of skewness coefficient of certain index, 0 is the value of skewness coefficient for a normal distribution, and $SE(S')$ is the standard error of the estimated skewness coefficient which calculated as the square root of 6/n, where n is the number of observations. (2) t-statistic, between parentheses, is calculated as $t = (K' - 3) / SE(K')$, where K' is value of kurtosis coefficient of certain index, 3 is the value of kurtosis coefficient for a normal distribution, and $SE(K')$ is the standard error of the estimated kurtosis coefficient which calculated as the square root of 24/n, where n is the number of observations. (3) Standardised return (or the approximate of Sharpe ratio), providing a measure of the return-risk profiles of the equity markets employed, is computed as the average of mean return of each series divided by its standard deviation. Unlike the standard Sharp ratio, computed as an asset's excess return divided by the asset's standard deviation, the approximate Sharpe ratio is computed as each series' mean return divided by the series standard deviation (Karemera et. al, 1999). * , ** indicate that the null hypothesis should be rejected at 1% or less and 5% or less level of significance respectively.

First, before proceeding to apply the rolling window analysis, MZ_2^*, JR_1, JR_2, and JS_1 tests are executed using the full sample for 2, 4, 8, and 16 week-holding periods for both local and dollar-based datasets, (see table 4.2). From

table 4.2, the Turkish and Israeli stock exchanges are found to be consistent with WFEMH irrespective of the employed test or currencies as the null could not be rejected at any conventional level of significance. On the other hand, the Egyptian, and the Moroccan exchanges are found inefficient in pricing securities from the perspective of domestic and international investors as all tests reject the null at conventional levels of significance. According to MZ_2^*, the Jordanian exchange is consistent with the WFEMH from the perspective of domestic investors.

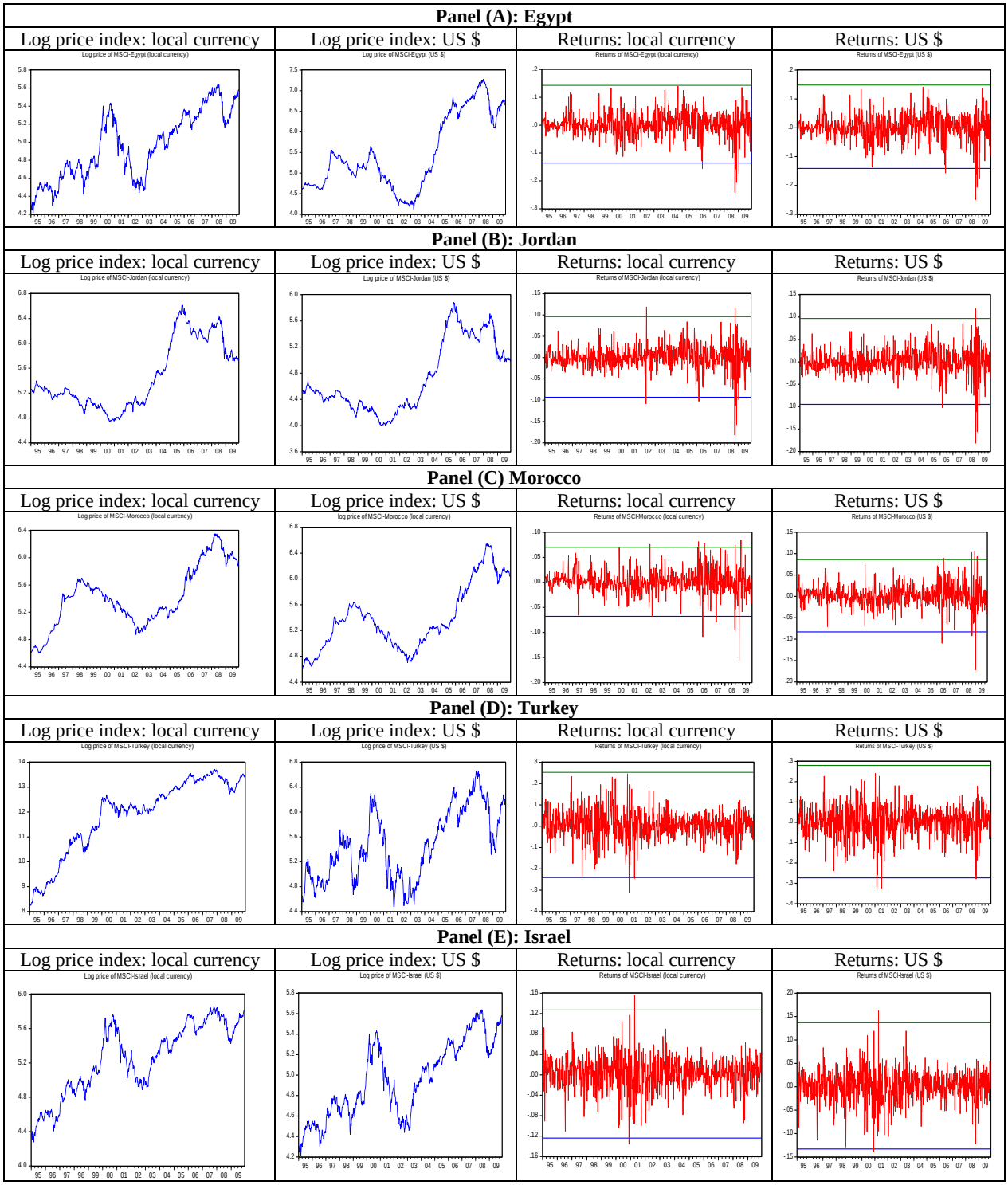
Table 4.2: Results of joint VR tests of local and US dollar-based weekly equity returns of MENA countries

Test employed	Panel (A): Results for the local currency-based data				
	Egypt	Jordan	Morocco	Turkey	Israel
MZ_2^*-p value	0.0004*	0.0531	0.0066*	0.4070	0.7705
JR_1- p-value	0.0000*	0.0013*	0.0000*	0.1351	0.5686
JR_2 -p-value	0.0000*	0.0021*	0.0000*	0.1864	0.6688
JS_1 p-value	0.0003*	0.0003*	0.0000*	0.1378	0.2895
Test employed	Panel (B): Results for the US dollar-based data				
	Egypt	Jordan	Morocco	Turkey	Israel
MZ_2^*-p value	0.0001*	0.0395*	0.0144**	0.3714	0.5503
JR_1-p-value	0.0000*	0.0009*	0.0000*	0.6593	0.7157
JR_2-p-value	0.0000*	0.0008*	0.0000*	0.5867	0.5656
JS_1-p-value	0.0063*	0.0009*	0.0000*	0.3206	0.6263

Note: number of both wild bootstrap MZ_2^* and Monte Carlo simulation (of JR_1, JR_2, and JS_1) was set to 10000 replications.

*, ** indicate the rejection of the null at 1% (or less) and 5% (or less) respectively.

Figure 4.1: Plots of prices indexes and returns in the employed countries



Note: The above and the bottom horizontal lines in each graphs represent (Q1-3IQR) and (Q3+3IQR) respectively, where Q1 is the first quartile, Q3 is the third quartile and IQR (Interquartile range) = Q3−Q1

It may be too early to draw a concrete conclusion regarding the behaviour of stock prices in Egypt, Jordan, and Morocco as it is likely that the rejection of WFEMH in the whole sample is driven by the behaviour of equity prices in earlier times of the employed sample[1]. Conversely, the incapability of rejecting the WFEMH in the case of Turkey and Israel for the whole period under investigation does not necessarily indicate that the behaviour of their equity prices is consistent with RW throughout 1995 to 2009.

To track the evolution of efficiency across time, the above mentioned tests are executed for the aforementioned time horizons with moving sub-sample window, where the number of replication for both wild bootstrap and Monte Carlo simulation is set to 10000. If the *p*-values of employed tests are less than 5%, the null hypothesis has to be rejected at 5% level of significance for that period. Plots of *p*-values of MZ_2^*, JR_1, JR_2, and JS_1 for Egypt, Jordan, Morocco, Turkey, and Israel are displayed in Figures 4.2 through 4.6, respectively. In each figure, panels (A) introduce results of domestic currency-based datasets whereas panels (B) present exchange rates-adjusted datasets. It is worth mentioning that the *p*-values of each test are plotted against the last time points of moving sub-samples windows.

The behaviour of the Egyptian exchange did not satisfy the WFEMH in earlier periods, approximately up to 2002, but the WFEMH could not be rejected by, almost all tests, as the observations pertaining to earlier periods are dropped from the window. This is in line with the conclusion drawn in chapter three where

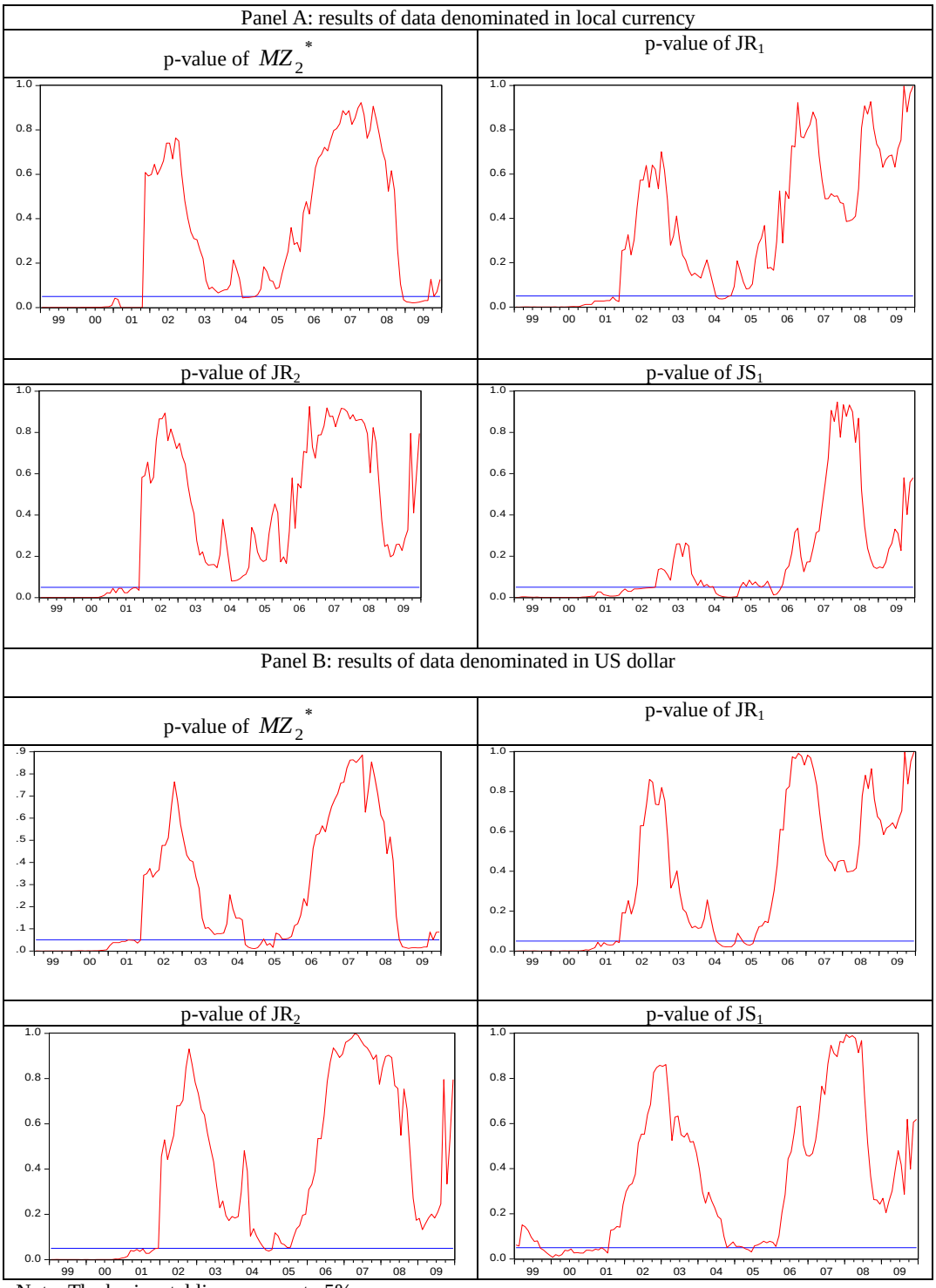
[1] Recall, from chapter three, that the EGX was found inefficient in pricing securities during 1997, February to 2002, July, but efficient after expanding price limits imposed on daily movements of equity prices and significant development in the trading infrastructure.

the inefficiency of the EGX up to the end of 2002 could be explained by (1) tight symmetric price limits of 5% imposed on daily movements of stock prices as they delay price discovery process, (2) limited information available to market participants about corporations' development due noncompliance with mandatory disclosure requirements, (3) and information asymmetry among market participants because of selective disclosure and self-dealing. The EGX convergence towards efficiency is a reflection of the growth in its size and liquidity, as mentioned earlier in chapter three, the relaxation of price limits and stipulating the trading halt mechanism, and remarkable improvements in the infrastructure and environment of trading such as the new automated trading system, shortening the duration of financial settlements, and allowing for trading on margin and market maker activities. What is more, corporate governance standards in Egypt have witnessed considerable improvement, between 2001 and 2004 [(World Bank, 2001, 2004) and (Fawzy, 2003)].

Similar to the EGX, the CSE of Morocco moved towards efficiency by the end of 2002. Before 2002, it was characterized by a lack of transparency (local accounting standard were employed), small number of individual investors, and extreme illiquidity represented by non-trade of many stocks for several consecutive weeks [(Ghysels and Cherkaoui, 2003) and (Marashdeh, 2006)]. Extensive series of reforms, deregulations and privatization have taken place in recent years which has been reflected in the market size and liquidity [(Jefferis and Smith, 2005) and (Marashdeh, 2006)]. For example, the market capitalization ratio to GDP jumped from 24.09% in 2001 to 100.36% in 2007. Similarly the

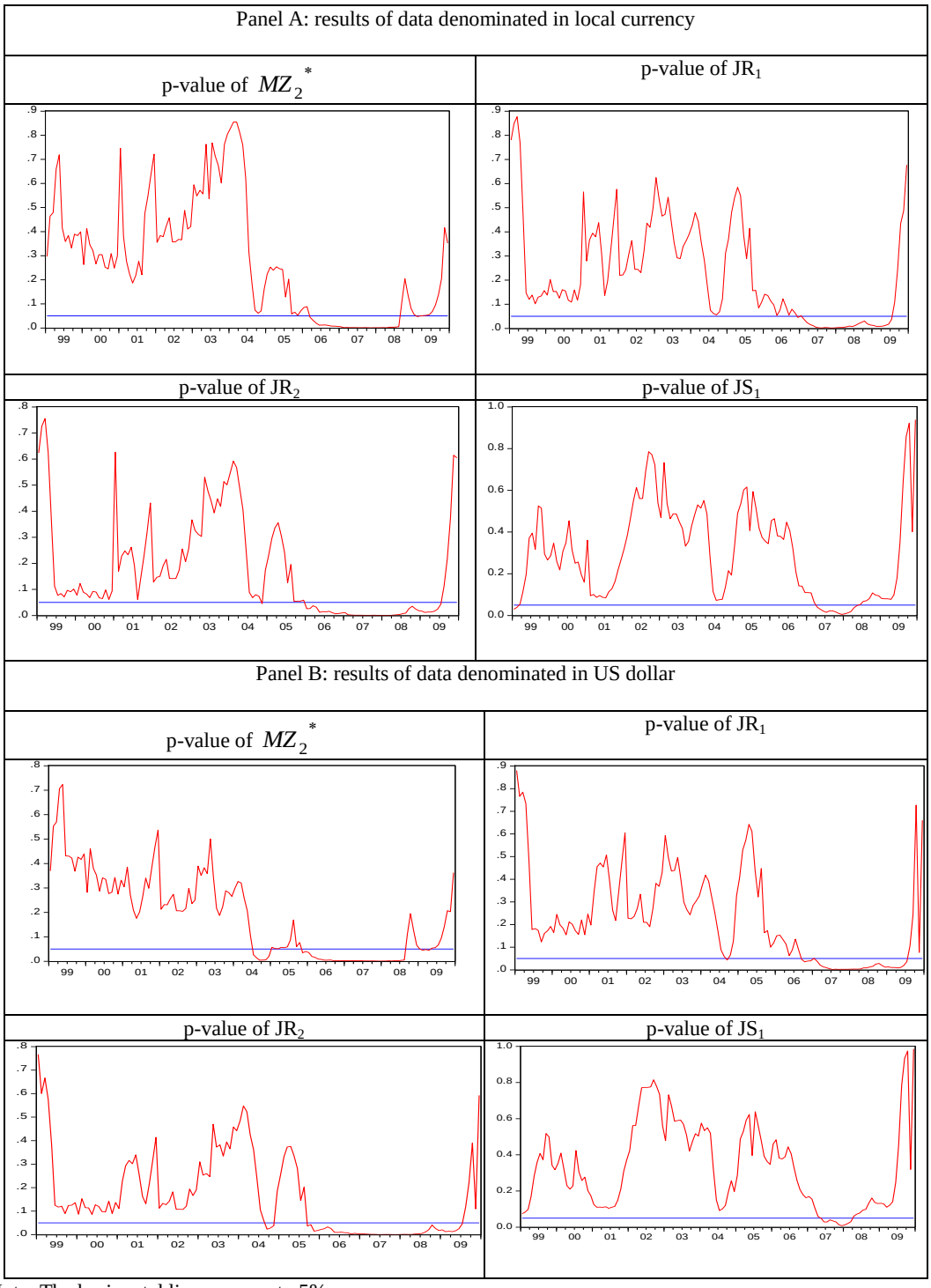
value of stock traded to GDP and turnover ratio increased from 2.58% and 9.74% in 2001 to 34.93% and 42.09% in 2007, respectively.

Figure 4.2: Multiple VR tests for Egypt



Note: The horizontal line represents 5%

Figure 4.3: Multiple VR tests for Jordan



Note: The horizontal line represents 5%

Important reasons that are likely to cause the CSE move towards efficiency include adopting the international accounting standards, improvements in the information dissemination process (e.g. the CSE created its own website to provide market participants with information regarding corporate developments

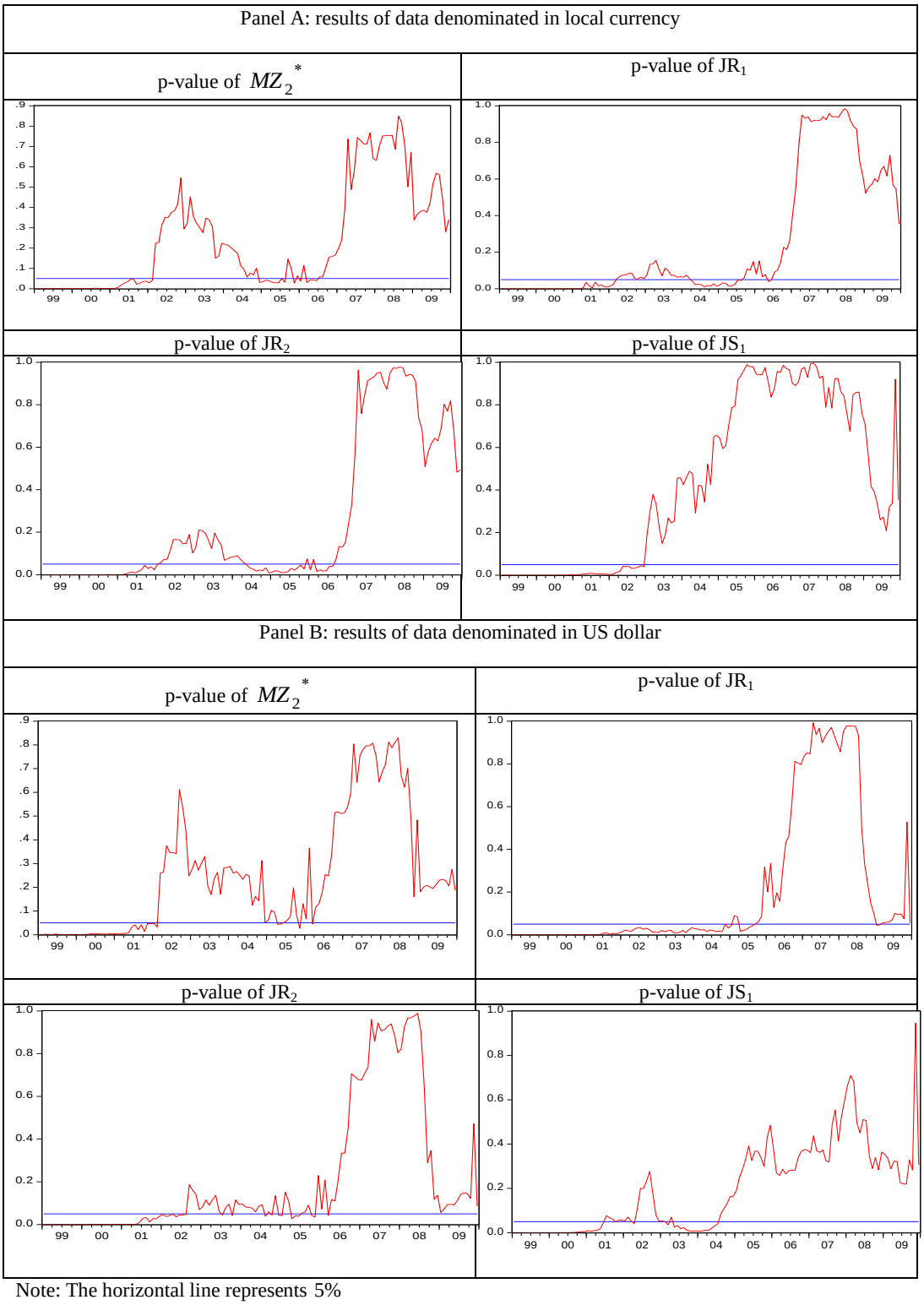
on timely basis). For this reason, it has passed the criteria of transparency and market depth information set by FTSE for stock market quality (refer to table 2.A.A in appendix attached to chapter 2).

The Jordanian exchange was efficient in pricing equities up to the end of 2005. Periods of inefficiencies are detected since then, however; the duration of these periods differs from test to another. The Jordanian exchange was overvalued by the end of 2005 because of spillover effect from oil-producing regional neighbours (i.e. Saudi Arabia and Kuwait) experiencing sharp increase in oil prices. However, a process of price correction took place when Arab investors from Gulf countries had withdrawn considerable funds from the ASE to cover their financial positions in their domestic markets after the sharp decline in stock prices in Saudi Arabia and other Gulf stock markets[1] (Saadi-Sedik and Petri, 2006)

The Turkish and Israeli exchanges seem to be the most efficient markets among those studied here since the WFEMH could not be rejected by MZ_2^* in all sub-samples and approximately in all sub-samples by JS_1. This is not surprising since both are, as mentioned in chapter two, the biggest in size (according to the absolute value of market capitalization), the most liquid (according to the turnover ratio) , and more importantly they currently pass the 22 criteria set by FTSE to assess stock market quality and, thus, they are classified as developed exchanges. In addition, both possess very-developed financial system (Lagoarde-Segot and Lucey, 2008a)

[1] By the end of 2005, Arab investors accounted for 36% of market capitalization in Jordan.

Figure 4.4: Multiple VR tests for Morocco

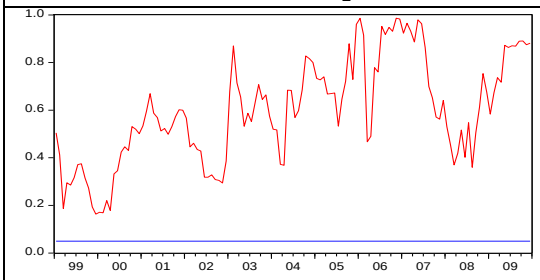


Note: The horizontal line represents 5%

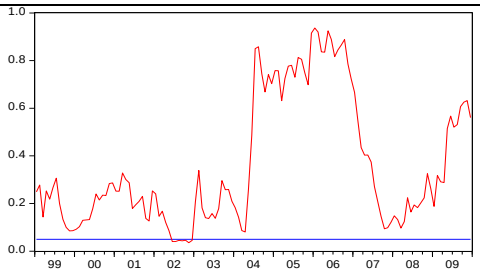
Figure 4.5: Multiple VR tests for Turkey

Panel A: results of data denominated in local currency

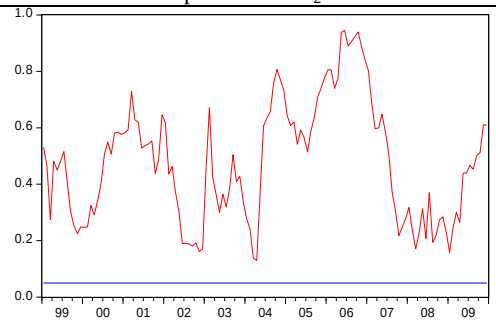
p-value of MZ_2^*



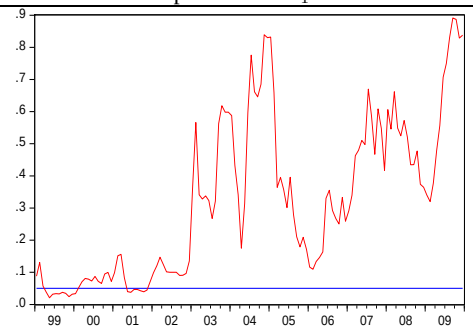
p-value of JR_1



p-value of JR_2

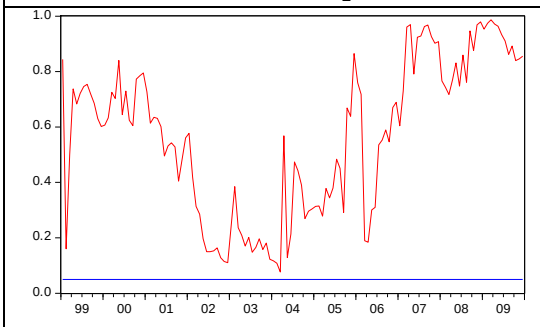


p-value of JS_1

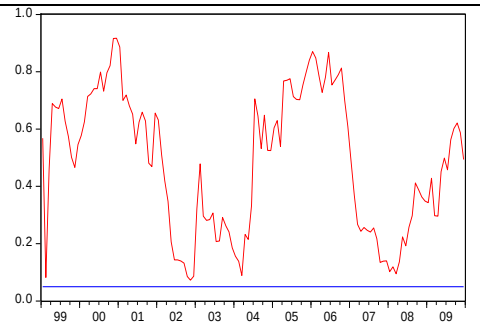


Panel B: results of data denominated in US dollar

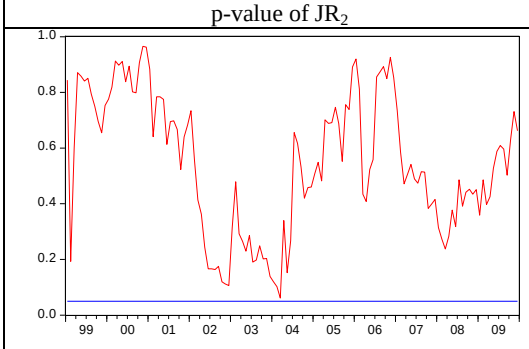
p-value of MZ_2^*



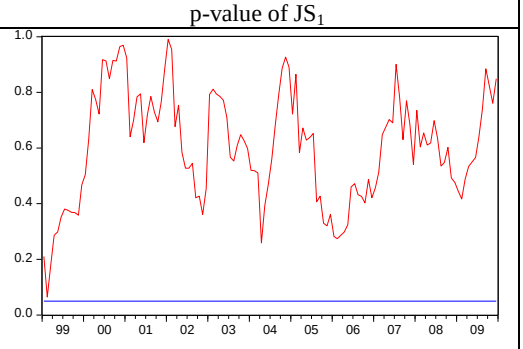
p-value of JR_1



p-value of JR_2



p-value of JS_1

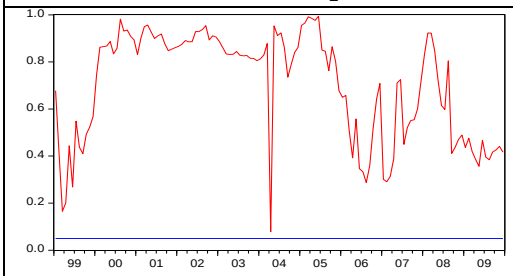


Note: The horizontal line represents 5%

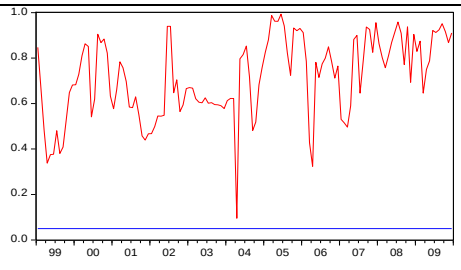
Figure 4.6: Multiple VR tests for Israel

Panel A: results of data denominated in local currency

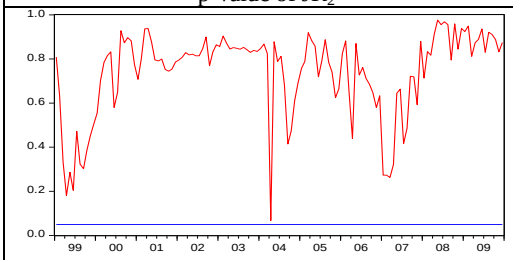
p-value of MZ_2^*



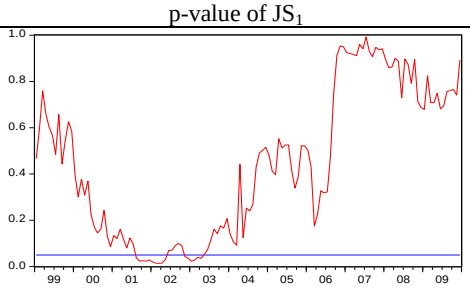
p-value of JR_1



p-value of JR_2

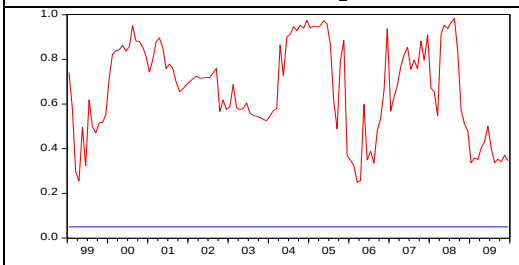


p-value of JS_1

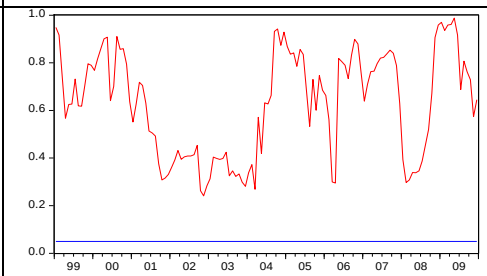


Panel B: results of data denominated in US dollar

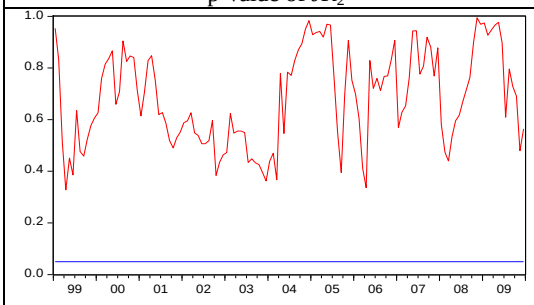
p-value of MZ_2^*



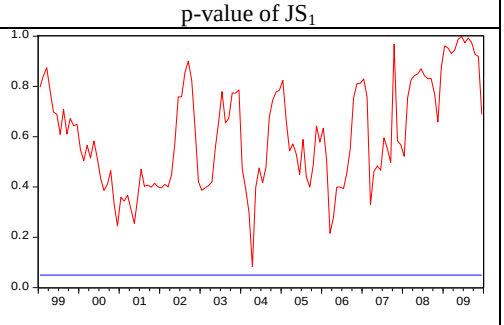
p-value of JR_1



p-value of JR_2



p-value of JS_1



Note: The horizontal line represents 5%

Roughly speaking, based on empirical results of VR tests robust for heteroscedasticity, it seems that exchange rate dynamics do not have significant impact on testing for weak-form-efficiency in countries under examination. This conclusion is in line with the findings of Lagoarde-Segot and Lucey (2008a) who found that exchange rates do not matter in testing for WFEMH in Egypt, Jordan, Morocco, Turkey and Israel. The recent American mortgage crisis did not affect the efficiency of stock markets under examination. These findings are in line with other empirical work tested the impact of financial crisis on market efficiency [e.g. Hoque *et.al,* (2007), Auer and Schuster (2011)].

Given that both MZ_2^* and JS_1 are robust for heteroscedasticity, they are used to rank the efficiency of markets under examination, as shown in table 4.3. According to JS_1 and MZ_2^*, Turkish and Israeli exchanges are the most efficient irrespective of the currency employed. Jordan is ranked the second efficient market from the perspective of domestic investor according to both JS_1 and MZ_2^*. Egypt and Morocco are ranked the third and the fourth according to MZ_2^* where this rank is reversed according to JS_1 when local currency-based dataset is employed. When dataset based on US dollar is employed Jordan maintains the second rank according to JS_1 but comes the third, after Morocco, according to MZ_2^*. It is worth noting that, with the exception of results based on JS_1test applied to datasets denominated in local currencies, the number of sub-samples in which the WFEMH has to be rejected is very similar for Jordan and Egypt.

Table 4.3: Results of relative efficiency of MENA exchanges under examination

Panel A: Local currency- based dataset						
Country	MZ_2^*			JS_1		
	No of sub-samples in which WFEMH is rejected	% Of whole sub-samples	Rank	No of sub-samples in which WFEMH is rejected	% Of whole sub-samples	Rank
Egypt	40	30.53%	**3**	49	37.40%	**4**
Jordan	35	26.7%	**2**	16	12.21%	**2**
Morocco	44	33.58%	**4**	41	31.29%	**3**
Turkey	0	0%	**1**	7	5.34%	**1**
Israel	0	0%	**1**	16	12.21%	**2**
Panel B: US $ currency- based dataset						
Country	MZ_2^*			JS_1		
	No of sub-samples in which WFEMH is rejected	% Of whole sub-samples	Rank	No of sub-samples in which WFEMH is rejected	% Of whole sub-samples	Rank
Egypt	45	34.35%	**4**	17	12.97%	**3**
Jordan	43	32.82%	**3**	11	8.39%	**2**
Morocco	33	25.19%	**2**	49	37.40%	**4**
Turkey	0	0%	**1**	0	0%	**1**
Israel	0	0%	**1**	0	0%	**1**

It would be interesting to compare conclusion drawn here to that of Lagoarde-Segot and Lucey (2008a) who studied the WFEMH in countries considered here, in addition to Tunisia and Lebanon. They investigated informational efficiency in relation to its theoretical foundations in the above mentioned countries. They, first, aggregated the results of VR tests and technical trade analyses into a single efficiency index, which enabled them to rank the efficiency level of the seven sampled MENA stock markets. Their results showed that Turkey and Israel showed the strongest evidence of weak-form-efficiency followed by Jordan, Egypt, and Morocco, and the rank of Egypt and Jordan was very close as the case here. They interpreted these findings in terms of liquidity and market size. Then, using multinomial ordered logistic regression, Lagoarde-Segot and Lucey (2008a) analysed the impact of market development (value

traded, market capitalization, number of listed firms, and turnover ratio), corporate governance (disclosure, shareholder protection, and management liability) and the degree of institutional and economic liberalization (rule of law, intervention of government, external financial liberalization, and the degree of economic freedom) on the efficiency. Their results showed that that the extent of weak-form- efficiency in the MENA stock exchanges is mainly explained by differences in stock market development and corporate governance, whereas the impact of overall economic liberalization did not seem to have explanatory power. Accordingly, they enhanced that a country aims at creating positive economic spillovers from stock market activity is encouraged to develop the size and liquidity of its stock market. In addition, such country has to simultaneously implement an adequate regulatory structure with more emphasis on managerial liability and shareholder protection.

To conclude, the most liquid and the biggest exchanges of Turkey and Israel are considered the most efficient since the RWH could not be rejected throughout all sub-samples whereas the efficiency of the three remaining exchanges were found vary across time and their relative ranking depends on the test employed. However, with the exclusion of results based on sign test applied to datasets expressed in local currencies, the number of sub-samples in which the WFEMH has to be rejected is very similar for Jordan and Egypt. The Egyptian and Moroccan exchanges converged towards efficiency by 2002 due to remarkable improvements in liquidity, information dissemination, transparency and disclosure, and microstructure. Thus, one may conclude that developing countries aim to achieve informational efficiency are highly recommended to take

procedures that improve market liquidity and enhance the quality of disclosed information. Conforming to the findings of other papers cited in literature [e.g. Hoque *et.al,* (2007), Auer and Schuster (2011) and Lagoarde-Segot and Lucey (2008a)], results indicated that exchange rate dynamics and the recent financial crisis did not affect testing for WFEMH in exchanges under consideration.

4.4. Conclusion

Campbell *et.al*, (1997) argued that that perfect efficiency is an unrealistic benchmark that is unlikely to be attainable in practice or in theory. They debated that if markets are perfectly efficient in the sense that investors are not compensated for the cost of information gathering and processing, then there will no incentive to trade and, therefore, markets will eventually collapse. They proposed the concept of relative efficiency, which is the efficiency of one market measured against another, indicating it may be a more useful concept than all-or-none view investigated by bulk of market efficiency literature. In addition, it is sensible to expect market efficiency to vary over time due to changes in macro-institutions, market regulations and information technologies (Lim and Brooks, 2011). For this reason, Emerson *et.al* (1997), when testing for WFEMH in Central and Eastern Europe transition economies, claimed that a more relevant hypothesis to be tested is how such embryonic markets move towards efficiency since it takes time for the price discovery process to become known. Motivated by these arguments, the current chapter re-examined the WFEMH for Egypt and some selected MENA exchanges during 1995-2009 by employing MVR tests in overlapping sub-samples to capture smooth change of market efficiency over time and to construct a measure of relative efficiency where a large percent of sub-

samples in which the null of RW has to be rejected is interpreted as an inferior degree of informational efficiency. In addition, the chapter questioned the impact of the recent financial crisis, hitting international exchanges in 2007, on the informational efficiency of stock markets under consideration. The argument is that during financial crises characterized by panic and high levels of volatility and uncertainty are likely to adversely affect the ability of investors to efficiently price securities (Lim and Brooks, 2011). Furthermore, some movements of the equity price indexes are likely to be reflection of the foreign exchange exposure of listed firms. Accordingly, the chapter addressed the effect of exchange rate dynamics on testing for market efficiency in MENA stock markets under examination by employing data expressed in both local and US dollar currencies. From the perspective of foreign investors, the performance of stock markets using common currency is what matters since foreign stocks are assets comprise both the local currency stock index and the dollar/local currency exchange rate (Saadi-Sedik and Petri, 2006).

Applying the rolling window procedure casts doubts on the validity of testing for the WFEMH in an absolute sense since the degree of market efficiency of Egypt, Morocco, and Jordan were found to vary across time according to the former procedure whereas they were found inefficient in pricing equities according to the latter procedure. As one may expect, the big, the most liquid exchanges of Turkey and Israel [that satisfy the 22 criteria set by FTSE to assess market quality] were found to be the most efficient in pricing equities since the null of RW could not be rejected through, almost, all sub-samples. The Jordanian exchange was found efficient in pricing equities up to 2005, however; since then

it has experienced inefficiencies. Overvaluation of the Jordanian equities could be attributed to the spillover effects from neighbouring oil-producing countries that experienced sharp increase in oil prices. A process of price correction took place when Arab investors withdrew considerable funds from the Jordanian market and thus it restored its efficiency. The Egyptian and Moroccan exchanges converged towards efficiency by 2002 due to remarkable improvements in liquidity, information dissemination, transparency and disclosure, and microstructure. The relative ranking of the Egyptian, Jordanian and Moroccan exchanges depends on the test employed. However, it is worth mentioning that, with the exclusion of results based on JS_1test applied to datasets denominated in local currencies, the number of sub-samples in which the WFEMH has to be rejected is very similar for Jordan and Egypt.

Broadly speaking, empirical results suggest that exchange rates do not matter in determining the dynamics of share returns for equity markets examined here. In addition, the recent financial crisis seems not affect testing for weak-form-efficiency in exchanges under examination. These findings regarding the impact of exchange rate and financial crisis on testing for WFEMH are in line with findings of other scholars [e.g. Hoque *et.al*, (2007), Auer and Schuster (2011), and Lagoarde-Segot and Lucey (2008a)].

Chapter Five

Information Transmission across Domestic Super-sectors: Evidence from the Egyptian, Turkish and Israeli Stock Exchanges.

5.1. Introduction

An important feature of the RW process, which holds true for RW1, RW2 and RW3 models of Campbell *et.al* (1997), is nonstationarity. Thereby, unit root tests have been employed in finance literature to test whether logarithm of stock prices are stationary or not. If these prices are found to be generated by a unit root process, a conclusion is drawn that the underlying market is weak-form efficient since such process does not have a tendency to revert to its mean. The finance literature proceeds a step further, when examining weak form efficiency, by testing for collective efficiency of a group of international (regional) exchanges by means of cointegration tests (Chan *et al*., 1997). If price of two indexes are found to be cointegrated, then there must be Granger causality, at least in one direction, between series under consideration raising the possibility of using information content in one series to help forecasting the others, implying violation of the WFEMH. A large body of literature explored comovements and linkages among international and regional stock exchanges to shed lights on how they are linked. The main contribution of these studies is providing useful information for financial market participants in formulating their international diversification strategy among international stock markets. However, the influence of country effects is becoming less important in the management of portfolio investments due to the increasing regional and economic integration[1].

[1] The International economies and financial markets are becoming more and more integrated, mainly due to relaxation of legal restrictions on international capital flows across borders, the ongoing expansion of large multinational companies, reducing barratries facing international trade and investment, the reduction of the cost of information because of exponential advances in the field of communication technology, and improvements in trading systems. Thus, diversification potentials across borders are less than before.

The decline in international differentials is the main determinant of the change in dominance from country specific to sector specific effects on portfolio investment risks (Mohammad *et.al*, 2006). Recently, empirical research has revealed that the sector (industry) effects are now roughly equal to the country (market) effects, implying that international diversification across industries is more likely to reduce portfolio risk compared to the traditional diversification across borders. Being aware of the increasing influence of sector effects, fund managers started to construct their portfolios based on sectors rather than markets (Al-Fayoumi *et.al*, 2009)**.** This has been reflected in the introduction of several sector-specific tracker funds where investors have the opportunity to invest in products that specialise in specific economic sectors (Mohammad *et.al*, 2006). What is more, effectiveness of portfolio diversification across borders is likely to be eroded by the series of financial crisis hitting the world's capital markets during the few past decades (e.g. The Black Monday crash in 1987, the Asian financial crisis in 1997, and the recent American subprime mortgage in 2007)[1].

A relatively less explored area of research has been the linkage between sector (industry) indexes within the same exchange, with a handful number of studies conducted to date, as mentioned earlier**.** This branch of studies is quite important from the point of view of both domestic investors who are interested in diversifying their portfolios in their local exchanges and policymakers. If sector indexes of a single country are found to be cointegrated [e.g. findings of (Arbeláez *et.al*, 2001) and (Al-Fayoumi *et.al*, 2009) for the Colombian and Jordanian Stock Exchanges, respectively], then the benefits of long-run domestic

[1] See for example, Arshanapalli and Doukas (1993) and Bekeart *et al.*, (2005).

diversification across sectors are altered due to the presence of common factors that limit the size of independent variation and lead to joint variation of sector indexes. On other hand, if sector indexes are found not be cointegrated [e.g. findings of (Wang *et.al*, 2005) for the Chinese Stock Exchange], this implies the possibility of long-run diversification across sectors. However, benefits from short-run domestic diversification across sectors are still possible whether these indexes are cointegrated or not [(Arbeláez *et.al*, 2001) and Al-Fayoumi *et.al*, (2009)].

If one sector, or more, is found to influence other sectors to considerable extent according to variance decomposition and/or impulse response functions, then financial trouble in one sector could be easily transmitted to others creating financial market instability during a crisis. This financial turmoil could further spread to the production side of the economy. For this reason, policymakers could design policies to improve non-influential sectors to prevent the potential negative transmission of shocks from the influential sector to others. Nevertheless, it might also be undesirable to directly regulate the influential sector since it is a good source of information for other sectors and it spreads information faster (Wang *et.al*, 2005).

The current chapter aims at studying interdependence and information transmission between super-sectors within three exchanges in the MENA region, namely; the EGX, the ISE and TASE. DataStream categorizes industries, as defined by the Financial Times classification, into 19 super sectors (refer to table A.5.1 in appendix attached to the current chapter). However, due to lack of sector diversification in MENA exchanges as recognized by Benncuer *et.al* (2009), six

indexes for each exchange accounting for 84%, 80%, and 71% of total market capitalization during the period 2003-2007 in the EGX, ISE, and TASE, respectively are being employed. Employing sector indexes rather than individual stocks is justified by the fact that, as pointed out by Ewings *et.al*, (2003), financial market participants tend to use sector indices as benchmarks to track the performance of publicly traded stocks and actively managed portfolios.

5.2. Methodology:

The employed methodology is based on vector autoregression (VAR) analysis suggested by Johansen (1988) and Johansen and Juselius (1990). First, the order of integration is determined. To identify that order, the unit root tests of Augmented Dickey-Fuller (ADF) test (Dickey-Fuller, 1979 and 1981) and (Kwiatkoski-Phillips- Schmidt-Shin (KPSS), 1992) are conducted as recommended by Brooks (2002) given that the power of ADF is low if the underlying process is stationary but with a root close to the nonstationary boundary. Second, the long-run relationships are examined using the VAR analysis suggested by Johansen (1988) and Johansen and Juselius (1990). This VAR analysis allows disclosing the degree of interdependence across national super sectors and the impulse responses estimated from the VAR system could be utilized to infer how soon shocks in one sector are transmitted to other super sectors within the same exchange. The VAR techniques as applied to simultaneous equation system, estimates unrestricted reduced form equations with uniform sets of the lagged dependent variables of each equation as regressors. Since VAR approach places no restrictions on the structural relationships of the economic variables, it circumvents misspecification problems

(Assaf, 2003). Thereby it is possible to use Granger causality to identify the causal relationship among the six endogenous variables in the following VAR systems: VAR_{EGY1}, VAR_{TUR1}, and VAR_{ISR1} for Egyptian, Turkish and Israeli super sector indexes, respectively. In addition, VAR approach permits analysing the speed of information transmission among variables in the system providing insights into the dynamic nature of the interactions among these variables (Assaf, 2003).

Suppose that a set of g ($g \geq 2$) variables are under consideration that are individually integrated of order one and are thought to be cointegrated. A VAR with k lags containing these variables may be set up as follows:

$$y_t = \mu + A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + \varepsilon_t \qquad 5.1$$

Where $\varepsilon_t \sim iid\left(0, \sigma^2\right)$

Following Johansen (1988) and Johansen and Juselius (1990), VAR in 5.1 could be rewritten as an error correction model as follows [(Ndako, 2010), (Patra and Poshakwale, 2008) and Al-Fayoumi *et.al*, (2009)]:

$$\Delta y_t = \mu + \Gamma_1 \Delta y_{t-1} + \ldots + \Gamma_{p-1} \Delta y_{t-p+1} + \Pi y_{t-p} + \varepsilon_t \qquad 5.2$$

Where, $\Gamma_i = -\left(I - A_1 - \ldots - A_i\right), i = 1,\ldots,p-1$

$\Pi = -\left(I - A_1 - \ldots - A_p\right)$, I = identity vector

$\Delta \equiv$ 1-L where L is the lag operator

Where y_t is a 6×1 vector of first order integrated variables (i.e. six super sector indexes for VAR_{EGY1}, VAR_{TUR1}, and VAR_{ISR1} systems constructed for Egyptian, Turkish and Israeli data), Γ are 6×6 coefficient matrices, and ε_t is a vector of disturbance terms. The Π term determines whether the system of equations is cointegrated, i.e., whether a long-run equilibrium relationship exists. Thus, the

form 5.2 ensures that all the long-run information in the y_t process is fairly summarized by the "long-run impact matrix", Π**,** and it is the rank ***r*** of this matrix that identifies the number of cointegrating vectors as follows [(Gunduz and Omran, 2000); (Marshdeh, 2006) and (Parta and Poshakwale, 2008)]:

1. If the matrix Π has zero rank $r = 0$, i.e. null matrix, then 5.2 reduces to a standard VAR in first differences and the components in y_t are not cointegrated. Therefore, a long-run equilibrium relationship and the error correction mechanism, $\Pi\ y_{t-p}$ does not exist
2. If the matrix Π has full rank $r = g$, all the variables in y_t are stationary.
3. If the rank of the matrix Π is $0 < r < g$, then there are r linear combinations of nonstationary variables that are stationary, and there are multiple cointegrating vectors, and the matrix Π can be expressed as $\Pi = \alpha\beta'$, where α and β are $g \times r$ matrices with r cointegration vectors.

To determine the rank of matrix Π (i.e., number of cointegrating vectors), the characteristic roots or eigenvalues, $\hat{\lambda}_i$ of Π should be calculated. Johansen (1988) and Johansen and Juselius (1990) introduced trace $\left(\lambda_{trace}\right)$and maximum eigenvalue $\left(\lambda_{\max}\right)$ test statistics to establish whether the characteristics roots are significantly different from zero as follows.

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{n}\ln\left(1-\hat{\lambda}_i\right) \qquad 5.3$$

$$\lambda_{\max}(r, r+1) = -T\ln\left(1-\hat{\lambda}_{r+1}\right) \qquad 5.4$$

where λ_i are estimated eigenvalues ranked from largest to smallest. λ_{trace} is called the Trace statistic, which is a likelihood ratio test statistic for the

hypothesis that there are *at most r* cointegrating vectors. The second statistic $\lambda_{\max}$, the Max statistic, tests the hypothesis of *r* cointegrating vectors against the hypothesis of *r* + 1 cointegrating vectors. If the computed values of the statistics are less than the corresponding critical values, then the null hypothesis cannot be rejected (Parta and Poshakwale, 2008). In this regard, the non-standard critical values of MacKinnon- Haug- Michelis (1999), derived through Monte Carlo simulation, are employed.

If there is no cointegration or long-term relationship between the indexes then the short-term relationship is examined using the Granger causality between the endogenous variables in the following way [Parta and Poshakwale, 2008) and (Marshdeh, 2006)]:

$$R_{y,t} = a + \sum_{i=1}^{n} \beta_i R_{y,t-i} + \sum_{i=1}^{n} \gamma_i R_{x,t-i} + \varepsilon_t \qquad 5.5$$

$$R_{x,t} = a + \sum_{i=1}^{n} \delta_i R_{x,t-i} + \sum_{i=1}^{n} \zeta_i R_{y,t-i} + \varepsilon_t \qquad 5.6$$

Where $R_{y,t}$ and $R_{x,t}$ are the returns of index y and x at time t, respectively.

In the above regressions the coefficients γ_i and ζ_i are examined whether they are significantly differ from zero using a standard F-test. If γ_i and ζ_i coefficients are different from zero then we conclude that there is a bidirectional causality between $R_{y,t}$ and $R_{x,t}$. Alternatively, if both coefficients are found to be equal to zero, then we are able to conclude that there is no causality. Finally, in Equation 5.5, $R_{y,t}$ Granger causes $R_{x,t}$ if $\gamma_i = 0$ for $i = 1, 2, ..., n$. Similarly, in Equation 5.6 causality implies that $R_{x,t}$ Granger causes $R_{y,t}$, provided that $\zeta_i \neq 0$ for $i = 1, 2, ..., n$. If underlying variables are nonstationary and there is no long-

run relationship between them, then Granger causality tests in levels will be misleading. In such case, Granger causality test is applied to the returns. However, Granger causality tests are not capable to reveal whether changes in the value of a variable have a positive or negative effect on the other variable in the system, or how long it will take for the effect of that variable to work through the system. The impulse response function is used to explore the dynamics of the system as it traces the time path of structural shocks in the VAR system. However Cholesky decomposition is one of the common techniques used to examine the time path of the shock, this method is criticised as it is quite sensitive to the ordering of the variables in the system. Therefore, the study employs the Generalised impulse response functions (GIRFs) of Pesaran and Shin (1998). The reason is that this approach is invariant to the ordering of the variables in the VAR system (Ndako, 2010). If there are g variables in a system, a total number of g^2 impulse responses could be generated. The way that this is achieved in practice is by expressing the VAR model as a vector moving average (Brooks, 2002).

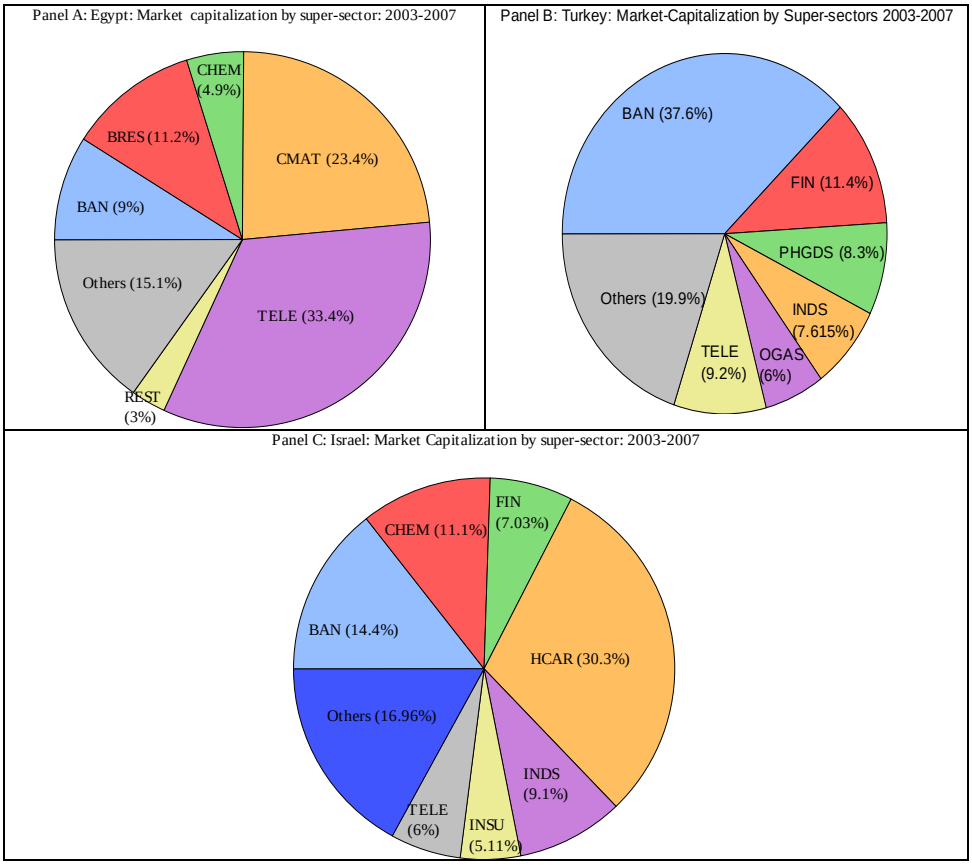
5.3. Empirical Results

5.3.1. Data and preliminary Check:

Super sector indexes employed for Egypt are: Banks (BAN), Basic Resources (BRES), Chemicals (CHEM), Construction & Materials (CMAT), Real Estate (REST), and Telecommunications (TELE) account for around 84% of total market capitalization, on average, during the period 2003-2007. For Turkey, the employed six super sectors, account for around 80% of total market capitalization during the period 2003-2007, are Banks (BAN), Financial Services (FIN),

Industrial Goods & Services (INDS), Oil & Gas (OGAS), Personal and Household Goods (PHGDS), and Telecommunications (TELE). For Israel, the employed six super sectors, account for around 71% of total market capitalization during the aforementioned period, are Banks (BAN), Financial Services (FIN), Health Care (HCAR), Industrial Goods & Services (INDS), Insurance (INSU), and Telecommunications (TELE).

Figure 5.1: Market Capitalization by Super Sector during 2003-2007



Source: calculated from DataStream

Table 5.1 presents descriptive statistics of employed super sectors in Egypt, Turkey and Israel in panels A, B and C respectively. For Egyptian series, all indexes display significant positive mean return with Real Estate and Telecommunications introducing the highest mean return (0.0025) and highest levels of volatility measured by the standard deviation. Banks and Basic

Resources exhibit significant negative skewness whereas the other four super sectors display significant positive skewness. The coefficient of kurtosis is soundly greater than three implying that the distributions of employed indexes are leptokurtotic. In line with this, the null hypothesis of unconditional normality has to be rejected, beyond 1% level of significance, by the JB statistics. For Turkish series, the Banks super sector outperforms other sectors in terms of (significant) positive mean return but displaying the second highest volatility (0.0228) after Telecommunications super sectors (0.0260). The distributions of three indexes (Financial Services, Oil and Gas, and Telecommunications) are symmetric whereas the distributions of the other studied indexes are found to be left skewed. Returns of all indexes show excess kurtosis and, therefore, the null of unconditional normality has to be rejected as supported by JB statistics. Concerning Israeli data, the Health Care seems to be the most volatile amongst the six super sectors with the highest standard deviation of 0.0145 while the Industrial Goods and Services, displaying the highest positive significant mean return, seems to be the least volatile with the lowest standard deviation of 0.0120. With the exception of the Health Care super sector, return series distributions are symmetric. Similar to other countries, all return series are leptokurtotic and the null hypothesis of unconditional normality is soundly rejected, beyond 1%, according to JB statistics.

Panels A, B, and C of figure 5.2, showing visual representation of logs of daily prices of employed indexes for Egypt, Turkey, and Israel respectively, suggest that all series may have a positive drift and indexes within the same market tend to move together.

Table 5.1: Descriptive statistics of daily returns of super-sectors in employed countries

Sub-sector	Mean[(1)]	SD	SK[(2)]	KU[(3)]	JB
	Panel A: Egypt				
BAN	0.0014* (2.478)	0.0165	−0.544* (−7.603)	18.95* (111.459)	12472* (0.000)
BRES	0.0020* (3.107)	0.0188	−0.289* (−4.039)	4.65* (11.53)	150.37* (0.000)
CHEM	0.0012** (2.163)	0.0162	0.170** (2.375)	9.93* (48.427)	2350.28* (0.000)
CMAT	0.0023* (4.096)	0.0164	0.273* (3.815)	9.91* (48.287)	2348.14* (0.000)
REST	0.0025* (2.956)	0.0247	0.515 (7.197)	6.02* (21.104)	498.74* (0.000)
TELE	0.0025* (3.202)	0.0228	1.132* (15.821)	12.44* (65.967)	4600.45* (0.000)
Panel B: Turkey					
BAN	0.0016** (2.049)	0.0228	−0.193* (−2.697)	7.41* (61.634)	960.52* (0.000)
FIN	0.0008 (1.038)	0.0225	−0.097 (−1.355)	6.96* (27.672)	667.66* (0.000)
INDS	0.0007 (1.070)	0.0191	−0.304* (−4.248)	7.54* (31.725)	1025.40* (0.000)
OGAS	0.0008 (1.097)	0.0213	−0.065 (−0.908)	7.47* (31.236)	976.93* (0.000)
PHGDS	0.0007 (1.027)	0.0199	−0.385* (5.380)	8.53* (38.644)	1524.81* (0.000)
;TELE	0.0013 (1.4605)	0.0260	0.040 (0.559)	5.89* (20.195)	410.02* (0.000)
Panel C: Israel					
BAN	0.0009** (1.933)	0.0136	0.005 (0.011)	4.74* (12.159)	149.44* (0.000)
FIN	0.0008** (1.693)	0.0138	−0.003 (−0.0419)	4.295* (9.049)	82.004* (0.000)
HCAR	0.0005 (1.007)	0.0145	−0.506* (−7.071)	9.08* (42.487)	1857.6* (0.000)
INDS	0.0009** (2.190)	0.0120	−0.022 (−0.307)	4.20* (8.385)	70.95* (0.000)
INSU	0.0006 (0.012)	0.0142	0.037 (0.517)	6.26* (22.781)	520.83* (0.000)
TELE	0.0006 (0.013)	0.0128	0.112 (1.565)	5.25* (15.723)	251.72* (0.000)

SD= standard deviation, SK= skewness, KU= kurtosis, JB= Jarque- Bera.

Notes: (1) t-statistic, between brackets is calculated as t = mean return/(standard deviation * square root of the sample size).(2)t-statistic, between parentheses, is calculated as $t = (S' - 0) / SE(S')$, where S' is value of skewness coefficient of certain index, 0 is the value of skewness coefficient for a normal distribution, and $SE(S')$ is the standard error of the estimated skewness coefficient which calculated as the square root of 6/n, where n is the number of observations. (3) t-statistic, between parentheses, is calculated as $t = (K' - 3) / SE(K')$, where K' is value of kurtosis coefficient of certain index, 3 is the value of kurtosis coefficient for a normal distribution, and $SE(K')$ is the standard error of the estimated kurtosis coefficient which calculated as the square root of 24/n, where n is the number of observations. * , ** indicate significance at 1% or less and 5% or less level of significance respectively.

BAN=Banks, BRES= Basic Resources, CHEM= Chemicals, CMAT= Construction &Materials, FIN= Financial Services, HCAR= Healthcare, INDS=Industrial Goods and Services, INSU=Insurance, OGAS=Oil &Gas, PHGDS= Personal and Household Goods, REST= Real Estate, TELE=Telecommunications.

Figure 5.2: plot of daily super-sector price indexes (in logs) during 2nd, January, 2003 to 29th of June, 2007

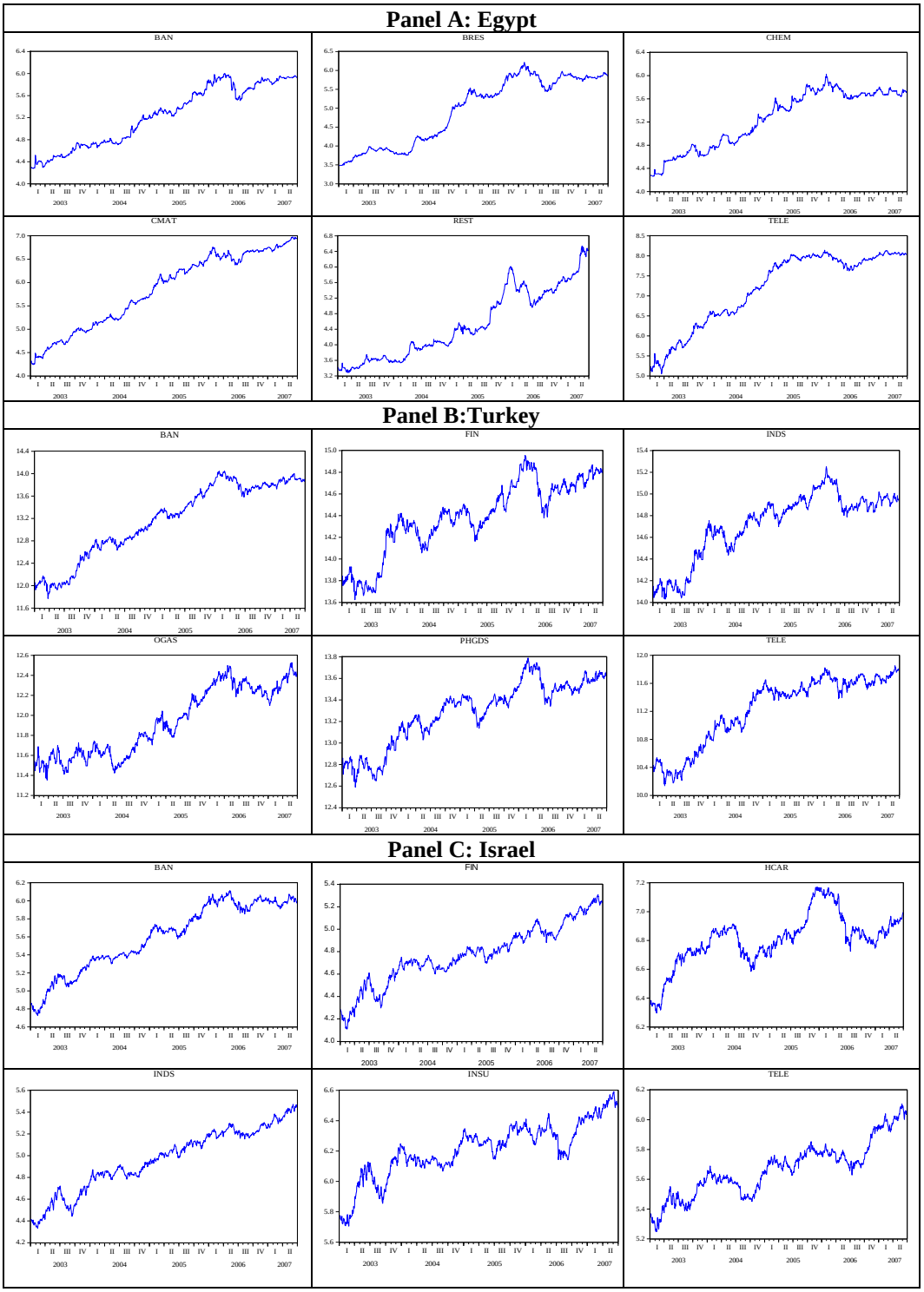


Table 5.2, reporting results of the contemporaneous correlations matrix amongst the six sub-indexes within each exchange, indicates relative high

(especially for Turkey and Israel) and positive pairwise correlations implying short-term simultaneous interactions between super sectors within each market. High correlation among the employed indexes in the same market indicates that they tend to move together, reacting simultaneously to the market forces and the arrival of new relevant information. Such phenomenon is observed in developed exchanges like the USA. However, high correlation amongst sub-indexes in the same market does not imply causality (Arbeláez *et.al*, 2001). The issue of whether one index causes another in terms of Granger causality and impulse responses is to be highlighted later in the following discussion.

Table 5.2: Correlation matrix among stock returns of super-sectors within the studied exchanges

Panel A: Egypt						
	BAN	BRES	CHEM	CMAT	REST	TELE
BAN	1					
BRES	0.354	1				
CHEM	0.305	0.384	1			
CMAT	0.468	0.452	0.377	1		
REST	0.301	0.367	0.260	0.376	1	
TELE	0.457	0.351	0.291	0.682	0.298	1
Panel B: Turkey						
	BAN	FIN	INDS	OGAS	PHGDS	TELE
BAN	1					
FIN	0.845	1				
INDS	0.775	0.833	1			
OGAS	0.707	0.690	0.632	1		
PHGDS	0.784	0.776	0.733	0.656	1	
TELE	0.6464	0.618	0.585	0.521	0.583	1
Panel C: Israel						
	BAN	FIN	HCAR	INDS	INSU	TELE
BAN	1					
FIN	0.679	1				
HCAR	0.163	0.192	1			
INDS	0.670	0.880	0.228	1		
INSU	0.675	0.747	0.154	0.729	1	
TELE	0.545	0.594	0.139	0.582	0.612	1

BAN=Banks, BRES= Basic Resources, CHEM= Chemicals, CMAT= Construction &Materials, FIN= Financial Services, HCAR= Healthcare, INDS=Industrial Goods and Services, INSU=Insurance, OGAS=Oil &Gas, PHGDS= Personal and Household Goods, REST= Real Estate, TELE=Telecommunications.

5.3.2. Tests of Nonstationarity

As mentioned earlier, a precondition for testing for cointegration amongst sub-indexes within each market is to determine the order of integration of individual series. Tables 5.3, 5.4 and 5.5 introduce the results of testing for unit roots for Egyptian, Turkish and Israeli indexes, respectively. ADF and KPSS tests are carried with intercept and with intercept and trend as plots of all series show an upward trend. All employed series are found to be nonstationary in levels but their first differences are found to be stationary according to ADF and KPSS tests. All series are said to be individually integrated of order one and, thus, it is possible to proceed testing for cointegration relationship amongst super-sectors within each exchange.

Table 5.3: Results of ADF and KPSS tests for Egypt

Index	Panel A: Results of ADF test				
	Levels in logs		First difference		Order of integration
	Test Stat[(1)]	lag	Test Stat[(1)]	lag	
BAN	-1.169	1	**-28.488**	0	BAN~ I(1)
	-2.270	1	**-28.488**	0	
BRES	-1.351	1	**-27.088**	0	BRES ~I(1)
	-0.799	1	**-27.116**	0	
CHEM	-1.976	1	**-28.486**	0	CHEM ~I(1)
	-1.544	1	**-28.526**	0	
CMAT	-1.534	1	**-30.162**	0	CMAT ~I(1)
	-1.923	1	**-30.190**	0	
REST	0.610	1	**-26.771**	0	REST ~I(1)
	-2.007	1	**-26.806**	0	
TELE	-2.657	1	**-30.793**	0	TELE ~I(1)
	-1.173	1	**-30.947**	0	
	Panel B: Results of KPSS test				
Index	level		First difference		Order of integration
	Test Stat[(1)]	WB	Test Stat[(1)]	WB	
BAN	**4.317**	26	0.085	4	BAN~ I(1)
	0.445	26	0.042	5	
BRES	**4.154**	26	0.283	4	BRES ~I(1)
	0.614	26	0.139	10	
CHEM	**4.113**	26	0.243	5	CHEM ~I(1)
	0.780	26	0.043	4	
CMAT	**4.364**	26	0.183	3	CMAT ~I(1)
	0.811	26	0.030	4	
REST	**4.178**	26	0.141	15	REST ~I(1)
	0.281	26	0.040	4	
TELE	**3.933**	26	0.315	2	TELE ~I(1)
	0.990	26	0.046	6	

BW = bandwidth BAN=Banks, BRES= Basic Resources, CHEM= Chemicals, CMAT= Construction &Materials, FIN= Financial Services, HCAR= Healthcare, INDS=Industrial Goods and Services, INSU=Insurance, OGAS=Oil &Gas, PHGDS= Personal and Household Goods, REST= Real Estate, TELE=Telecommunications.

(1) Each row has two cells. The above cell represent the calculated test statistic in a regression that includes an intercept only whereas the other cell includes the calculated test statistic for a regression that includes both intercept and time trend.
ADF critical values are -3.435(1%), -2.863(5%), -2.568(10%) and -3.965(1%), -3.413(5%), and -3.128(10%) for regression includes intercept only and intercept and trend respectively. Critical values for KPSS test are 0.739(1%), 0.463(5%), 0.347(10%) and 0.216(1%), 0.146(5%), and 0.119(10%) for equations that include intercept only and intercept and trend respectively. Automatic lag selection for ADF is based on SIC and the automatic bandwidth selection, for KPSS, is Newey-West methodology.

In bold indicates the rejection of the null hypothesis of nonstationarity in the case of ADF and null of stationarity in the case of KPSS.

Table 5.4: Results of ADF and KPSS tests for Turkey

Index	Panel A: Results of ADF test				
	level		First difference		Order of integration
	Test Stat[(1)]	lag	Test Stat[(1)]	lag	
BAN	-1.398	0	**-34.018**	0	BAN~ I(1)
	-1.624	0	**-34.028**	0	
FIN	-1.405	0	**-34.109**	0	FIN ~I(1)
	-2.600	0	**-39.096**	0	
INDS	-1.849	0	**-35.176**	0	INDS ~I(1)
	-1.915	0	**-35.191**	0	
OGAS	-0.926	0	**-35.204**	0	OGAS ~I(1)
	-3.058	0	**-35.191**	0	
PHGDS	-1.375	0	**-35.218**	0	PHGDS ~I(1)
	-2.700	0	**-35.204**	0	
TELE	-1.328	0	**-33.618**	0	TELE ~I(1)
	-2.252	0	**-33.607**	0	
	Panel B: Results of KPSS test				
Index	level		First difference		Order of integration
	Test Stat[(1)]	WB	Test Stat[(1)]	WB	
BAN	**4.179**	**26**	0.188	15	BAN~ I(1)
	0.720	**26**	0.052	16	
FIN	**3.636**	**26**	0.043	4	FIN ~I(1)
	0.290	**26**	0.031	4	
INDS	**3.511**	**26**	0.162	7	INDS ~I(1)
	0.774	**26**	0.030	8	
OGAS	**4.117**	**26**	0.043	12	OGAS ~I(1)
	0.357	**26**	0.039	12	
PHGDS	**3.757**	**26**	0.045	10	PHGDS ~I(1)
	0.519	**26**	0.032	10	
TELE	**3.895**	**26**	0.081	12	TELE ~I(1)
	0.876	**26**	0.038	12	

Notes: as those of table (5.3)

Table 5.5: Results of ADF and KPSS tests for Israel

Index	Panel A: Results of ADF test				
	level		First difference		Order of integration
	Test Stat[(1)]	lag	Test Stat[(1)]	lag	
BAN	-1.751	0	**-32.675**	**0**	BAN~ I(1)
	-1.806	0	**-32.707**	**0**	
FIN	-1.079	1	**-30.413**	**0**	FIN ~I(1)
	-3.401	1	**-30.400**	**0**	
HCAR	-2.380	0	**-34.803**	**0**	HCAR ~I(1)
	-2.326	0	**-34.815**	**0**	
INDS	-0.995	0	**-32.299**	**0**	INDS ~I(1)
	-3.303	0	**-32.287**	**0**	
INSU	-2.002	0	**-32.174**	**0**	INSU~I(1)
	-3.070	0	**-32.169**	**0**	
TELE	-0.889	0	**-34.064**	**0**	TELE ~I(1)
	-2.791	0	**-34.051**	**0**	
	Panel B: Results of KPSS test				
Index	level		First difference		Order of integration
	Test Stat[(1)]	WB	Test Stat[(1)]	WB	
BAN	**4.188**	**26**	0.226	17	BAN~ I(1)
	0.567	**26**	0.035	18	
FIN	**3.988**	26	0.030	14	FIN ~I(1)
	0.237	**25**	0.030	14	
HCAR	**2.201**	**26**	0.201	11	HCAR ~I(1)
	0.377	**26**	0.084	11	
INDS	**4.235**	**26**	0.040	14	INDS ~I(1)
	0.400	**25**	0.028	14	
INSU	**3.389**	**26**	0.071	19	INSU~I(1)
	0.251	**26**	0.039	19	
TELE	**3.656**	**26**	0.055	20	TELE ~I(1)
	0.158	**26**	0.047	26	

Notes: as those of table (5.3)

5.3.3. Cointegration results

Cointegration tests are performed using the methodology developed by Johansen (1988) and Johansen and Juselius (1990). This is done by applying the maximum likelihood approach to identify the existence of cointegrating vectors between nonstationary super sector indexes in the aforementioned VAR systems, i.e., VAR_{EGY1}, VAR_{TUR1}, and VAR_{ISR1}.

To investigate the long run cointegration relationship between super sector indexes within each exchange, one needs to determine the adequate lag structure for VAR_{EGY1}, VAR_{TUR1}, and VAR_{ISR1} systems. Akaike Information Criterion (AIC), and Scharz Information Criterion (SIC) in conjunction with the

examination of the residuals from estimated models, to ensure that are they free from autocorrelation, are employed.

For both VAR_{EGY1} and VAR_{ISR1} systems, lag structure of order two is found adequate for the VAR system according to AIC criterion and Lagrange Multiplier (LM) test for serial correlation. For VAR_{TUR1} system, lag one is found adequate to describe the data according to both AIC and SC, and LM test[1]. Results of cointegration tests amongst super sector indexes within the Egyptian, Turkish and Israel exchanges are displayed in panels A, B, and C of table 5.6 respectively. From table 5.6, it is clear that both the trace and the maximum eigenvalue statistics indicate the absence of cointegration (long-run) relationship amongst the employed 6 super sector within any of the studied exchanges. These results are consistent with findings of Wang *et.al,* (2005) for China and Berument *et.al*, (2005) for Turkey respectively. Accordingly, the absence of cointegration relationship between super sector indexes within the same exchange enables domestic traders who are interested in investing in their local exchanges to gain long-run benefits of portfolio diversification among these indexes' asset.

[1] Lag length 1 is advocated by SIC criterion for VAR system of Egyptian and Israeli data, however; LM test indicates that the VAR systems are not free from serial correlation at conventional levels of significance (1% and 5%).

Table 5.6: Cointegration Tests for Super-sector indexes in Egypt, Turkey and Israel

Panel A: Trace test statistic						
Null	**Alternative**	**Egypt**	**Turkey**	**Israel**	**Critical values(1)**	
H0	H1				5%	1%
r = 0	r ≥ 1	98.360	103.218	98.151	103.847	113.419
r ≤ 1	r ≥ 2	65.851	64.380	64.841	76.972	85.336
r ≤ 2	r ≥ 3	38.963	40.045	40.826	54.079	61.266
r ≤ 3	r ≥ 4	25.456	23.306	25.373	35.192	41.195
r ≤ 4	r ≥ 5	14.661	13.085	14.694	20.261	25.078
r ≤ 5	r ≥ 6	5.307	4.557	7.011	9.164	12.760
Panel B: Maximum Eigenvalue test						
r = 0	r = 1	32.509	38.838	33.309	40.965	46.745
r = 1	r = 2	26.887	24.335	24.015	34.805	40.295
r = 2	r = 3	13.507	16.738	15.452	28.588	33.732
r = 3	r = 4	10.795	10.221	10.679	22.299	27.067
r = 4	r = 5	9.354	8.528	7.682	15.892	20.161
r = 5	r = 6	5.307	4.557	7.011	9.164	12.760

(1)Critical values of MacKinnon-Haug-Michelis (1999)

Given the non-existence of a linear combination of the nonstationary super sector price indexes within the three exchanges, and therefore that there is no error correction representation, the first difference of logged super sector price indexes (i.e. returns) would be used in the following estimation and inferences. The VAR_{EGY2}, VAR_{TUR2}, VAR_{ISR2} systems, each consists of six variables, are used to model relationship between returns in Egypt, Turkey, and Israel, respectively. To determine the optimal lag length for the above mentioned VAR systems, AIC, SC, and examining the estimated models' residuals are used. According to these criteria, lag length of 1 was found adequate for VAR_{EGY} and VAR_{TUR} whereas lag 2 was found adequate for VAR_{ISR}. In all models, a constant term is allowed to account for possible time trend in returns. Granger causality test results, which are based on the estimates of the VAR_{EGY2}, VAR_{TUR2}, and VAR_{ISR2} models, are presented on panels A, B, and C of table 5.7 respectively.

The results of Egyptian Exchange show that Basic Resources Granger causes only Chemicals, while Chemicals leads returns in Real Estate and

Telecommunications leads returns in Real Estate. Results of the joint test indicate that the null hypothesis that each super sector is not Granger caused by other super-sectors could not be rejected only, at 5%, for Chemicals and, thus, Chemicals is considered endogenous whereas remaining super sectors are considered exogenous of the system. Similar conclusion could be drawn for the Israeli Exchange where unidirectional relationship is found from Financials to both Health Care and Industrials and from Industrials to Health Care. However, all super sectors seem to be exogenous, at 5%, according to the joint null that each super sector is not Granger caused by the remaining ones. For Turkish exchange, no individual super sector leads another and none of them is found to be jointly Granger caused by others. These results conform to those of Wang *et.al*, (2005) regarding the two exchanges of China.

Table 5.7: Granger causality tests across super-sectors within the same market

Panel A: Egypt	Eq. of					
	ΔLBAN	ΔLBRES	ΔLCHEM	ΔLCMAT	ΔLREST	ΔLTELE
ΔLBAN	-------	0.188 (0.664)	0.021 (0.883)	2.095 (0.147)	1.792 (0.386)	1.074 (0.299)
ΔLBRES	0.022 (0.880)	--------	4.100 (0.042)	2.422 (0.119)	0.776 (0.378)	0.003 (0.950)
ΔLCHEM	0.019 (0.890)	0.045 (0.829)	--------	0.020 (0.887)	0.194 (0.659)	0.095 (0.756)
ΔLCMAT	1.113 (0.484)	1.733 (0.187)	0.669 (0.413)	-------	4.895 (0.026)	2.714 (0.099)
ΔLREST	3.566 (0.059)	3.075 (0.079)	1.751 (0.185)	1.940 (0.163)	---------	0.039 (0.723)
ΔLTELE	0.010 (0.579)	0.382 (0.536)	0.002 (0.964)	0.024 (0.875)	5.605 (0.017)	-------
All	8.254 (0.142)	6.696 (0.244)	12.584 (0.027)	6.707 (0.243)	10.704 (0.057)	3.991 (0.550)
Panel B: Turkey	Eq. of					
	ΔLBAN	ΔLFIN	ΔLINDS	ΔLOGAS	ΔLPHGDS	ΔLTELE
ΔLBAN	-------	1.174 (0.278)	0.009 (0.924)	0.185 (0.667)	1.311 (0.252)	0.695 (0.404)
ΔLFIN	1.830 (0.176)	--------	0.232 (0.629)	0.507 (0.476)	1.841 (0.174)	1.791 (0.180)
ΔLINDS	0.959 (0.327)	0.0001 (0.992)	-------	0.218 (0.640)	0.0198 (0.887)	1.956 (0.161)
ΔLOGAS	2.404 (0.121)	1.114 (0.291)	0.0129 (0.909)	-------	0.426 (0.513)	1.022 (0.311)
ΔLPHGDS	2.136 (0.143)	0.323 (0.569)	0.293 (0.587)	0.176 (0.674)	-------	0.738 (0.390)
ΔLTELE	0.650 (0.419)	0.759 (0.383)	0384 (0.535)	0.507 (0.476)	0.1059 (0.744)	------
All	8.596 (0.126)	2.881 (0.718)	1.061 (0.957)	2.140 (0.829)	7.134 (0.210)	4.783 (0.442)
Panel C: Israel	Eq. of					
	ΔLBAN	ΔLFIN	ΔLHCAR	ΔLINDS	ΔLINSU	ΔLTELE
ΔLBAN	-------	2.841 (0.241)	0.449 (0.798)	4.978 (0.083)	0.730 (0.694)	7.923 (0.019)
ΔLFIN	4.925 (0.085)	--------	11.108 (0.003)	8.330 (0.015)	4.387 (0.111)	2.704 (0.258)
ΔLHCAR	3.577 (0.167)	0.256 (0.879)	--------	0.354 (0.837)	0.256 (0.879)	0.490 (0.782)
ΔLINDS	1.854 (0.395)	1.402 (0495.)	10.825 (0.004)	-------	4.348 (0.113)	2.819 (0.244)
ΔLINSU	3.509 (0.173)	0.165 (0.920)	1.031 (0.597)	0.057 (0.971)	---------	1.113 (0.573)
ΔLTELE	0.0167 (0.991)	0.640 (0.725)	0.288 (0.865)	0.911 (0.634)	0.536 (0.768)	-------
All	10.591 (0.390)	8.860 (0.545)	16.640 (0.082)	13.755 (0.184)	7.483 (0.679)	17.110 (0.072)

Note: For the first five cells of each panel, the first raw represent the calculated chi-square test statistic and the second raw represent the accompanied *p*-value associated with the null hypothesis that the coefficient of all lags of the variable in the left column are zero in the regression with dependent variable in the top row. The last cell contains the calculated tests statistic (in the first raw) and the accompanied *p*-value (in the second raw) associated with the null hypothesis that the coefficients of all lags of all right-hand side variables except those of the dependent variable are zero. Δ represent the first lag operator

To shed some lights on the duration of the effect of the innovation in one super sector index to other indexes, the results of GIRFs obtained from VAR_{EGY2},VAR_{TUR2}, and VAR_{ISR2} are presented in figures 5.3, 5.4, and 5.5 respectively. Each figure consists of 36 graphs showing the dynamic responses of the index return to one standard deviation innovation over forecast horizons from one to seven days. Each impulse response has a standard error band of ±2 S.E. computed using 10000 Monte Carlo simulation techniques.

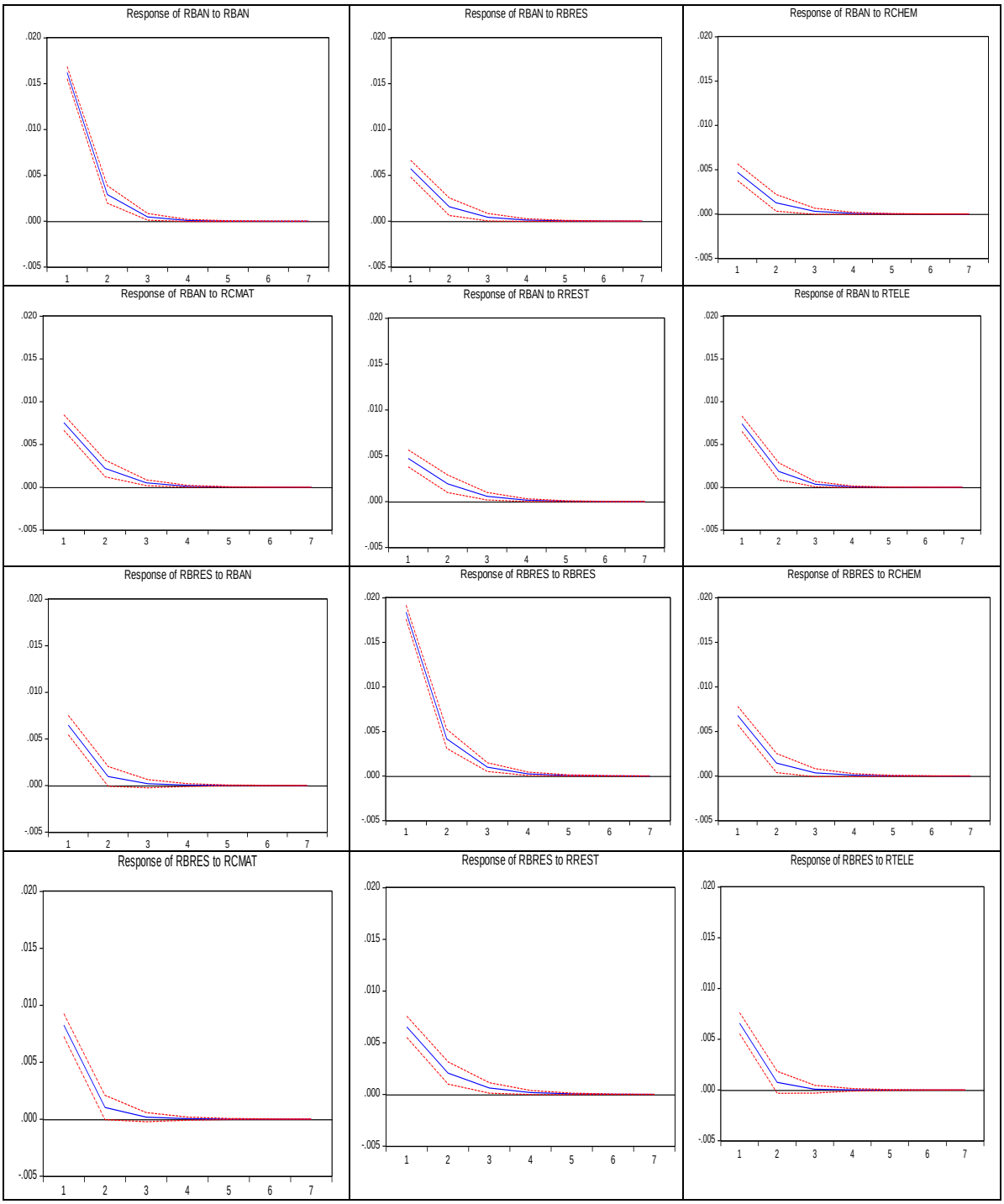
Inspection of GIRFs in figure 5.3 indicates that the impact of a positive shock in one index in the Egyptian Exchange is significant and positive over all other indexes, however; this impact declines rapidly and persists only for two or three days**.** More importantly, most of the impact is on the index experiencing the innovation and the effect on the remaining indexes is relatively small. In many cases response to shocks does not exceed 10% (in many cases, this percent declines to around 5%). In addition, the shocks worked through the system in the system in two or three days. Thus, the impulse responses show the existence of short-run comovement factor among Egyptian sub-indexes and the short persistence of the responses seems to indicate efficiency in processing news.

The examination of GIRFs among Turkish sub-indexes shows that, in contrast to results from Granger causality tests, that the impact of a positive shock in one index, especially in Banks and Financial Services super sectors, is significant and positive over all remaining indexes, even though; this impact persists only for one or two days. The influence of Banks and Financial Services super sectors over other employed indexes could be explained by their large sizes in terms of market capitalization (they represent 37% and 12%, on average, of

total market capitalization during 2003-2007). The response to shocks ranges between 15% and 20% in many series which is quite higher compared to the Egyptian case. However, shocks to the system tap off quickly after two days in most cases.

Interdependence between sub-indexes in TASE is detected. A striking feature of the GIRFs of TASE is that the Health Care, accounting for 30% of market capitalization during the study period, is the least influential super sector as responses of other sectors to one standard deviation in that sector is relatively small and that its responses to shocks in other sectors are relatively small as well. Similar to the other two exchanges, shocks work through the systems for few days (around three days, at most). In addition, response in either series does not exceed 15%

Figure 5.3: Generalized Impulse Responses for VAR_{EGY2}



RBAN= Returns of Banks, RBRES=Returns of Basic Resources, RCHEM=Returns of Chemicals, RCMAT= Returns of Construction & Materials, RREST= Returns of Real Estate, RTELE=Returns of Telecommunications.

Figure 5.3: continued

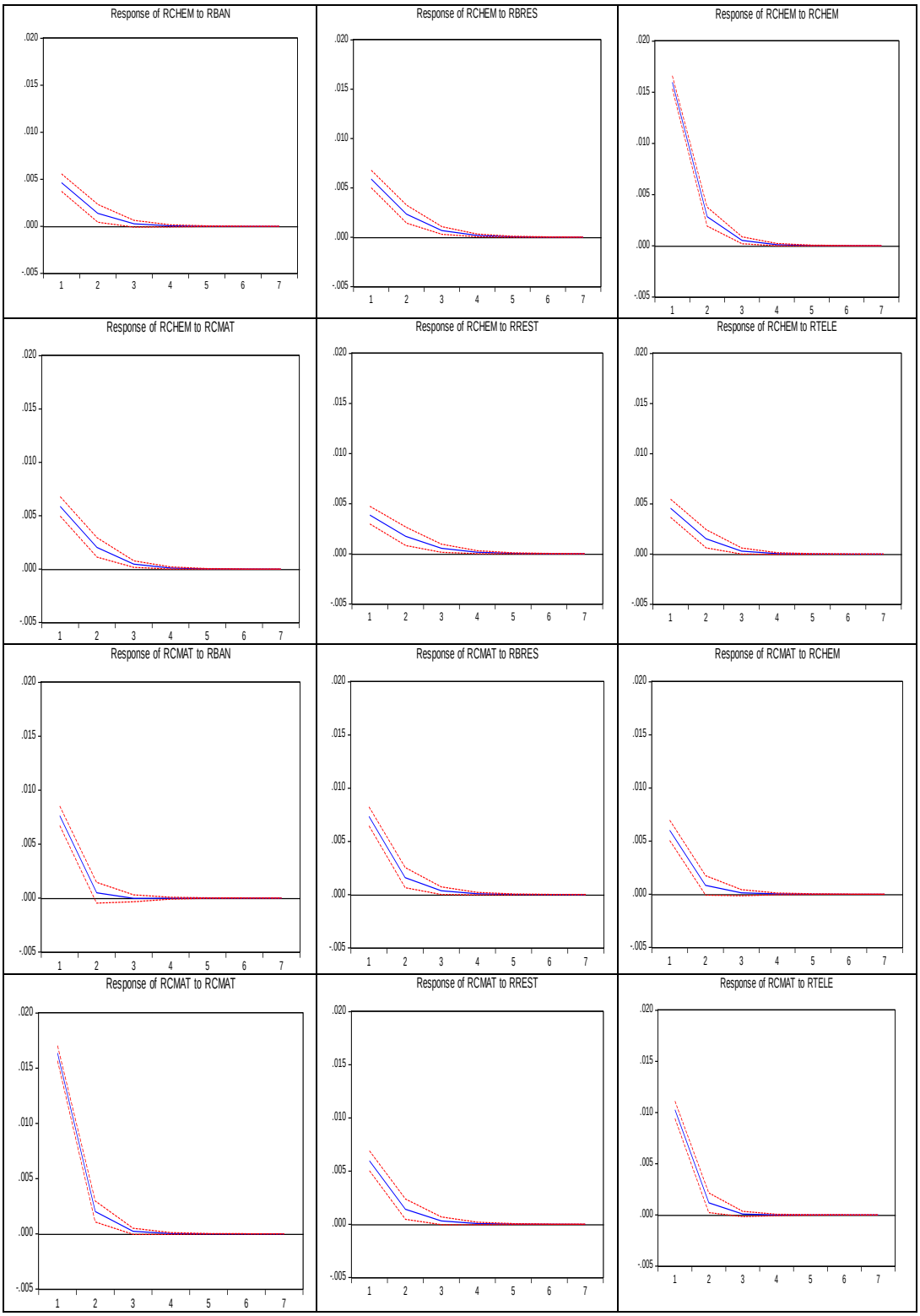


Figure 5.3: continued

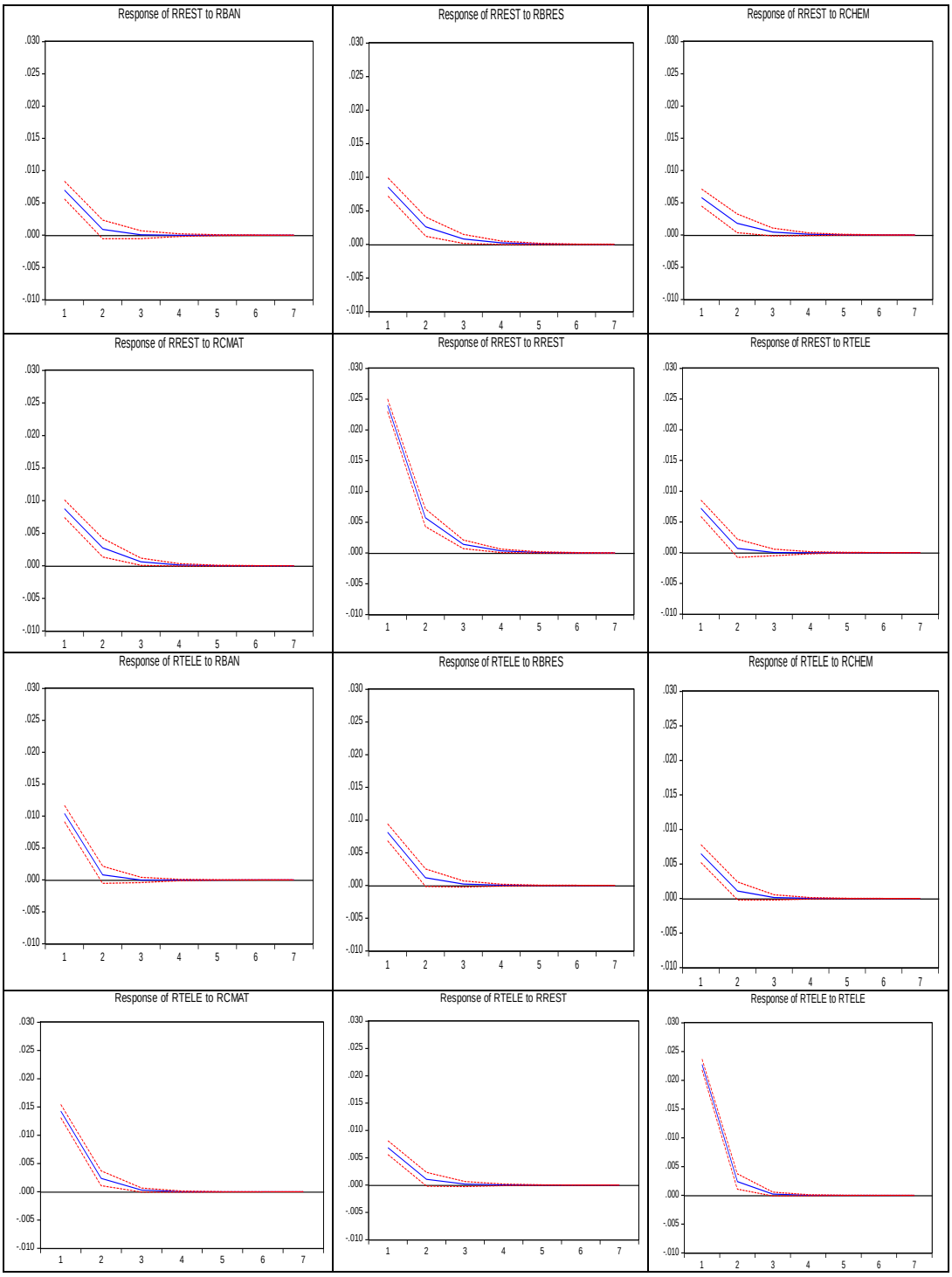
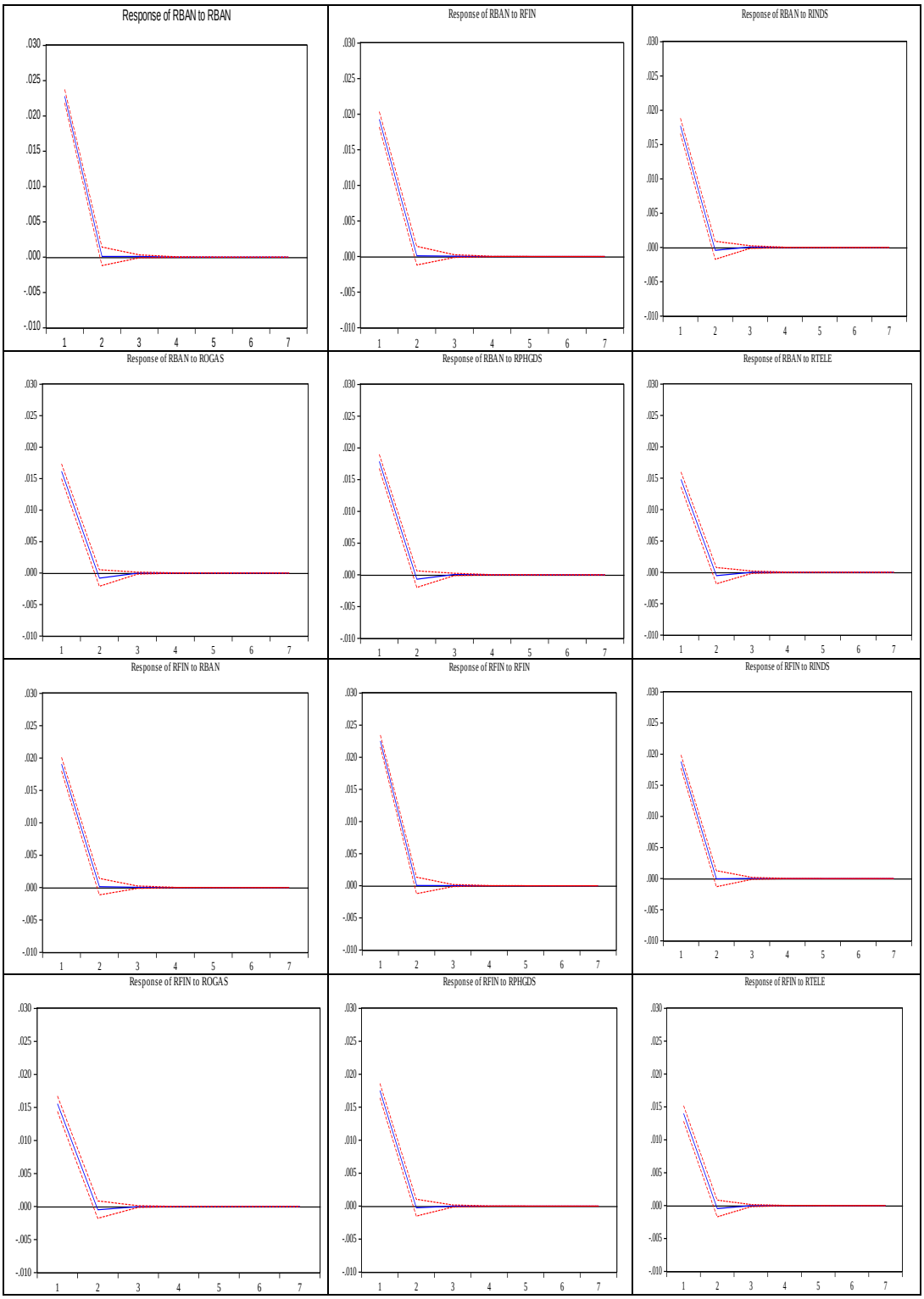


Figure 5.4: Generalized Impulse Responses for VAR_{TUR2}



RBAN= Returns of Banks, RFIN= Returns of Financial Services, RINDS= Returns of Industrial Goods and Services, ROGAS= Returns of Oil & Gas, RPHGDS= Returns of Personal and Household Goods, RTELE=Returns of Telecommunications.

Figure 5.4: continued

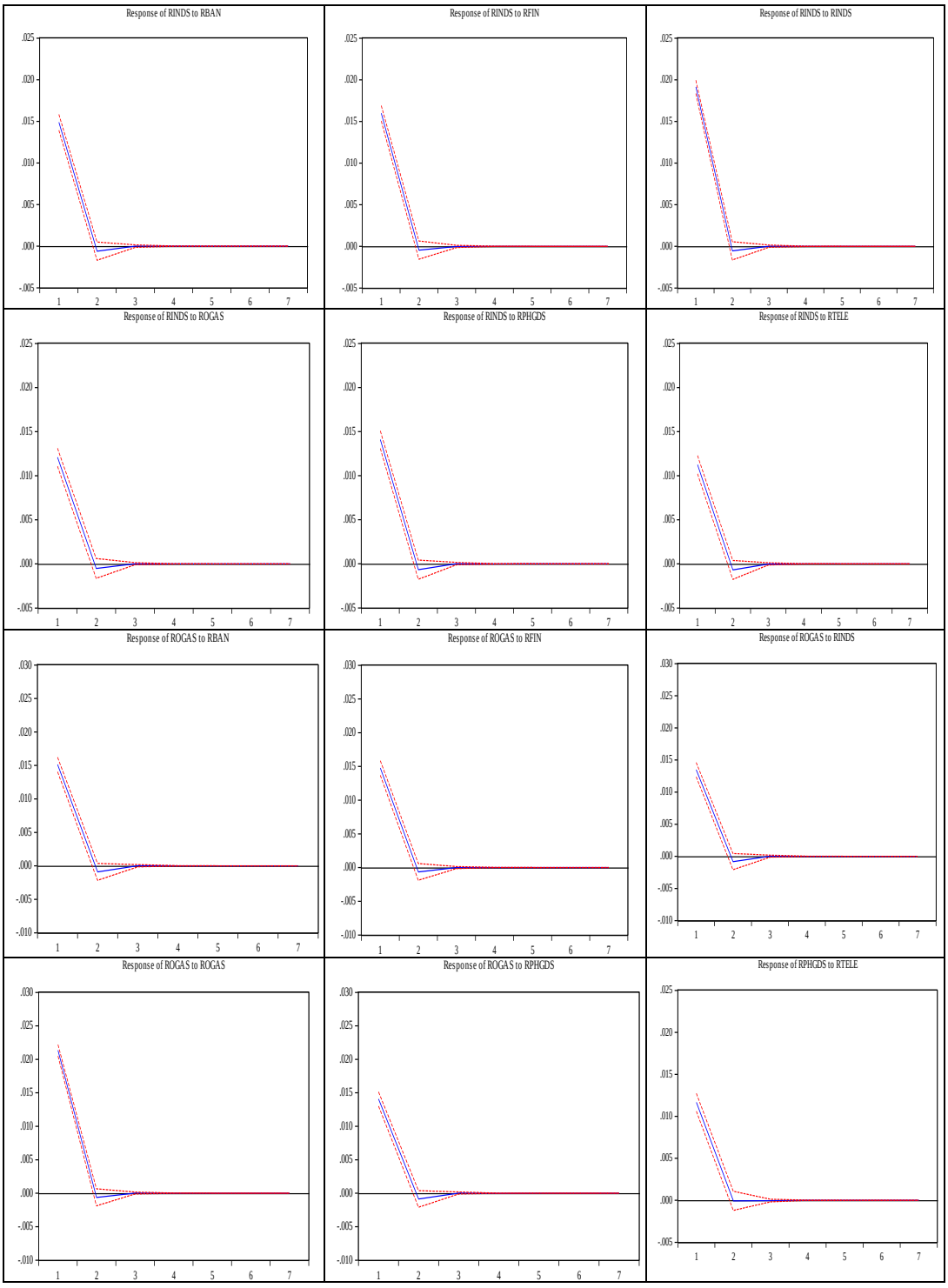


Figure 5.4: continued

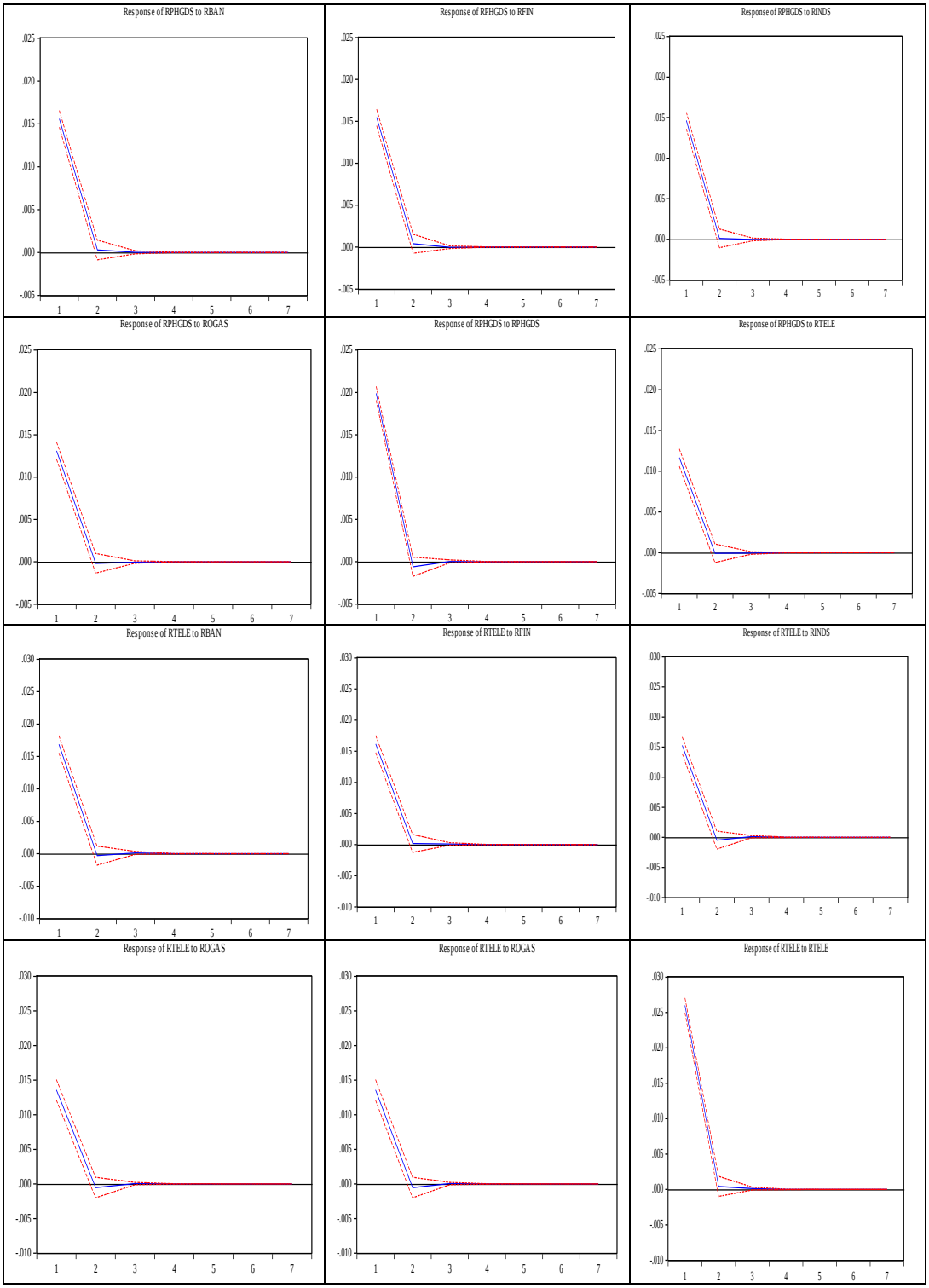
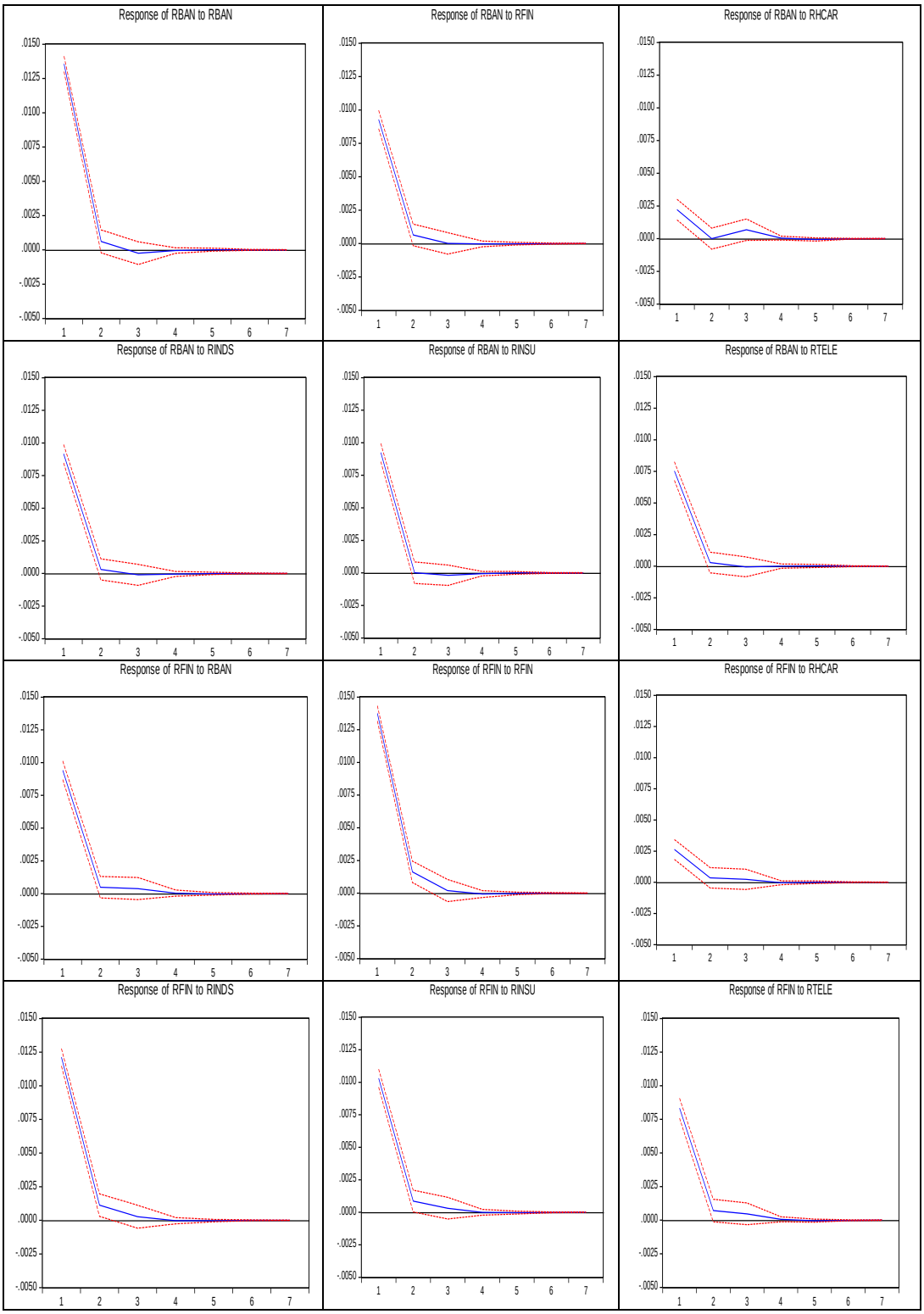


Figure 5.5: Generalized Impulse Responses for VAR_{ISR2}



RBAN= Returns of Banks, RFIN= Returns of Financial Services, RHCAR= Returns of Health Care, RINDS= Returns of Industrial Goods and Services, RINSU= Returns of Insurance, RTELE=Returns of Telecommunications.

Figure 5.5: continued

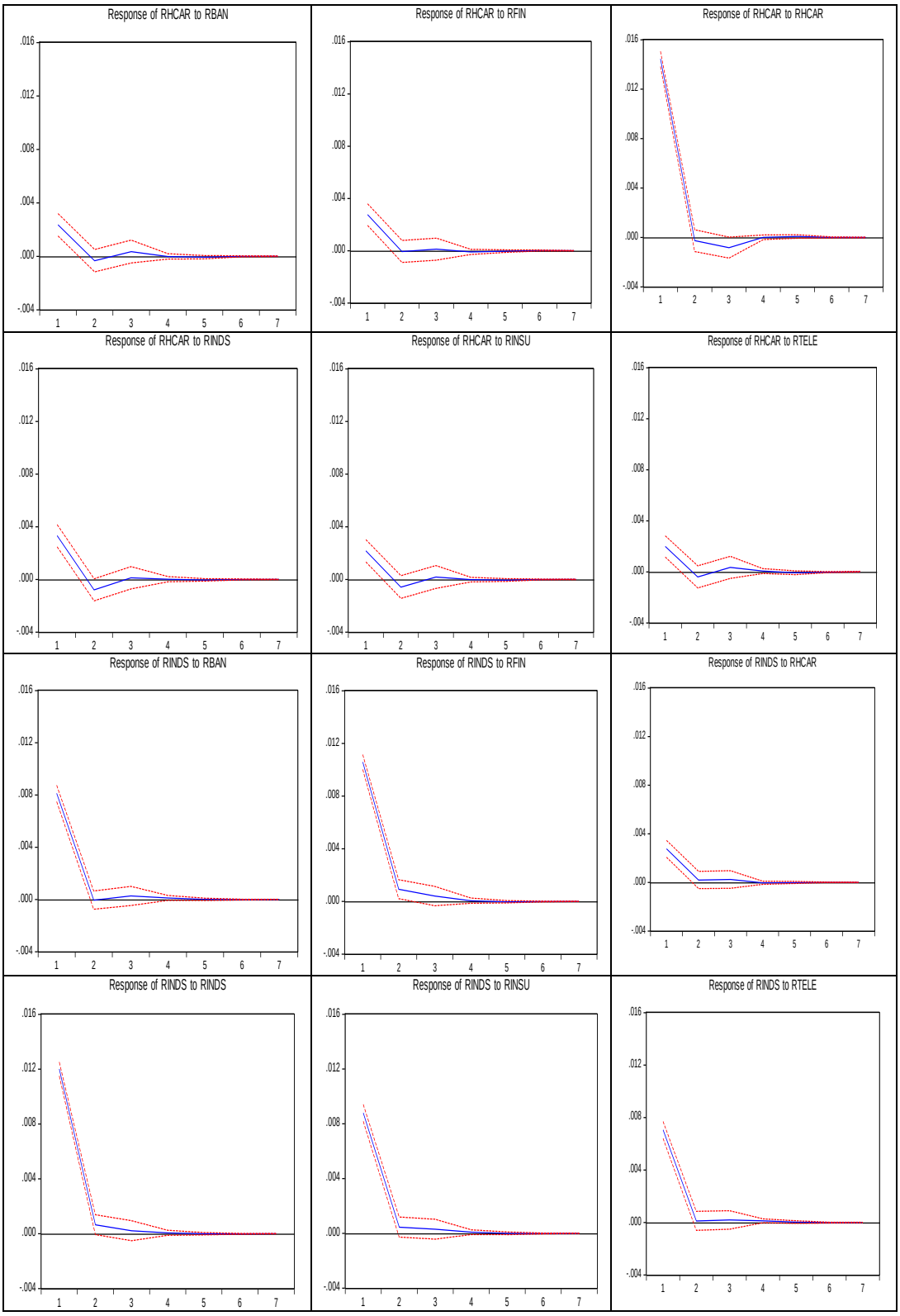
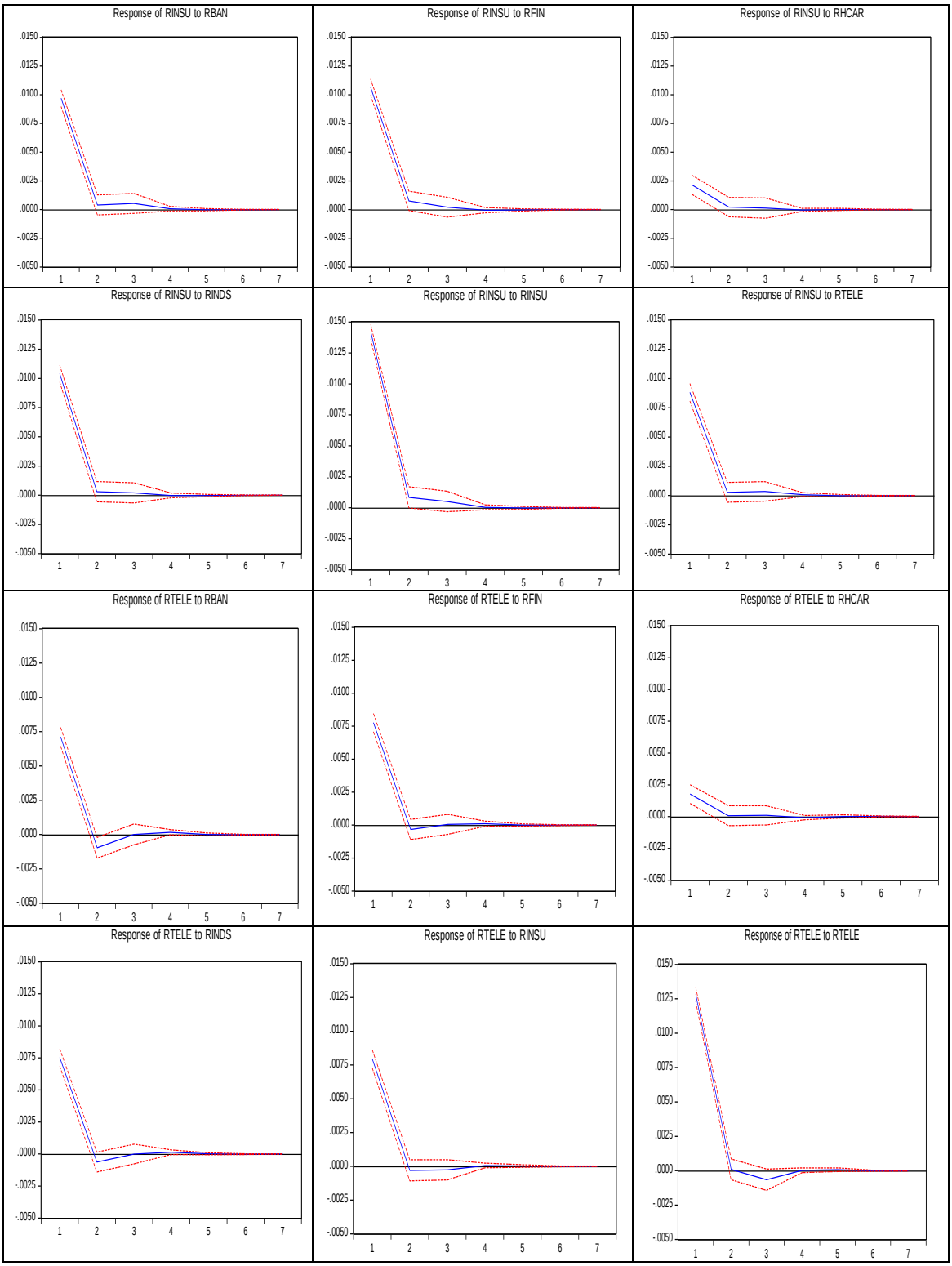


Figure 5.5: continued



5.4. Conclusion

The current chapter explored the dynamic interactions among daily super sectors indexes within the same market in the Egyptian, Turkish and Israeli stock Exchange over the period from 2nd, January, 2003 through 29th, June, 2007. Unit root test indicated that the six series in each exchange are individually integrated of order one and, therefore, the multivariate cointegration for each exchange was examined based on three VAR systems; VAR_{EGY1}, VAR_{TUR1}, and VAR_{ISR1}. No cointegrating vectors are detected in either VAR system implying that super sector indexes in the aforementioned systems do not share a common stochastic trend in the long-run. Thus, domestic investors in Egypt can diversify their portfolios across Banks, Basic Resources, Chemicals, Construction and Materials, Real Estate and Telecommunications super sectors in the long run. Similarly, local Turkish and Israeli traders are able to diversify their portfolios across the employed super sectors in Istanbul and Tel Aviv stock exchanges, respectively. Results of Granger Causality, based on VAR_{EGY2}, VAR_{TUR2}, and VAR_{ISR2} systems in which returns are employed, indicated that there are limited short-run unidirectional causality in Egyptian and Israeli exchanges whereas none is identified for the Turkish exchange. The GIRFs analyses confirmed these results and indicated that the movements of super sector indexes within employed exchanges seemed relatively independent of one another and also informationally efficient in the sense that shocks work through the $VAR_{EGY2,}$ VAR_{TUR2}, and VAR_{ISR2} systems very quickly. There is never a response more than 20%, 15%, and 10% in any series for Turkey, Israel, and Egypt respectively. In addition, most of the influence is on the index experiencing innovations. More importantly, shocks die out after few days reflecting efficiency in information dissemination.

Generally, speaking, the possibility of making excess returns by trading in super sector on the basis of old news from the other super sectors appears very unlikely.

Appendix 5:

Table A.5.1: Industry classification by super sectors

Industry	Super sector
Oil & Gas	0500 Oil & Gas
Basic Materials	Chemicals
	Basic Resources
Industrials	Construction & Materials
	Industrial Goods & Services
Consumer Goods	Automobiles & Parts
	Food & Beverage
	Personal & Household Goods
Health Care	Health Care
Consumer Services	Retail
	Media
	Travel & Leisure
Telecommunications	Telecommunications
Utilities	Utilities
Financials	Banks
	Insurance
	Real Estate
	Financial Services
Technology	Technology
The above classifications are obtained from the Financial Times classification	

Source: FTSE (2010).

Chapter Six

Conclusion

Testing for MH, which has been developed to RWH by Campbell *et.al,* (1997), has received considerable attention in finance due to its theoretical importance and practical implications [i.e. potential trading rules]. Theoretical importance arises from the close relationship between the RWH and the WFEMH as the former is considered as an outcome of the latter. The presence or absence of RWs in share prices is of crucial importance to both the formulation of rational expectation models and the testing of EMH. If stock prices of an exchange are found to follow the RW process, then it is said to be informationally efficient in pricing equities since information contained in past prices is instantaneously, fully, and continuously incorporated in the equities' current prices. The stock market is a vital institution in the financial system of any country since its major role is to improve the mobilization of savings, the provision of equity capital to the corporate sector, and the promotion of efficient investment choices via continuous monitoring of equity prices and the possibility of merger and acquisition (Mecagni and Sourial, 1999). Hence, achieving and sustaining high levels of informational efficiency plays a key objective for capital market development since the efficiency of the stock market in allocating capital to the most productive sectors of the economy crucially depends on its informational efficiency [(El-Erian and Kumar, 1995) and (Lagoarde-Segot, 2009)]. If stock markets are characterised by the absence of informational impediments, financial assets prices are likely to adjust rapidly to new information regarding prospects for investment and the business environment. Conversely, if they are characterised by gradual dissemination of less reliable information regarding companies' performance and policies, market participants are likely to face difficulties in selecting investment opportunities. Such uncertainty would result in

high levels of volatility and would probably induce potential investors to shorten their investment horizons or to pull out altogether from the market. Likewise, the supply of the investable resources may be shrunk if investors fear being penalized for bearing risk. In addition, excessive volatility may weakness confidence and deters risk-neutral or risk-averse investors (Mecagni and Sourial, 1999).

The current research is motivated by the inconclusive conclusion regarding testing for own-history-return-predictability in Egypt and other MENA countries, namely; Jordan, Morocco, Turkey and Israel, and the rare investigation of information transmission across sector indexes within the same exchange. Testing for own-history-return-predictability is conducted by employing a battery VR tests that give attention to the stationary component of the RW process. In other words, if the natural logarithm of price forms a RW, then the variance of *q*-period return is q times the variance of one period returns. Accordingly, the VR for lag q, VR(q) could be defined as the ratio of the variance of q-period return to q times the variance of one-period return, should be equal unity for any holding period q. In addition to the single VR tests of LOMAC (1988), a battery of joint VR tests introduced by CHODE (1993), Kim (2006), BFRCON (2004) and KISH (2008), have been employed. Thus, it is possible to compare their inferential outcomes.

Investigating the information transmission across sub-indexes within the same exchange pays attention to the nonstationary component of the RW process. In this regard, unit root tests and the cointegration analysis are used to addresses the issue of information transmission. The rationale behind employing cointegration approach in testing for WFEMH is that: if two price series are

found to be cointegrated, then there must be Granger causality, at least in one direction, between them which raise the possibility of using information content in one series to help forecasting the other, implying violation of the WFEMH.

The current thesis contributed to the ongoing debate regarding the efficiency of exchanges under consideration by addressing three empirical issues which have not been investigated before for this group of countries. The first empirical chapter (chapter three) addressed whether the efficiency of the EGX is related to size and regulatory changes. The objective of chapter three has been achieved through (i) employing eight indexes tracking the performance of different assets (e.g. large, medium, and small-capitalized firms), and (ii) dividing the period under consideration into two non-overlapping periods: the first one, in which narrow price limits of ±5% imposed on daily movements of listed shares, extends from 2nd of February 1997 to 21st of July 2002, whereas the second period stretches from 22nd of July 2002 to 29th of June 2007 where the price boundaries were expanded and accompanied by applying trading halt for a period of 30 minutes, 45 minutes or until the end of the trading session if the weighted average price of stocks hit the limits of ±10%, ±15% or ±20% respectively, when compared to their opening prices. The adverse effects of tight price limits on stock market efficiency have been demonstrated for other exchanges [e.g. (Ryoo and Smith, 2002) and (Chen and Ting, 2000)]. In addition the relation between efficiency and firm size is well documented in literature [e.g. Hung *et.al*, (2009)]. In this regard, the argument is that: large-capitalised stocks, with the availability of more information, tend to follow RW whereas small-capitalised stocks require more time to incorporate new information into prices inducing strong positive

autocorrelation in small-sorted portfolios. Results indicated that the relaxation of price limits, accompanied with improvements in the trading infrastructure and environment, has had a positive impact on the efficiency of the EGX. The claim that returns of large-capitalized firms tend to form an MDS has been demonstrated in the second sub-period when price limits were expanded where prices of small- capitalized firms are found in disagreement with WFEMH in the two sub-periods. Thus, it may be concluded that the policy of adopting tight price limits is not recommended since it hinder the price discovery process causing inefficient pricing of equities. Given that prices of small-capitalized firms were found to violate the MH, traders were able to develop trading strategies to reap abnormal returns. Regarding comparing inferential outcomes of employed tests, the misleading inferences drawn from employing single VR of LOMAC, when testing for martingale, has been highlighted. In addition, JS_1 is more robust than MZ_2^*, and of course the asymptotic CHODE, in testing for MH specifically in the presence of extreme outliers.

The second empirical chapter (chapter four) re-examined the issue of WFEMH for Egypt, Jordan, Morocco, Turkey and Israel during the period 1995-2009. Distinctive from previous research [e.g. Al-Khazali *et.al* (2007), Lagoarde-Segot and Lucey (2008a) and Smith (2008)], the chapter employed MVR tests in rolling window procedure. Lim and Brooks (2011) support using VR methodology in overlapping sub-samples when testing for WFEMH since: (1) It captures the smooth change in the level of efficiency through time; thereby it would be useful in identifying factors that lead markets to become (in)efficient, and, therefore, whether the recent American mortgage crisis hitting international

markets affect the efficiency of employed countries could be addressed. Financial crisis, characterized by panic, are thought to adversely affect the ability of investors to efficiently price equities [Yilmaz (1999) and Lim and Brooks (2011)]. (2) Employing overlapping sub-samples may serve as a measure of constructing efficiency ranking, i.e. relative efficiency, because the main purpose of rolling window estimation is to measure how frequent the WFEMH is rejected during the whole sample period where large percentage of rejections interpreted as an inferior degree of informational efficiency. Campbell *et.al*, (1997) argued that perfect efficiency is an unrealistic benchmark that is unlikely to be attainable in practice or in theory. They emphasised if markets are perfectly efficient in the sense that investors are not compensated for the cost of information gathering and processing, then there will no incentive to trade and, hence, markets will eventually collapse. For this reason, Campbell *et.al*, (1997) proposed the concept of relative efficiency, which is the efficiency of one market measured against another.

In addition, chapter four questioned the effect of exchange rate dynamics on the efficiency of the aforementioned countries by employing data expressed in both local and US dollar currencies. Results indicated that exchange rate dynamics and the recent financial crisis did not affect testing for WFEMH in exchanges under consideration. These findings are in line with findings of other scholars interested in testing the impact of financial crisis and exchange rate dynamics on informational efficiency [e.g. Hoque *et.al*, (2007), Auer and Schuster (2011) and Lagoarde-Segot and Lucey (2008a)]. As one may expect, the big, the most liquid exchanges of Turkey and Israel [that satisfy the 22 criteria set by FTSE to assess

market quality] were found to be the most efficient in pricing equities since the null of RW could not be rejected through, almost, all sub-samples. The Jordanian exchange was found efficient in pricing equities up to 2005, however; since then it has experienced inefficiencies. Overvaluation of the Jordanian equities could be attributed to the spillover effects from neighbouring oil-producing countries that experienced sharp increase in oil prices. A process of price correction took place when Arab investors withdrew considerable funds from the Jordanian market and thus it restored its efficiency. The Egyptian and Moroccan exchanges converged towards efficiency by 2002 due to remarkable improvements in liquidity, information dissemination, transparency and disclosure, and microstructure. A conclusion to be drawn is that developing countries desire to achieve informational efficiency are highly recommended to take procedures that improve market liquidity and enhance the quality of disclosed information.

The third empirical chapter (chapter five) investigated interdependence between super sector indexes within the same stock market for Egypt, Turkey, and Israel during 2003-2007 in long and short runs. It addressed three questions: (1) Do super sector indexes within the same exchange share common stochastic trends?, (2) Do these indexes influence each other in the short-run?, and (3) questioned the speed of adjustment to their own shocks and shocks from other super sectors. In line with other research cited in literature [e.g. (Wang *et.al*, 2005) and Berument *et.al,* (2005)], empirical results demonstrated the absence of cointegrating vectors in either VAR system for these exchanges. This implies that super sector indexes in the aforementioned systems do not share a common stochastic trend in the long-run, thereby domestic investors in these countries could benefit from long-

run portfolio diversification across employed super sectors. Given no cointegration, the analysis proceeds to investigate short-run dynamics employing return series. The GIRFs indicated that shocks work through the three systems constructed for Egypt, Turkey and Israel very quickly. In addition, most of the influence is on the index experiencing innovations and shocks die out after few days reflecting efficiency in information dissemination. This indicates that the possibility of making excess returns by trading in super sector on the basis of old news from the other super sectors appears very unlikely.

Limitations of the current work include (1) using rolling procedure in a fixed-length sub-sample windows cannot differentiate the impact on the variance ratio statistic of the observation dropped from the sample and the observation added to the sample (Yilmaz, 1999), and (2) all tests employed in the current research are designed to work in linear environment. For example, all VR approaches employed here are designed to detect serial linear dependence in the mean of return series. Nevertheless, the non-existence of linear predictability does not imply efficiency since the underlying return series may exhibit nonlinear serial dependence in the mean (e.g. bilinear process). Thus, further area of research may be (1) using moving window procedure with fixed end point in which the end point is hold fixed at the last observation and moves the starting point forward by one observation, and (2) employing non-linear serial dependence tests to investigate for WFEMH.

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