Are There Trends Towards Efficiency For the Egyptian Stock Market?”

By

Maher Asal

School of Economics and Commercial Law

University of Göteborg, Sweden

Abstract

The purpose of this paper is to investigate the efficiency of the Egyptian stock market. The paper is concerned with the weak form test of the efficient market hypothesis. If the evidence fails to pass the weak form test, there is no reason to examine strong forms before declaring the market inefficient on such evidence. In order to capture the institutional features of such a growing market (i.e., thin trading, low liquidity, and possibly less informed investors), a non-linear GARCH model is estimated. In addition, by investigating efficiency on a yearly basis we are able to examine impact of the market maturing and regulatory changes on the trading behavior and efficiency of that market. The results show that up to 1996 the market was inefficient, but the inefficiency manifested itself through non-linear behavior However, the results show that in 1997 the market is not characterized by predictability and is therefore informationally efficient.

Keywords: efficiency, thin trading, GARCH model.

I. Introduction

The past ten years have witnessed impressive growth in both the size and relative importance of emerging equity markets in developing countries. The process of liberalization within these countries, high economic growth and trends towards financial markets globalization provided the setting in which equity markets could advance. In addition, western investors and equity fund managers were attracted to these markets by the potentially high rate of returns offered and the desire to peruse international diversification. As these markets developed, considerable attention has been given to the question of whether they function in an efficient manner.

An efficient market is a market in which prices provide accurate signals for resource allocation: that is, a market in which firms can make production-investment decisions, and investors can choose among the securities that represent ownership of firm's activities under the assumption that security prices at any time *"fully reflect"* all available information (Fama, 1970). When this condition is satisfied, investors cannot earn an unusual profit by exploiting available information. The macroeconomic importance of market efficiency is derived from the role of prices as aggregators of structural information. When asset and commodity markets are efficient, economic agents who make decisions on the basis of observed prices will insure an efficient allocation of resources. Furthermore, the issue of efficiency is particularly important for emerging markets because efficiency signals an increase in liquidity, a removal of institutional restrictions and an increase in the quality of information revealed in these markets.

The term "fully reflect" has been illustrated into three forms, or levels, of market efficiency. First, the *weak form* of the Efficient Market Hypothesis (EMH) states that all information contained in past price movements is fully reflected in current prices. Therefore, information about recent, or past, trends in stock prices is of no use in selecting miss-priced stocks—the fact that a stock has risen for the past two days, for example, gives us no useful information as to what it will do tomorrow. Second, the *semi-strong form* of the EMH states that current market prices reflect all publicly available information. If this is true, no abnormal returns can be earned by analyzing stocks. So, it does no good to analyze annual reports or other published data because market prices will have adjusted to any good or bad news contained in such reports as soon as they were revealed. Third, *strong form* which states that current market prices reflect all kind of information, whether publicly available or privately held. If this is true, even insiders would find it impossible to earn abnormal returns in the stock market. A review of earlier studies indicates that for emerging stock markets empirical evidence in support for efficiency is much less than that from developed markets.

One explanation of the poor support for market efficiency in emerging markets is that test procedures applied to developed markets fail to reflect the characteristic features of emerging markets. Specifically, tests of efficiency have been developed for testing markets which are characterized by high level of liquidity, sophisticated investors with access to high quality and reliable information and few institutional impediments. In emerging markets, unlike mature ones, market structures, market participants and the availability of information as well as its quality change rapidly through time. Furthermore, emerging markets are typically characterized by low liquidity, thin trading, possibly less well-informed investors with access to unreliable information and considerable volatility. Furthermore, during the early years of trading, emerging markets may be characterized by investors who do not act rationally. Such characteristics of emerging markets may suggest prices responding to information in a non-linear manner (see, for example, Miller et al, 1994 and Antonious, Ergul and Holmes, 1997).

The purpose of this paper is to investigate the efficiency of the Egyptian stock market. The paper is concerned with the weak form test of the efficient market hypothesis. If the evidence fails to pass the weak form test, there is no reason to examine strong forms before declaring the market inefficient on such evidence. To account for the characteristic features and trading conditions of such rapidly growing markets (such as thin trading, low liquidity, liberalization, and possibly less than rational investors), a non-linear regression is estimated in form of the GARCH model.

The remainder of this paper is organized as follows. Section II investigates the issue of the Efficient Market Hypothesis. The different forms of market efficiency and the corresponding empirical tests are provided. In addition, we review the empirical evidence found in the literature. Section III examines the aspects of efficiency in emerging markets where prices are assumed to respond in a non-linear manner to information. Section IV examines the efficiency of Egypt's Stock Exchange (ESE), using both linear and non-linear models. The major features of the ESE and its development over time are also discussed in this section. Section V offers a discussion of the results, conclusions summary as well as some policy recommendations.

II. The Efficient Market Hypothesis (EMH)

The EMH, which is at the heart of financial economics literature, relies on the efficient exploitation of information by economic actors and is often referred to as 'informational efficiency'. Generally, an asset market is said to be informationally efficient if the asset price in question always 'fully reflect' available information (Fama 1970). If this is a characteristic of an asset market then it should not be possible for market participants to earn abnormal profits. To implement the hypothesis empirically and to make sense of the term "fully reflect", Levich (1979) and Hallwood and MacDonald (1994), found that a measure of equilibrium expected returns or equilibrium prices is required. Using equilibrium expected returns, for example, the excess market return on asset i may be expressed as:

$$d_{i,t} = r_{i,t} - E(\bar{r}_{i,t} \mid I_{t-1}) \qquad (1)$$

where d denotes the excess market return, $r_{i,t}$ is the one-period percentage return, I_{t-1} is the information set, available up to previous period (t-1), a bar denotes an equilibrium value and E is the expectations parameters. If the market for asset i is efficient then the sequence of $d_{i,t}$ should be orthogonal to the information set (i.e., $E(d_{i,t} \backslash I_{t-1}) = 0$) and serially uncorrelated. In that sense, the EMH is a joint hypothesis because it assumes that agents in forming their expectations in period t-1 are rational. Rationality, in turn, implies that investors are risk averse and unbiased in their forecasts of expected market equilibrium/returns. It also implies that stock prices/returns respond instantaneously to information. Furthermore, the EMH must be tested jointly using some model of equilibrium, an asset-pricing model. This joint hypothesis represents a serious problem as how to measure inefficiency from the empirical point of view. For example, if we found significant excess returns (i.e., $E(d_{i,t} \backslash I_{t-1}) \neq 0$), we still do not know whether this is because of inefficiency (irrational agents, biased forecasts, the existence of institutional impediments, time varying expected returns, or seasonality)[1] or because of using a misspecified model of market equilibrium. This joint hypothesis problem was behind the unpopularity of equation (1) in the empirical literature.

However, the fact that market efficiency must be tested jointly with rationality and an equilibrium-pricing model does not mean that the efficiency issue is irrelevant. After all, the empirical work on market efficiency can change the views and practices of market professionals. Tests of market efficiency also enrich our knowledge of resource allocation and the behavior of returns across securities and through time. Thus, a more precise and testable hypothesis of "fully reflect" is warranted.

II. A Forms of Market Efficiency

Efficiency can be more precisely defined with reference to the information set available to market participants (I) in equation (1). Fama (1970), defined three forms of market efficiency, namely, *weak*, *semi-strong* and *strong*. Each one is concerned with the adjustment of stock prices to one relevant information subset. Let us discuss these forms in some detail.

The Weak Form of Market Efficiency

The *weak* form of the hypothesis states that prices efficiently reflect all information contained in the past series of stock prices. In this case it is impossible to earn superior returns simply by looking for patterns in stock prices. In other words, a market is described as *weakly-efficient* when it is not possible for a trader to make abnormal returns using only the past history of prices/returns, that is, price changes are random.

Semi-strong Form of Market Efficiency

If by increasing the information set to include publicly available information (such as information on money supply, exchange rate, interest rates, announcement of dividends, annual earnings, stock splits, etc.) it is not possible for a market participant to make abnormal profits, then the market is said to be *semi-strong* efficient. That means it is impossible to make consistently superior returns just by reading newspapers.

Daily data on returns are a major boost for the accuracy of semi-strong tests. When the announcement of an event can be dated to a certain day, daily data allow precise measurement of the speed of the stock-price response- the central issue for market efficiency. Another powerful advantage of daily data is that they can eliminate the joint-hypothesis problem, that market efficiency must be tested jointly with an asset-pricing model.

Strong Form of Market Efficiency

---

[1] Recent literature stresses the issue of seasonality. That is, Monday returns are on average lower than returns on other days (French, 1980). Returns are on average higher the day before a holiday, and the last day of the month. There also seems to be seasonality in intra-day day returns, with most of the average daily returns coming at the beginning and the end of the day. The most common seasonal is the January effect. Stock returns on small stocks, are on average higher in January than in other months.

If by increasing the information set to include private information, it is not possible for a market participant to make abnormal profits, then the market is said to be *strong* efficient. Under the *strong form*, the consideration is whether some investors (e.g., managers of mutual funds) have monopolistic access to any information relevant to the information of stock prices.

The *strong* form of market efficiency tells us that inside information is hard to find because in pursuing it we are in competition with many active intelligent investors. The best we can do in this case is to assume that securities are fairly priced. A precondition for this strong version is that information and trading costs, the costs of getting prices to reflect information, are always zero (Grossman and Stiglitz, 1980). Since there are surely positive information and trading costs, the extreme version of the market efficiency hypothesis is very unlikely to hold.

In reality, prices reflect the information of informed individuals (arbitrageurs) but only partially, so that those who expended resources to obtain information do receive compensation. The only way informed traders can earn a return on their activity of information gathering, is if they can use their information to take positions in the market which are better than the position of uninformed traders. Under these circumstances prices will not reflect all the information. Let us highlight in some detail the corresponding tests for these forms of market efficiency.

II. B Testing for Market Efficiency

The weak form of the EMH involves two separate hypotheses: (a) successive stock price changes are independent, and (b) the price changes are identically distributed random variable. Because the second hypothesis is more difficult to test and so far has not been investigated conclusively, we concentrated on testing the first hypothesis throughout this paper. In addition, the first hypothesis is more interesting because it has an important economic implication. If successive stock price changes are independent of one another, then historical price changes cannot be used to predict future price movements in any meaningful way. Thus, past stock price movements would not be useful for improving investment performance.

Numerous tests for establishing statistical independence in a stock-price time series are available in the literature. Three main tests are widely used in the literature, namely random walk, the Sample Autocorrelation Function (SACF) and Q-statistic. Let us highlight the essence of these three tests.

1- Random Walk and Efficiency

As mentioned earlier, for a market to be efficient, price changes should behave randomly. To illustrate what is meant by the notion of random walk, suppose that an asset price, $x_{t,}$, can be described by the following process

$$E[y_{t+1}|I_t] = y_t \qquad (2)$$

The variable x_t is said to be a martingale with respect to the information set I_{t-1}. If we allow for a constant term in equation (2) the process is said to follow sub-martingale. Given the information set, $I_{t-1,}$ equation (2) says that the value of today is the best prediction for the value of tomorrow. Thus equation (2) bears in the predictability of the future value of x based on today's value. If we parameterize the martingale (given in equation 2) we can get the random walk model,

$$y_{t+1} = y_t + \varepsilon_{t+1} \qquad (3)$$

where ε_t ~NID(0,σ^2). Substituting backwards from x_{t-1}, x_{t-2}, etc., leads to

$$x_t = \sum_{t=1}^{t-1} \varepsilon_t + x_0 \qquad (4)$$

Where x_0 is some initial value of x_t . The first term on the right hand side represents the stochastic trend in x_t. Expression (4) shows that any shocks will have permanent effects on the stock price in the future. Taking the first difference of (4) leads to a white noise process,

$$\Delta x_t = r_t \equiv \varepsilon_t \qquad (5)$$

where r_t denotes the first difference of the series and ε_t is a white noise error term. Adding a constant term to (5), three different tests can be used for testing whether x_t is a random walk and thus ε_t ~ NID (0, Φ^2). Under the null hypothesis of a random walk the first differences of the series should be normally and independently distributed. The first most important test is the Lagrange Multiplier (LM) which tests for autocorrelation. This test uses F-statistics and was suggested by Harvey (1981). The test is based on the autocorrelation of the above residual and tests whether the sample autocorrelations are insignificantly different from zero (i.e., white noise). When the autocorrelations are insignificantly different from zero, a series is judged to have no systematic components, and the null hypothesis of the random walk may not be rejected. The second test is denoted by the AutoRegressive Conditional Heteroscedasticity (ARCH) that was suggested by Engel (1982). Under the null hypothesis of a random walk the value of this test should be insignificant. The third test is denoted by "normality" which was suggested by Jarque and Bera (1980)[2].

2- Serial Correlation Analysis

The Sample Autocorrelation Function (SACF) can also be used to determine the independence of the stock price changes. The SACF, l_k, measures the amount of linear dependence between observations in a time series that are separated by lag k, and is defined as

[2] For the description of these tests, see Doornik and Hendry (1992).

$$l_k = \frac{\sum_{t=1}^{n-k}(x_t - \bar{x})(x_{t+k} - \bar{x})}{\sum_{t=1}^{n}(x_t - \bar{x})^2} \qquad (6)$$

where l_k is the autocorrelation coefficient for a lag of k time units and n is the number of observations. If the price changes of the stocks are independently distributed, the l_k will be zero for all time lags. An approximate formula for the standard error of l_k, $SE(l_k)$, has been derived by Bartlett (see Kendall and Stuart, 1961):

$$SE(l_k) = \frac{1}{n^{0.5}} \qquad (7)$$

3- The Q-statistic

The Q-statistic can be used to test whether a group of autocorrelations is significantly different from zero. Ljung and Box (1978) used the sample autocorrelations to form the statistic

$$Q(k) = n(n+2)\sum_{m=1}^{k}\frac{1}{n-m}l_m{}^2 \qquad (8)$$

Under H_0: $l_1 = \ldots.. = l_k = 0$, Q is asymptotically χ^2 distributed with k degrees of freedom. The initiation behind the use of this statistic is that high sample autocorrelations lead to large values of Q. If the calculated value of Q exceeds the appropriate values in a χ^2 table, we can reject the null hypothesis of no significant autocorrelations and thus indicating predictability of the series. Rejecting the null hypothesis means accepting an alternative that at least one autocorrelation is not zero.

The analysis thus far does not take into consideration the characteristics of emerging markets. In emerging markets, unlike in mature ones, market structures, market participants and the availability of information as well as its quality change rapidly through time. If the evidence on efficiency is to be reliable it is essential that the methodology adopted in statistical tests takes into account these features. Only then can we address the more important issue of what makes markets efficient or inefficient.

II.C Emerging Markets and the EMH

The conventional tests of efficiency have been developed for testing markets which are characterized by a high level of liquidity, sophisticated investors with access to high quality and reliable information and few institutional impediments. Under these circumstances, stock prices respond proportionally or linearly to information.

On the other hand, emerging markets are typically characterized by low liquidity, thin trading, possibly less well-informed investors with access to unreliable information and considerable volatility. Furthermore, during the early years of trading, emerging markets may be characterized by investors who do not act rationally. In particular, investors may not always display risk aversion. Investors may be loss averse, in that they are more sensitive to losses than to gains (Bennartzi and Thaler, 1993). Such loss aversion may lead to investors acting in a risk loving or risk neutral manner. In addition, investors may place too much faith in their own forecasts introducing bias into their action (Dabba, Smith and Brocato, 1991). Furthermore, investors do not always respond instantaneously to information (Schatzberg, and Reiber, 1992). In particular, uniformed traders may delay their response to see how informed market participants behave because they do not have the resources to fully analyze the information or because the information may not be reliable.

Moreover, emerging markets change very rapidly through time. The liberalization process causes changes in the institutional and regulatory framework which in turn affect the informational efficiency of the market. It is therefore important to examine the evaluation of these markets, rather than taking a picture of the market at a particular point in time. This will allow us to identify the impact of regularity changes on the efficient functioning of the market and allows us to draw a policy conclusion regarding the appropriate regulatory framework for newly developing equity markets. Such characteristics of emerging markets may suggest that stock prices in those markets respond to information in a non-linear fashion.

Non-linearity

If stock prices are non-linear and a linear model is used to test for efficiency, then the hypothesis of no predictability may be wrongly accepted. Standard tests of efficiency, such as autocorrelation and random walk tests are thus incapable of capturing non-linearity and therefore inferences drawn of such tests may be inappropriate. Failure to consider the institutional features of emerging markets may lead to wrong inference regarding efficiency. For example, failure of the price to follow random walk may reflect thin trading and illiquidity rather than inefficiency. Information may not be free or reliable or investors may not be able to process information.

This non-linearity is likely to exist because of market psychology where markets over-react to bad news and under-react to good news (see DeBondt and Thaler, 1985, 1987, and de Costa, 1994). To illustrate this point, assume that stock prices evolve in the following manner:

$$x_t = a\, x_{t-1} (1-x_{t-1}) = a\, x_{t-1} - ax^2_{t-1} \quad (9)$$

The term ax^2_{t-1} is a negative non-linear reaction term, it suggests that whenever the price of an asset deviates from its equilibrium value then market forces will drive the price back to its equilibrium level. Empirically, in the presence of non-linearity, the EMH can be tested by examining the significance of the coefficients $_n$) in the following equation:

$$r_t = \alpha_0 + \alpha_1\, r_{t-1} + \alpha_2\, r^2_{t-1} + \ldots + \alpha_n\, r^n_{t-1} + \varepsilon_t \quad (10)$$

where r_t is the log changes of stock prices (returns). If the EMH holds, then, $\alpha_0 = \alpha_1 = \alpha_2 = \alpha_n = 0$, and ε_t is a white noise process.

There are other reasons why non-linearity is likely to exist. Non-linearity could arise because of the presence of transaction costs. Although information arrives randomly to the market, market participants respond to such information with lag, due to transaction costs. That is, market participants do not trade every time news comes to the market, but, rather they trade when it is economically profitable, leading to clumping the price changes. When announcements of important factors are made less often, than the frequency of observation then non-linearity may be also observed. For example, monthly money supply announcements will cause non-linearity in daily or weekly series. Furthermore, a financial market contains heterogeneous participants with different interests and reactions. It would be difficult if these differences always averaged out to give aggregate linear feedback.

The existence of non-linearity is supported empirically in mature markets. For example, Savit, 1988, suggests that asset returns may not follow a stochastic process. Rather, they might be generated by deterministic chaos in which case the forecasting error grows exponentially. Scheinkman and LeBaron, 1989, and Peters, 1991, supported the hypothesis that stock returns follow a non-linear dynamic system. Given these findings in developed markets, non-linearity is more likely to exist in emerging markets due to the typical characteristics of these markets, some of which are mentioned above.

Thin Trading

In testing for efficiency in emerging markets it is not sufficient to recognize the presence of non-linearity, it is also necessary to take into account thin trading which typically characterizes these markets. When stocks trade continuously, index level changes can be measured precisely. Since each stock trades at the end of each price change measurement interval, the observed stock price change will be equal to the true stock price change. However, with non-synchronous trading, all securities in the portfolio are traded at least once during each interval but not necessarily at the end point. A number of studies have investigated the impact of infrequent trading (see, for example, Lo and Mackinlay, 1990; Stoll and Whaley, 1990, and Miller, Kmuthuswamy and Whaley, 1994).

Infrequent trading has two forms. The first occurs when stocks are traded every consecutive interval, but not necessarily at the close of each interval. This form of infrequency, often dubbed “non-synchronous trading,” has been studied by Scholes and Williams (1977). Infrequent trading is also said to occur when stocks are not traded every consecutive interval[3]. The key to distinguishing between non-synchronous trading from non-trading is the interval over which price changes or returns are computed. When returns are measured on a monthly basis, for example, all stocks will have been traded at least once, but not all stocks will have been transacted exactly at the close of trading on the last trading day of the month. That is non-synchronous trading. When returns are measured over trading intervals as short as fifteen minutes, however, all stocks are unlikely to have been traded at least once in every consecutive fifteen-minute interval. That is non-trading. As the trading interval shrinks non-synchronous trading becomes non-trading.

---

[3] Lo and MacKinlay (1990) and Stoll and Whaley (1990b) focus on this non-trading and its consequences.

Such infrequent trading introduces bias into efficiency results. The main source of bias is that prices recorded at the end of a time period have a tendency to represent transactions which occurred earlier in, or prior to, the period in question. Thus, infrequent trading induces false autocorrelation in the series. *Miller et al* have shown that estimating AR(1) can solve the problem of infrequent trading. Specifically, the following model can be estimated:

$$r_t = \beta_0 + \beta_1 r_{t-1} + \varepsilon_t \qquad (11)$$

Using the residuals from the regression, adjusted returns are estimated as follows:

$$r_t^{adj} = \varepsilon_t /(1-\beta_1) \qquad (12)$$

where r_t^{adj} is the return at time t, adjusted for infrequent trading. Equations (11) and (12) assume that the non-trading adjustment required to correct returns is constant over time.

II.D: Empirical Studies

Empirical evidence on the weak form efficiency indicates mixed results. Fama (1965a), using the 30 US companies which make up the Dow Jones industrial index, found evidence of dependence in the price changes. Conrad and Juttner (1973) applied parametric and non-parametric tests to daily stock price changes in the German Stock Market. They found that the random walk hypothesis is inappropriate to explain the price changes. Cooper (1982) studied world stock markets using monthly, weekly and daily data for 36 countries. He examined the validity of the random walk hypothesis by employing correlation analysis, run tests and spectral analysis. With respect to the USA and the UK, the evidence supports the random walk hypothesis. For all other markets, the random walk hypothesis can be rejected. Panas (1990) could not reject the hypothesis of random walk and thus demonstrated that the Athens stock Market is efficient. Frennberg and Hansson (1993) examined the random walk hypothesis using Swedish data from 1919 to 1990. They found that Swedish stock prices have not followed a random walk in that period.

The typical result in event studies on *semi-strong* market efficiency using daily data is that, on average, stock prices seem to adjust within a day to event announcements. However, evidence on *strong form* of market efficiency suggest the presence of insider trading and that some security analysts (e.g.., Value Line) have information not reflected in stock prices[4]. Jaffe (1974), for example, found that for insiders the stock market is not efficient; insiders have information that is not reflected in prices. He also found that the market does not react quickly to public information about insider trading and outsiders can profit from the knowledge that there has been heavy insider trading for up to 8 months after.

Unfortunately, most of the empirical evidence of market efficiency is based on a developed market, notably the US Stock Market. This is probably due to the fact that the issue of autocorrelated stock returns, especially multi-period returns, requires a long time series of high quality data.

[4] The Value Line Investment Survey publishes weekly rankings of 1700 common stocks into 5 groups. Group 1 has the best returns prospects and group 5 the worst. There is evidence that, adjusted for risk and size, group 1 stocks have higher average returns than group 5 stocks for horizons up to 1 year (Black, 1973).

Empirical Events of Emerging Markets

As mentioned earlier, most empirical evidence found on the EMH is based on matured markets. Literature that provides empirical evidence for a potential trend towards efficiency in emerging markets is limited and the results are mixed. For example, Hong (1978) investigated the efficiency of the Singapore Stock Exchange and found evidence that it was efficient in the weak form. Another study made by Ang and Pohlman (1978) on Far-East Asian stocks also found support for the weak form efficiency. On the other hand, evidence for the inefficiency of markets was obtained by Ghandi *et al* (1980) in a study of the Kuwait stock market. Wong and Kwong (1984) examined the behavior of the daily closing prices of 28 Hong Kong stocks. The results of serial correlation coefficients showed that the successive stock price changes were dependent random variables. They concluded the Hong Kong market is not efficient in the weak form. Barnes (1986) reports the Kuala Lumpur Stock Market to be inefficient. Butler and Malaikah(1992) found evidence of inefficiency in the Saudi Arabian Stock Market, but not in the Kuwaiti Market and Panas (1990) concluded that market efficiency could not be rejected for Greece. It is difficult to believe that the Nairobi Stock Market is efficient, as argued by Dickinson and Muragu 1994, when there is evidence that some of the most developed markets in the world are characterized by inefficiency (see, for example, De Bondt and Thaler, 1985, 1987; Lo and Mackinlay, 1988). Unfortunately, there has been to my knowledge no study on the efficiency of the Egyptian Stock Market.

To summarize this section, the EMH is often investigated by examining whether stock prices exhibit patterns which allow future prices to be predicted, and thus, abnormal profits to be achieved. For a market to be efficient no such patterns should exist and prices should follow a random walk. Implicitly the EMH assumes rationality (see Peters, 1991). Rationality implies first that investors are risk averse, second, that they are unbiased in their forecasts and third, they respond instantaneously to new information. These assumptions lead to a linear relationship which is used to test market efficiency. If these assumptions are not valid and if prices respond in a non-linear manner, using a linear model will give a false inference as the hypothesis of independence of successive price changes may wrongly be accepted. This is because non-linear systems exhibit similar patterns to a random walk (see Antoniou, Ergul and Holmes, 1997).

IV. Efficiency of the Egyptian Stock Exchange(ESE)

Recent Developments of the Egyptian Financial Sector

It is commonly recognized that the availability of financial capital is a prerequisite for the development and transformation of any nation’s economy. Finding and efficiently managing the scarce resources depend on the existing financial institutions whether they are banks or non-bank financial institutions such as insurance companies, national provident funds, issuing houses and stock markets.

Banks mobilize financial resources from the surplus sector of the economy and channel such funds to the deficit units of the economy, whereas the stock market is a market were trading activities for securities take place and its primary function is to allocate resources to the most profitable investment opportunities. Decades of inadequate policies, and a multitude of other constraints made it difficult for Egypt to develop its financial sector that was dominated by four big public banks. Up to the end of the 1980s, the financial sector in Egypt was primarily dominated by the banking sector running mainly public. However, other financial intermediaries such as brokers, portfolio managers and mutual funds, etc were lacking. Furthermore, protection to investors, adequate regulation and supervision in the security market were lacking[5].

By 1991, the Egyptian government had implemented a comprehensive economic reform and structural adjustment program (ERSAP) to bring about transformation in the structure and performance of the economy. A main component of the economic reform program has been to deregulate the financial sector through several liberalization measures. These measures include allowing each bank to set its interest rate according to market forces, allowing foreign banks to carry out transactions in Egyptian pounds, the elimination of foreign exchange controls, the removal of many distortions to competition including the abolishment of credit ceiling on both private and public sector. A new Capital Market Law (CML) was implemented to replace the multiplicity of existing laws. The law assures the release of information from the issuer's and secures that the public has access to complete information concerning the security market. The role of the Capital Market Authority (CMA) includes monitoring the performance of the exchanges and enforcement of listing and trading regulations. The CML also encourages business to establish service institutions, intermediary firms such as brokerage firms, underwriters, portfolio managers and depositories. International investors can invest in securities with neither limitations on capital mobility nor foreign exchange controls. In addition, foreign intermediaries can now operate in the market under the same non-discriminated legal and administrative treatment of national firms. The CML prohibited insider trading, illegal takeovers and any unfair trading practices including price manipulations.

In 1996, the Egyptian government approved a new Banking and Credit Law that allows foreigners to own more than 49% of the total capital of any joint venture banks. Further steps towards privatization have been undertaken in 1996. The liberalization process has encouraged banks and other institutions to structure a number of mutual funds. The number of mutual funds has increased from one in 1994 to more than thirteen in 1997.

At the present, the two stock exchanges of Alexandria and Cairo are electronically linked for quotations and trading. Full computerization is taking place, linking trading to clearance, settlement and transfer of ownership. Companies offering their stock to the public are required to apply international accounting standards and auditors are required to apply international auditing standards. Companies with listed securities are

---

5 The discussion here draws on Ashraf Shams El-Din, "Capital Market Performance in Egypt: Efficiency, Pricing and Market Based Risk", a paper presented at the ECES Conference in Cairo, " Towards an Efficient Financial Market in Egypt", papers presented at the ECES Conference, Cairo, February 26 -27, 1997.

required to provide periodic disclosure of financial statements and other relevant information through quarterly issued reports. The ESE publishes daily bulletins containing market quotations, daily transactions and other details of trading.

These reforms, the process of liberalization and the associated high economic growth provided the foundation for the Egyptian stock market to grow rapidly in recent years. Table 1 shows that tremendous increase has taken place in the value of trading between 1992 and 1997. Market capitalization has increased by 443% during this period, from LE 10.8 billion (6% of GDP) in 1992 to LE 70.8 billion (39 % of GDP) in 1997. The number of yearly transactions increased from nearly 12,500 in 1992 to about 1,2 million transactions in 1997. Further evidence of the growing maturing of the market is provided by the fact that the number of trading companies rose from 239 in 1992 to 416 in 1997. The implication of table 1 is that the changes in regulation and liberalization of the market increased activities in the stock market and, by making information more reliable, helped to bring about a reduction in the perceived riskiness of the market. Although Egypt's Stock Market is developing very fast, no research has been devoted to the issue of efficiency of its stock prices. Thus, the important question from the point of view of resource allocation is whether these changes have affected the efficient functioning of the market, which is discussed next.

Table 1: Development of the Egyptian Stock Market.

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Value of Trading(L.E.M)	134.3	229	341.5	427.8	596.6	568.6	2557.2	3849.4	6811.5	24219.8
Volume of Trading (M)	6.6	9.2	17	22.7	29.6	17.7	59.8	72.2	142	372.5
Number of Traded Companies	169	179	199	218	239	264	300	352	311	416
Market Capitalization	4147	2381	5071	8845	10845	12807	14480	27420	36912	70873
Number of Transactions	4267	7271	7858	10305	12503	11934	94742	469615	2316364	1225351

Source, Capital Market Authority

Is the Egyptian Stock Market Efficient?

As mentioned above, the principal role of a stock market is to allocate resources to the most profitable investment opportunities. If stock prices provide accurate signals for resource allocation, firms are able to make accurate production-investment decisions, and investors are able to choose the most suitable stocks for investment. These choices are only possible if the market is efficient, that is, if stock prices "fully reflect" all available information.

In this section the weak form efficiency of the ESE is examined using daily returns for the period 1-1-1992 to 15-4-1997 for listed companies (index 2). We started the weak form efficiency, if the evidence fails to pass the weak form test there is no reason to examine stronger forms before declaring the market inefficient on the evidence. We focus on the index because it will reflect the impact of regulatory changes on the market as a whole, which is not possible if we use prices for individual companies.

As mentioned earlier, the weak form of the EMH can be carried out by testing whether successive stock price changes are independent. Different sets of tests are employed here. We first estimated the autocorrelation (SACF) and the partial autocorrelation

(PACF) up to the first 24 lags. If there is to be any significant correlation in successive stock price changes, the series is judged as predictable and therefore the stock market will be inefficient and vice versa. It should be noticed here that the coefficient of the first lag in the SACF represents the coefficient of the random walk model.
The results of the estimated SACF and PACF are shown in the first and the second panels of table (2), respectively. The figures in the first column represent number of lags. For lag 1, the coefficient is negative and significant as for lag 17, the coefficient is positive and significant. Thus, the results fail to support the hypothesis that the Egyptian Stock Market is weakly efficient. The second panel of Table 2 shows the partial autocorrelation coefficients up to 31 days. Once again the first and the seventeenth lags are significant.

In order to provide more evidence about the independence of successive stock-price changes, we employed the Ljung-Box statistic-Q test, rather than considering each individual SACF and PACF. The Q-Statistics test predicts the white noise process in successive price changes. Generally, small values of that test indicate white noise for successive price changes and therefore testify efficiency.
The figures of Q-Statistics shown in panel C in (table 2) are consistent with the above findings and do not exceed the critical values of χ^2. All the three tests employed expose the predictability of the stock returns for one day and 17 days and thus suggest inefficiency in the ESE.

In addition to testing for efficiency over the whole sample period (1992-1997), tests are also carried out on a yearly basis to examine the impact of regulatory changes which took place in the recent years. Tables 2A..2F show the results of the SACF, PACF and Q-statistics for each individual year from 1992 to 1997. Table 2A, for example, shows the results for 1992, and Table 2B shows the results for 1993 and so on. The results shown in the tables indicate that only in 1992 can the hypothesis of efficiency be supported. This is indicated by the low values of SACF, PACF and Q-statistics. This might be caused by the non-linearity induced by the massive regulatory changes of 1992.

Should one expect small markets to be less efficient in the weak form than larger ones? Gandhi *et al* (1980) conclude that "there is evidence of inefficiency in price determination on the Kuwaiti Stock Market, as might be expected in a relatively thin market. In the following discussion we assume that the inefficiency of the ESE found above is due to thin trading.

Thin Trading and Efficiency

In this section we attempt to examine the issue of efficiency after correcting for thin trading. We adopt the methodology of Miller *et al* based on the estimating AR(1) model as described in equations 16 and 17 for adjusted returns. Table 3 shows the coefficients of SACF and PACF as well as the values of Q-statistics for the adjusted return of the whole sample period. The results shown in the Table 3 indicate a significant first order autocorrelation of 0.50 and thus imply predictability and inefficiency using adjusted returns of the ESE.

Once again, by investigating efficiency on a yearly basis we are able to examine the impact of the market maturing and regulatory changes on the trading behavior and efficiency of the market. Tables 3A through 3F show the results of weak efficiency for adjusted returns on a yearly basis. Table 3A, for example, shows the results for 1992, while table 3B shows the results for 1993 and so on. The results shown in Tables 3A through Table 3D indicate a significant first order autocorrelation in the adjusted stock returns and thus imply predictability and inefficiency. The values of SACF, PACF and Q-statistics shown in Table 3A, for example, were 0.50, 0.50 and 62.74, respectively. All are significant at a 5% level and indicate predictability. Up to 1995, the results shown in the Tables indicate the same pattern of predictability. However, the degree of predictability is reduced significantly in 1996 and eroded completely in 1997. For 1996 (as shown in Table 3E) the values of the first order SACF and Q-statistics, respectively, were -0.19 and 17.68 comparing to the values of 1995 of 0.37 and 47.15 as shown in Table 3D. Up to April 1997, the values of the first order SACF and Q-statistics up to 8 lags were 0.02 and 1.86, respectively, which are insignificant at any confidence levels. From these results one could reach the conclusion that the overall successive changes in stock prices exhibited a significant move towards independence in 1996 and 1997. This suggests that the ESE has become weakly efficient particularly in 1997.

Time-Variation of Risk Premium

As mentioned above, inefficiency may be the result of time-variation in the risk premium, i.e. the compensation for holding a risky asset. The inferences drawn above assume that the observed predictability is true return predictability and not evidence for time-variation of risk premium. When the market risk premium is too high, the volatility (as measured by the variance) will also follow, leading to a false rejection of inefficiency. For this reason and in order to examine the robustness of the analysis, a term of time-varying risk premium is introduced. Merton (1980) shows that the risk premium of the market is a function of the volatility as in the following equation:

$$E_{t-1}(r_{mt}) = \lambda_{t-1} \text{var}_{t-1}(r_{mt}) \qquad (13)$$

Where r_m is the return on the market portfolio, var is the variance, λ is the market price of risk (i.e., risk premium necessary to induce the risk-averse agent to hold the long-term asset rather than one period bond) and E_{t-1} is the expectations operator. As discussed by Engle, Lilien and Robbins, (1987), this model can be estimated using General Autoregressive Heteroscedasticity (GARCH) model which allows for time variation in the conditional variance. Thus, the following GARCH model is estimated:

$$r_t = \alpha_0 + \lambda h_t + \alpha_1 r_{t-1} + \ldots\ldots \alpha_n r_{t-n} + \varepsilon_t \qquad (14)$$

$$h_t = b_0 + b_1 \varepsilon_{t-1}{}^2 + b_2 h_{t-1}$$

where h_t is the conditional variance and ε_t is an error term. If the pattern of results identified above is not due to time-varying risk premium, then α_1 and α_n should be statistically significant for the period between 93-96 and insignificant in 1992 and 1997. Tests are, therefore, carried out by estimating equations (13) and (14) both for the whole sample period and for each year from 1992 to 1997. The usefulness of GARCH is to capture the unusual volatility that might exist in stock price changes.

Table 4 shows the results of GARCH model for the entire sample period. The coefficients α_1 and α_n turned out to be significant with t-statistics of -7.24 and 212.71 which are significant at a 1% significance level. The results here confirm that for the entire sample period the Egyptian Stock Market is predictable when a non-linear term is introduced and shows that this predictability is outside the risk-return relationship. Therefore, the predictability identified from Table 3 is due to inefficient pricing rather than changes in the perception of risk premia.

Tables 4A through 4F show the results of GARCH model for each year. Three facts emerge from these Tables. First, the inefficiency of 1992 suggested by the results of table 3A is due to a time-varying risk premium. The values of α_1 and α_n have t-statistics of 0.32 and -.07 which are insignificant at any significance level. Second, the results shown in Tables 4B through 4E confirm the previous findings of stock price predictability for the period 1993 to 1996 when a non-linear term of time-varying risk premium is introduced. Third, most importantly, the results of Table 4F confirm the absence of predictability even when a non-linear term is presented. The t-values of α_1 and α_n were 1.17 and -0.03, which are insignificantly different from zero at any significance level. Thus, the Egyptian stock prices whether based on a linear or non-linear test can effectively be described as weakly efficient during 1997.

V. I Discussions of the Results

Our results show that the residual autocorrelation from the lagged returns declined significantly in 1997, suggesting that historical information was more precisely incorporated into prices. Improvements in this price discovery were associated with increases in volume of trading in 1997, implying that liquidity gains may be realized with better price discovery. Another implication of this *weak form efficiency* on financial decisions is that most stocks appear to be fairly valued because stock prices do seem to reflect historical information.

The decline in interest rates, regulatory changes such as the liberalization process, electronic trade, increased transparencies for the listed companies, tax reduction on stock funds and improvements in technology and applied finance since 1995, provide possible causes of the ESE move towards efficiency in 1997. However, this may not be the case if public information is added (*semi-strong efficiency*), as monetary and financial variables have proven to be important in predicting stock returns in other emerging markets. We leave to future research the task of determining that.

Having controlled for thin trading, non-linearity and time-varying risk premium, one possible explanation for the inefficiency (positive autocorrelations in returns) between 1992-1996 is the institutional trading patterns. There are several reasons for institutions to engage in trading patterns that contribute to positive autocorrelations in returns. First, institutional traders are likely to spread their trading over several days in order to conceal valuable private information. Second, institutional traders are likely to spread their large trades over several days in order to reduce the execution costs associated with market impact. Finally, institutions may engage in positive feedback trading and imitate each other.

V.II Summary and Conclusions

This paper investigated the issue of weak efficiency for the Egyptian Stock Exchange. Three widely accepted statistical tests have been used namely, random walk, serial correlation and Q-statistics tests. We have accounted for institutional features of the

Egyptian market when testing pricing efficiency. In particular, returns are adjusted for thin trading as suggested by Miller et al (1994). In addition, we recognized the possibility of non-linear behavior in market returns. More importantly, efficiency is investigated on a yearly basis to determine the impact of regulatory changes and the ability of investors to evaluate information. Through this investigation we were able to shed light on the important question of why markets are inefficient and what factors lead them to become efficient.

Using daily stock prices from the Egyptian Stock Exchange from 1992 to 1997, the results show that up to 1996 the market was inefficient. However the inefficiency manifested itself through non-linear behavior. It is likely that the non-linear behavior is the result of the features of the market at this time, as it has been shown to be outside the risk-return relationship. In particular information was not reliable as companies did not have to audit their financial statements leading to a lag in information being impounded into prices; there were restrictions on the repatriation of capital which may have deterred foreign participation, thus, contributing to illiquidity and low volume of trading. And there were no restrictions on insider trading which will impact on the confidence and perceived riskness of the market. The ESE went through a period of very considerable liberalization and regulatory changes from 1992 which directly addressed these shortcomings. The results of these changes improved participation considerably, increased the volume of trading and improved the reliability and timeliness of information. Unsurprisingly, the results show that in 1997 the market is not characterized by predictability and is therefore informationally efficient.

The main message of this paper is that informational efficiency of the Egyptian Stock Market, as in any other emerging market, is brought about by improving liquidity, ensuring that investors have access to high quality and reliable information and minimizing the institutional restrictions on trading. In addition, the evolution in the regulatory framework of the Egyptian Stock Market may mean that it was initially characterized by inefficiency, but over time will develop into an efficient and effectively functioning market which allocates resources efficiently.

V. III Some Policy Conclusions

Despite the impressive growth of the ESE in recent years, it does not, as yet, offer a real investment option in the Egyptian economy. Evidently, only 60 companies of 700 listed in the ESE are involved in active trading while the ratio of market capitalization to nominal capitalization stands for only 3.9% in 1997

Now, the question is: what can be done to enhance the efficiency of the ESE and to ensure its contribution to the development of the Egyptian economy? There is a series of policy actions that could improve the role of the ESE and improve its efficiency. These actions can be classified under four related headings: (i) improving trade mechanism, (ii) improving market quality (iii) deepening of financial markets; and (iv) improving market microstructure.

i. Improving Trade Mechanism

An improved trading mechanism can improve the price discovery process. Financial assets are typically traded under one of the two market structures: dealer market or an auction market. Auction markets are centered around a specialist who acts as an agent by matching customers buy and sell orders. In an auction market, liquidity is provided primarily by customers limit orders, specifying the price and quantity demanded by the investor. The inside spread is determined by investors offering the highest bid price and the lowest ask price. Thus, auction markets rely primarily on the competition among public investors to determine the inside spread. Standard economic theory presumes that a high degree of industry concentration, which seems to be the case in Egypt, is a necessary but not sufficient condition for non-competing pricing[6]. In contrast, dealer markets are quote-driven since bid and ask quotes are posted by individual market makers rather than by public. Dealers markets are designed to produce competitive bid-ask spreads through the competition for order flow. Each issue must have at least two market makers. In addition, continuous trading can also facilitate the convergence of prices to new information and contribute to a smoother price discovery process.

ii. Improving Market Quality

Improve market quality enhances the value of traded assets. When an individual investor places an order to trade a common stock, the broker chooses among several market venues standing ready to execute that order. The order flow is fragmented among several competing market venues. The order may be routed to the stock exchange that listed this stock, to regional stock exchanges, or to a third automated electronic trading system.

Whether order flow should be fragmented among several venues or concentrated on one venue has long been debated. It is now widely accepted that allowing one venue to dominate trading reduces competition and can harm investors. If trading becomes too focused, then the dominant venue may extract monopoly rents from investors in the form of fees/trading costs; having several workable trading venues prevents investors from being exploited.

Trading rules must offer multiple dealers the opportunity to become competing specialists in each stock. This means that brokerage firms must be able to take the other side of their customers' orders acting as dealer. This also means that to get dealer revenue dealers need only to match the best quote rather than being the first to "get to" the best price on the exchange. Dealers may also need to have the option to internalize an order (fill it themselves at the best quoted price) or route it to the dealer posting the best quote.

The presence of multiple market makers, each attempting to gain an advantage over the others by offering more competitive quotes, could be expected to lead to narrow

[6]Economic theory provides a standard measure to compute industry concentration using the Herfindahl-Hirshmann (HHI) index. The index is calculated by squaring the market share of each market maker in a particular stock and then summing the squared market shares across all dealers. The range of possible values extends from 0(where one market maker executes an infinitesimal fraction of the order flow) to 10 000 (where one market maker execute 100% of all orders). We leave calculation of that index to future work.

both inside spreads and effective spread[7]. This, in turn, would translate into competitive trading costs for investors. For example, suppose a broker enjoys a cost advantage in executing orders in high-volume stocks because of an investment in trading technology. To capitalize on this cost advantage the broker-dealer may wish to attract increased order flow by quoting higher bid/lower offer prices. Tighter spreads and more aggressive quoting by the dealer enjoying the cost advantage will be the result.

iii. Deepening of Financial Markets

The financial market in Egypt does not offer investors the variety of instruments or the kinds of services that are available in many other emerging countries. More competition in the banking sector would give banks more incentives to expand services. Creations of derivatives markets (such as forward contracts, futures, currency swaps and options) would both lower the costs of financial transactions and reduce companies exposure to interest and/or exchange rate risk, which in turn, increases transactions and liquidity. Furthermore, speeding up the base of privatization has proven to be an effective means both for developing equity markets and improving investment climate.

iv. Improving Market Microstructure

The microstructure theory suggests improvements to market microstructure (increases in firm value, liquidity and price discovery) leads to improvement in trading efficiency.

Completing the second stage of micro reforms, aimed at increasing investment and savings, as well as modernizing the financial sector is a crucial need in Egypt. Both fixed investment and savings rates at 19.6 % and 18% (of which only 9% for the private sector) of GDP respectively are almost half the levels in high-growth emerging markets. What is needed is to increase both domestic investments and savings rates to about 25% of GDP. Domestic savings can be boosted by marketing of long-term equity funds or issuance of corporate bonds. The bulk of domestic savings are currently invested in either short-term money market funds or real estate. , thus reducing the funds available for productive industrial investment. The World Bank estimates that higher savings rate can increase annual GDP growth by 2.7%. Egypt should enter the 21st century with a solid economic base, capable of providing higher job opportunities and improved living standards for whole population.

[7] The effective spread measures the distance between the trade price and the bid-ask midpoint

References

Ang, J.J.& R.A. Pohlman, (1978), A Note on The Price Behavior of Far Eastern Stocks, Journal of International Business Studies.

Antoniou, A., Erguul, N., Holmes, P. and Priestley, R (1996),”The Impact of Regulatory Changes on Stock Market Volatility and the Costs of Equity Capital: Evidence From Emerging Market” Paper Presented to the South Western Finance Association Meeting, San Antonio.

Antoniou, A., Erguul, N., and Holmes, P (1997)”Market Efficiency, Thin Trading and Non-Linear Behavior: Evidence From an Emerging Market”, EFM, Vol. 3.

Ashraf Shams El-Din, “Capital Market Performance in Egypt: Efficiency, Pricing and Market Based risk”, A paper presented at the ECES Conference in Cairo, “ Towards an Efficient Financial Market in Egypt”, February 26 -27 1997.

Barnes, P., (1986), ” Thin Trading and Stock Market Efficiency: The Case of the Kuala Lumpur Stock Exchange”, Journal of Business Finance and Accounting, Vol. 13.

Benatzi, S. and Thaler; R., H., (1992) ” Myopic Loss Aversion and the Equity Premium Puzzle”, National Bureau of Economic Research Working Paper, 4369.

Butler, K. C. and Malaikah, S. J., (1992), ”Efficiency and Inefficiency in Thinly Traded Stock Markets: Kuwait and Saudi Arabia, Journal of Banking and Finance, Vol. 16.

Barttles, R. (1982) The Rank of Von Neumann's Ratio for Randomness, Journal of the American Statistical Association, 77.

Cooper, J. C. B. (1982), " World Stock Markets: Some Random Walk Tests, Applied Economics, Vol. 14.

Conrad, K. and Juttner, D. J. (1973), "Recent Behavior of Stock Market Prices in Germany and the Random Walk Hypothesis, Kyklos, Vol. 26.

Da Costa, N. C. A. (1994)" Overreaction in the Braziliian Stock Market", Journal of Banking and Finance, 18.

Dabbs, R. E., Smith, K. and Brocato, J., (1991), " Test on the Rationality of Professional Business Forecasts with Changing Forecast Horizons", Quarterly Journal of Business and Economics, 30.

Dickinson, JP. and Muragu, K. (1979), " Market Efficiency in Developing Countries: A Case Study of the Nairobi Stock Exchange", Journal of Business Finance and Accounting.

DeBondt, W. F. M. and Thaler, R. H., (1985), "Does the Stock Market Overreact; Journal of Finance, Vol. 40.

Engle, R., Lillien, D. and Robbins, R., (1987), " Estimating Time-Varying Risk Premia in the Term Structure: The ARCH-M Model, Econometrica, Vol. 55.

Fama, E. (1965a), "The Behavior of Stock Market Prices", Journal of Business, 38.
..............(1970), " Efficient Capital Markets: A Review of Theory and Empirical Work, Journal of Finance, 25.
.........(1991), " Efficient Capital Market: II", Journal of Finance, 46.

Frennberg, P. and Hansson, B.(1993), " Testing The Random Walk Hypothesis on Swedish Stock Prices: 1919--1990, Journal of Banking and Finance, 17.

Grossman, S and Stiglitz, J., (1980), " On the Impossibility of Informationally Efficient Markets", American Economic Review, 70.

Gandhi, D.K., A. Saunders, et al., (1980), Thin Capital Markets: A Case Study of the Kuwaiti Stock, Applied Economics, Vol. 12.

Hong, H., (1978), " Predictability of Price Trends on Stock Exchanges: A Study of Some Far Eastern countries", Review of Economics & Statistics, Vol. 60.

Kendall, M.G. and Stuart, M. A. (1961) The Advanced Theory of Statistics, Vol. II, Griffin, London.

LeRoy, F, Stephan, "Efficient Capital Markets and Martingales" Journal of Economic Literature, December 1989.

Lo, A. and MacKinlay, A., (1990), " Data-Snooping Biases in Tests of Financial Asset Pricing Models", Review of Financial Studies, 1.
.....................(1988), " Stock Market Prices Do Not Follow Random Walk: Evidence From A Simple Specification Test", Review of Financial Studies, 1.

Merton, R. (1980), " On Estimating the Expected Return on the Market", Journal of Financial Economics, 8.

Miller, M. H., Kmuthuswamy, J. and Whaley, R., (1994)," Mean Reversion of Standard and Poor 500 Index Basis Changes: Arbitrage-Induced or Statistical Illusion, Journal of Finance, 49.

Peters, E. E. (1991), Chaos and Order in Capital Market (New York: Wiley).
Poterba, J.M and L.H. Summers, " Mean Reversion in Stock Prices: Evidence and Implications, Journal of Financial Economics, 25, 1988.

Schatzberg, J. D. and Reiber, R. R., "Extreme Negative Information and the Market Adjustment Process: The Case of Corporate Bankruptcy", Quarterly Journal of Business and Economics, 31.

Scheinkman, J., and LeBaron, B, (1989)," Nonlinear Dynamic and Stock returns", Journal of Business, 62.

Schwert, G. W., (1989)" Why Does Stock Market Volatility Change Over time? Journal of Finance, Vol. 44

Rogalski, R.J. and J.D. Vinso, (1977), Stock Returns, Money Supply and the Direction of Causality, Journal of Finance , Vol. 32.

Panas, E., (1990), " The Behavior of Athens Stock Prices". Applied Economics, 22.

Pearce, D, K. and V.V. Roley, (1983), The Reaction of Stock Prices to Unanticipated Changes in Money", Journal of Finance, Vol., 38:4.

Stoll, H. R., and Whaley, R.,(1990), "The Dynamics of Stock Index futures Returns", Journal of Financial and Quantitative Analysis, 25.

Wong, K.A. and K.S Kwong, (1984), The Behavior of Hong Kong Stock Prices, Applied Economics, Vol. 16.

Yohannes, Lulseged, G., "Efficiency of Emerging Financial Markets: The Case of Nigeria,", Memorandum nr. 241, Göteborg University, 1997.

<u>Table 2</u>: the SACF, PACF and Q-statistics, sample period 1992-1997.

A. SACF

1	-0.3680	0.0691	0.0144	-0.0227	-0.0455	0.0269
7	-0.0102	-0.0097	0.0257	0.0154	0.0316	0.0135
13	-0.0097	0.0459	0.0400	-0.0816	0.1762	-0.0994
19	-0.0591	0.0211	-0.0161	-0.0153	0.0111	-0.0060

B- PACF

1	-0.3680	-0.0766	0.0158	-0.0073	-0.0664	-0.0174
7	-0.0040	-0.0133	0.0160	0.0335	0.0592	0.0510
13	0.0131	0.0562	0.0961	-0.0314	0.1571	0.0292
19	-0.0925	-0.0536	-0.0303	-0.0202	-0.0255	-0.0365

C- Q-Statistics
Q(8) = 189.6570. Significance Level 0.0000
Q(16) = 206.3678. Significance Level 0.0000
Q(24) = 267.1186. Significance Level 0.0000

<u>Table 2A</u> : the SACF, PACF and Q-statistics, sample period 1-1-1992 to 31-1-1992

A:SACF

1	-0.0009	-0.0608	-0.0397	0.0325	0.0177	0.0147
7	-0.0223	-0.0800	0.0144	0.0093	0.0013	-0.0737
13	-0.0204	0.0205	-0.0271	-0.0100	0.0463	0.0188
19	0.0223	0.0399	0.0152	0.0033	-0.0027	-0.0250

B. PACF

1	-0.0009	-0.0608	-0.0399	0.0288	0.0131	0.0170
7	-0.0181	-0.0785	0.0120	-0.0026	-0.0023	-0.0679
13	-0.0192	0.0137	-0.0386	-0.0115	0.0494	0.0173
19	0.0267	0.0356	0.0179	0.0102	-0.0071	-0.0309

C. Q-Statistics
Q(8) = 3.5152. Significance Level 0.8980

Q(16) = 5.4624. Significance Level 0.9929
Q(24) = 6.9410. Significance Level 0.9997

Table 2B : the SACF, PACF and Q-statistics, sample period 1-1-1993 to 31-1-1993

A- SACF

1	-0.4382	0.0159	0.0091	0.0001	-0.0213	0.0257
7	-0.0203	0.0169	-0.0037	-0.0126	-0.0029	0.0176
13	-0.0708	0.0686	-0.0058	0.0211	0.0045	-0.0025
19	-0.0074	-0.0033	0.0091	-0.0010	0.0457	-0.0492
B. PACF						
1	-0.4382	-0.2180	-0.1013	-0.0458	-0.0483	-0.0066
7	-0.0177	0.0038	0.0053	-0.0125	-0.0192	0.0053
13	-0.0791	-0.0021	0.0189	0.0494	0.0535	0.0368
19	0.0188	-0.0006	0.0099	0.0076	0.0645	0.0058

C. Q-Statistics
Q(8) = 97.2830. Significance Level 0.0000
Q(16) = 102.7768. Significance Level 0.000
Q(24) = 105.2334. Significance Level 0.000

Table 2C : the SACF, PACF and Q-statistics, sample period 1-1-1994 to 31-1-1994`

A. SACF/	0.3591	0.3538	0.2839	0.2441	0.1543	0.1564
7	0.1699	0.0892	0.0259	0.0275	0.0906	0.0140
13	0.0060	0.0401	0.0122	-0.0171	-0.0246	-0.0593
19	-0.0430	-0.0724	-0.0338	-0.1194	-0.0509	-0.1015
B. PACF						
1	0.3591	0.2581	0.1192	0.0678	-0.0276	0.0271
7	0.0730	-0.0370	-0.0833	-0.0214	0.0967	-0.0229
13	-0.0366	0.0263	-0.0034	-0.0189	-0.0315	-0.0770
19	0.0050	-0.0140	0.0220	-0.1089	0.0341	-0.0257

C. Q-Statistics
Q(8) = 122.2303. Significance Level 0.0000
Q(16) = 125.3789. Significance Level 0.0000
Q(24) = 136.2796. Significance Level 0.0000

Table 2D: the SACF, PACF and Q-statistics, sample period 1-1-1995 to 31-1-1995

A. SACF

1	0.0571	0.0161	-0.0051	-0.0300	0.0291	-0.0456
7	-0.1942	0.0326	0.1432	-0.0062	0.0874	-0.0233
13	-0.0127	-0.0139	0.0357	0.0536	0.0959	0.0297
19	0.0397	-0.0015	0.0143	-0.0185	-0.1112	-0.0236
B. PACF						
1	0.0571	0.0129	-0.0067	-0.0296	0.0327	-0.0485
7	-0.1915	0.0567	0.1537	-0.0336	0.0756	-0.0144
13	-0.0300	-0.0592	0.0820	0.1051	0.0760	0.0278
19	0.0294	-0.0475	0.0117	0.0087	-0.0696	0.0004

C. Q-Statistics
Q(8) = 11.8394. Significance Level 0.15851
Q(16) = 20.5071. Significance Level 0.1982
Q(24) = 27.3517. Significance Level 0.2883

Table 2E : the SACF, PACF and Q-statistics, sample period 1-1-1996 to 31-1-1996

1	-0.4627	0.0221	0.0000	-0.0121	0.0050	0.0124
7	-0.0107	0.0086	-0.0053	-0.0091	-0.0091	0.0096
13	0.0050	-0.0120	0.0172	-0.2330	0.4804	-0.2263
19	-0.0219	0.0028	-0.0062	-0.0146	0.0253	-0.0004
B. PACF						
1	-0.4627	-0.2444	-0.1359	-0.0936	-0.0579	-0.0179
7	-0.0146	-0.0004	-0.0016	-0.0148	-0.0308	-0.0187
13	-0.0033	-0.0143	0.0072	-0.3098	0.3087	0.1764
19	0.0349	-0.0219	-0.0235	-0.0475	-0.0293	-0.0002

C. Q-statistics
Q(8) = 53.5742. Significance Level 0.0000
Q(16) = 68.1756. Significance Level 0.0000
Q(24) = 143.7438. Significance Level 0.0000

Table 2F : the SACF, PACF and Q-statistics, sample period 1-1-1997 to 15-4-1997

A- SACF

1	-0.3399	0.0853	0.0111	-0.0407	-0.0884	0.0310
7	-0.0152	-0.0273	0.0435	0.0296	0.0514	0.0093
13	-0.0254	0.0743	0.0500	0.0003	-0.0068	-0.0316
19	-0.0903	0.0349	-0.0277	-0.0230	-0.0079	-0.0170
B. PACF						
1	-0.3399	-0.0342	0.0334	-0.0267	-0.1287	-0.0448
7:	-0.0085	-0.0350	0.0124	0.0456	0.0872	0.0527
13:	-0.0176	0.0779	0.1416	0.0928	0.0211	-0.0304
19:	-0.1000	-0.0174	-0.0232	-0.0567	-0.0752	-0.0956

C. Q-Statistics
Q(8) = 10.0094. Significance Level 0.2643
Q(16) = 11.2682. Significance Level 0.7926
Q(24) = 12.4803. Significance Level 0.9739

Table 3: SACF, PACF and Q-Statistics for Adjusted Return, Sample period 1992----1997

A. SACF

1	0.49981	0.000008	6.07E-05	1.49E-05	-2.2E-05	1.12E-05
7	1.15E-05	-3.4E-06	7.1E-06	2.61E-05	5.49E-05	4.05E-05
13	0.000038	7.13E-05	-1.8E-05	-5.7E-05	5.48E-05	-1.8E-05
19	-8.6E-05	-0.0001	-6.5E-05	-2.5E-05	-0.00012	-7.9E-05
B.PACF						
1	0.4998	-0.3330	0.2496	-0.1995	0.1660	-0.1421
7	0.1241	-0.1101	0.0989	-0.0897	0.0820	-0.0755
13	0.0700	-0.0650	0.0606	-0.0569	0.0536	-0.0507
19	0.0479	-0.0456	0.0433	-0.0413	0.0393	-0.0375

C. Q-Statistics
Q(8) = 329.5002. Significance Level 0.0000
Q(16) = 329.5002. Significance Level 0.0000

Q(24) = 329.5002. Significance Level 0.0000

Table 3A: SACF, PACF and Q-statistics for Adjusted Return during 1992.

A- SACF

1	0.5000	-0.0001	-0.0001	-0.0001	-0.0002	-0.0002
7	-0.0002	-0.0003	-0.0003	-0.0003	-0.0003	-0.0004
13	-0.0004	-0.0004	-0.0005	-0.0006	-0.0006	-0.0006
19	-0.0007	-0.0008	-0.0008	-0.0008	-0.0009	-0.0009
B. PACF/1	0.5000	-0.3334	0.2499	-0.2001	0.1665	-0.1429
7	0.1248	-0.1112	0.0998	-0.0910	0.0831	-0.0771
13	0.0712	-0.0669	0.0621	-0.0589	0.0551	-0.0528
19	0.0494	-0.0478	0.0449	-0.0437	0.0409	-0.0400

C. Q-Statistics

Q(8) = 62.7440. Significance Level 0.0000
Q(16) = 62.7444. Significance Level 0.0000
Q(24) = 62.7456. Significance Level 0.0000

Table 3B: SACF, PACF and Q-statistics for Adjusted Return during 1993.

A- SACF

1	-0.1947	-0.1824	0.0250	-0.0089	-0.0238	0.0165
7	-0.0072	0.0198	-0.0037	-0.0246	-0.0013	-0.0035
13	-0.0632	0.0652	0.0363	0.0304	0.0106	-0.0085
19	-0.0197	-0.0085	0.0059	0.0194	0.0416	-0.0578

B. PACF

1	-0.1947	-0.2289	-0.0693	-0.0670	-0.0536	-0.0165
7	-0.0242	0.0131	-0.0023	-0.0209	-0.0141	-0.0185
13	-0.0803	0.0252	0.0295	0.0702	0.0558	0.0368
19	0.0104	-0.0029	0.0054	0.0183	0.0553	-0.0287

C. Q-Statistics

Q(8) = 18.5491. Significance Level 0.0175
Q(16) = 21.5131. Significance Level 0.1596
Q(24) = 23.2138. Significance Level 0.5072

Table 3C: SACF, PACF and Q-Statistics for Adjusted Return during 1994.

A- SACF

1	0.6472	0.4561	0.3878	0.3136	0.2307	0.2121
7	0.2024	0.1241	0.0519	0.0528	0.0846	0.0370
13	0.0192	0.0375	0.0164	-0.0168	-0.0399	-0.0656
19	-0.0691	-0.0787	-0.0777	-0.1187	-0.0990	-0.1071

B. PACF

1	0.6472	0.0641	0.1211	0.0133	-0.0227	0.0618
7	0.0368	-0.0806	-0.0616	0.0362	0.0754	-0.0637
13	-0.0035	0.0264	-0.0198	-0.0233	-0.0514	-0.0561
19	0.0207	-0.0136	-0.0131	-0.0915	0.0583	-0.0345

C. Q-Statistics

Q(8) = 262.2629. Significance Level 0.0000
Q(16) = 266.5729. Significance Level 0.0000
Q(24) = 282.6403. Significance

Table 3D: SACF, PACF and Q-Statistics for Adjusted Return during 1995.

A- SACF

1	0.3716	0.0297	-0.0082	-0.0177	0.0094	-0.0948
7	-0.1930	0.0171	0.1493	0.0666	0.0741	0.0015
13	-0.0251	-0.0056	0.0478	0.0911	0.1181	0.0714
19	0.0445	0.0182	0.0102	-0.0464	-0.1195	-0.0613

B. PACF

1	0.3716	-0.1258	0.0308	-0.0255	0.0283	-0.1305
7	-0.1257	0.1608	0.0851	-0.0370	0.0846	-0.0543
13	-0.0359	-0.0163	0.1288	0.0842	0.0551	0.0193
19	0.0010	-0.0420	0.0312	-0.0257	-0.0615	0.0199

C. Q-Statistics

Q(8) = 47.1562. Significance Level 0.0000
Q(16) = 58.5714. Significance Level 0.0000
Q(24) = 69.9499. Significance Level 0.0000

Table 3E: SACF, PACF and Q-Statistics for Adjusted Return during 1996.

A- SACF

1	-0.1909	-0.1840	0.0046	-0.0150	0.0070	0.0150
7	-0.0053	0.0051	-0.0067	-0.0195	-0.0126	0.0125
13	0.0057	-0.0067	-0.0893	-0.1028	0.4739	-0.1112
19	-0.1338	-0.0089	-0.0144	-0.0128	0.0273	0.0111

B. PACF

1	-0.1909	-0.2288	-0.0901	-0.0851	-0.0362	-0.0123
7	-0.0115	0.0026	-0.0070	-0.0224	-0.0286	-0.0083
13	-0.0050	-0.0093	-0.1039	-0.1735	0.4165	0.0391
19	0.0179	-0.0332	-0.0268	-0.0483	-0.0148	-0.0003

C. Q-Statistics

Q(8) = 17.6816. Significance Level 0.0237
Q(16) = 22.8007. Significance Level 0.1192
Q(24) = 91.1110. Significance Level 0.0000

Table 3F: SACF, PACF and Q-Statistics for Adjusted Return during 1997.

A- SACF

1	0.0239	-0.0233	0.0330	-0.0838	-0.1163	-0.0047
7	-0.0178	-0.0242	0.0575	0.0788	0.0858	0.0284
13	0.0078	0.1099	0.0981	0.0210	-0.0201	-0.0729
19	-0.1116	-0.0030	-0.0238	-0.0356	-0.0205	-0.0215

B. PACF

1	0.0239	-0.0239	0.0341	-0.0863	-0.1112	-0.0049
7	-0.0177	-0.0237	0.0398	0.0648	0.0856	0.0194
13	0.0099	0.1319	0.1304	0.0546	-0.0074	-0.0534
19	-0.0776	0.0090	-0.0385	-0.0568	-0.0758	-0.0875

C. Q-Statistics
Q(8) = 1.8698. Significance Level 0.9847
Q(16) = 5.4539. Significance Level 0.9930
Q(24) = 7.5616. Significance Level 0.9994

Table 4: ESTIMAING GARCH(1,1) USING LIKELIHOOD FUNCTION.
Sample Period 1992-1997

Variable	Coeff	Std Error	T-Stat	Signif
α_0	-0.18	0.01	-22.32	0.00
α_1	-0.05	0.01	-7.24	0.00
α_n	0.75	0.00	212.71	0.00
λ	1.19	0.02	49.17	0.00

Usable Observations 1314 Degrees of Freedom 1310
Function Value -2196.06246532

Table 4A: ESTIMAING GARCH(1,1) USING LIKELIHOOD FUNCTION.
Sample Period 1/1/92….31/1/1992

Variable	Coeff	Std Error	T-Stat	Signif
α_0	0.11	0.11	0.95	0.34
α_1	1.30	4.08	0.32	0.75
α_n	-0.30	4.08	-0.07	0.94
λ	-0.01	0.01	-0.93	0.35

Usable Observations 247 Degrees of Freedom 243

Table 4B: ESTIMAING GARCH(1,1) USING LIKELIHOOD FUNCTION.
Sample Period 1/1/93….31/1/1993

Variable	Coeff	Std Error	T-Stat	Signif
α_0	0.00	0.03	-0.06	0.9538
α_1	0.76	0.06	13.57	0.0000
α_n	0.00	0.00	-10.79	0.0000
λ	8.26	0.43	19.10	0.0000

Usable Observations 247 Degrees of Freedom 243

Table 4C: ESTIMAING GARCH(1,1) USING LIKELIHOOD FUNCTION.
Sample Period 1/1/94….31/1/1994

Variable	Coeff	Std Error	T-Stat	Signif
α_0	0.93	0.13	6.98	0.00
α_1	0.23	0.12	1.91	0.06
α_n	0.67	0.03	20.77	0.00
λ	0.53	0.08	6.73	0.00

Usable Observations 248 Degrees of Freedom 244

Table 4D: ESTIMAING GARCH(1,1) USING LIKELIHOOD FUNCTION. Sample Period 1/1/95….31/1/1995

Variable	Coeff	Std Error	T-Stat	Signif
α_0	-0.17	0.12	-1.43	0.15
α_1	4.64	1.01	4.59	0.00
α_n	-0.57	0.31	-1.83	0.07
λ	-0.011	0.022	-0.503	0.000

Usable Observations 247 Degrees of Freedom 243

<u>Table 4E;</u> ESTIMAING GARCH(1,1) USING LIKELIHOOD FUNCTION Sample Period 1/1/96….31/1/1996

Variable	Coeff	Std Error	T-Stat	Signif
α_0	0.6839	1.2457	0.5490	0.5830
α_1	134.28	6.46	20.79	0.00
α_n	-0.0247	0.0388	-0.6350	0.5254
λ	0.3458	0.2144	1.6130	0.1067

Usable Observations 248 Degrees of Freedom 244

<u>Table 4F</u>; ESTIMAING GARCH(1,1) USING LIKELIHOOD FUNCTION Sample Period 1/1/97….15/4/1997

Variable	Coeff	Std Error	T-Stat	Signif
α_0	8.1226	0.6690	12.1412	0.0000
α_1	13.3581	11.4019	1.1716	0.2414
α_n	-0.0021	0.0648	-0.0320	0.9745
λ	2.5541	0.3004	8.5011	0.0000

Usable Observations 64 Degrees of Freedom 60