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Testing the Random Walk Behavior and Efficiency of the Egyptian Equity Market

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Abstract

The main objective of this study is to investigate whether prices in Egypt emerging equity market follow a random walk process as stated by the efficient market hypothesis. Therefore, this study examines the weak-form of market efficiency in Egypt stock market by testing the random walk hypothesis (RWH) through multi-approaches, specifically unit root, runs and variance ratio tests on the daily price of EGX 30 index of Egypt equity market over the period from January 1998 until December 2010. The empirical results reject the RWH at the weak-form level, indicating that stock prices do not fully reflect all historical information.

Keywords: Egyptian Exchange, Weak-Form, Efficient Market Hypothesis, Run Test, Unit Root Tests, Variance Ratio Test.
JEL Classification Codes: C12, D53, G12, G14.

1. Introduction

The efficient market Hypothesis has attracted the attention of many researchers for the last several decades. However, Fama is considered one of the most important researchers who set the foundation and discussed in depth the market efficiency and the random walk theory. A market is said to be efficient if it responds immediately and accurately to all available information. On the other hand, the random walk theory asserts that stock price movements are unpredictable and it follows a random erratic behavior. Therefore, past stock price movements are of no use to predict future price movements. Kendall (1953) is considered one of the earlier scholars who suggested that stock prices move randomly. Later on, Fama (1965) concluded also that price changes are random and past movements were of no use in predicting future movements. This could be an indication that financial markets operates with high degree of efficiency (Gitman, Joehnk, and Smart 2011, 324). Fama (1970) suggested that investors can be confident that a current market price fully reflects all available information about a security and the expected returns based upon this price is consistent with its risk. He also divided the overall efficient market hypothesis (EMH) into three forms: the weak–form, the semi-strong-form, and the strong-form EMH. The weak-form of the EMH assumes that current stock prices reflect all security market information, including the historical sequence of prices, rates of return, trading volumes, and other market generated information. Therefore, we should gain little from using any trading rules that decides whether to buy or sell a security based on past rates of return, or any other past market data. On the other hand, the semi-strong-form of the EMH asserts that security prices adjust rapidly to the release of all public information. Therefore, it implies that investors who base their decisions on any important new information after it is public should not derive above-average risk–adjusted profits from their transactions. However, the strong-form of the EMH is the most extreme form. It states that security prices fully reflect all information from public and private sources. This means that no investor has a monopolistic access to information relevant to the formation of prices. Therefore, no investor will be able to consistently derive above-average risk-adjusted rates of return.

The objective of this study is to test the random walk hypothesis on the behavior of the Egyptian equity market. It utilizes multi-approaches, specifically, unit root, runs and variance ratio tests.

This study is different from other studies in several ways. Empirical researches that examined the efficiency of the stock market for Egypt are not abundant. Although, the Egyptian exchange is considered one of the oldest stock markets in the Middle East. Also, this study uses most recent daily observations of EGX 30 index for thirteen years covering the period of the global financial crises. In addition, it includes a comprehensive view of most previous studies that tested the weak-form efficiency on various stock markets around the world. Finally, the empirical tests results of this paper are checked with the findings of previous studies that were performed on some of the Middle Eastern stock markets.

This study is organized into six sections as follows: Section 2 describes the Egyptian exchange, while section 3 addresses the literature review. On the other hand, section 4 presents the data and illustrates the research methodology. Section 5 reports the empirical findings. Finally, section 6 provides the concluding remarks.

2. The Egyptian Exchange

The Egyptian exchange (EGX) is the only registered securities exchange in Egypt. It is owned by the government and managed like a private company. EGX is considered one of the oldest stock markets in the Middle East. It has a long history that goes back to 1883 when the Alexandria stock exchange was officially established and followed later by Cairo stock exchange in 1903. Therefore, the Egypt equity market was formerly known as the Cairo and Alexandria Stock Exchange (CASE). However, both exchanges were governed by the same board of directors and share the trading, clearing and settlement systems. The two exchanges were very active in 1940s and were ranked fifth in the world. In the mid of 1950s, the government adopted central planning and socialist policies which led the exchange to become inactive until 1990s. The revival of EGX began again in 1990s when the Egyptian government started restructuring and implementing a major economic reform program. The Egyptian Financial Supervisory Authority (EFSA) is the regulatory body for the exchange. In 1996, Misr for Central Clearing, Depository and Registry (MCDR), a private company, which handles the clearing and settlement operation for all securities in Egypt, moved toward a dematerialization of securities in which physical stocks are no longer existent. In 1999, Egypt for Information Dissemination (EGID) was established to stimulate investment growth in Egypt and the Middle East by increasing the level of transparency. Common and preferred equities, government and corporate bonds, and closed-end mutual funds are the three types of securities that trade on EGX. There are approximately over 200 companies listed on EGX where most of them belong to banks and financial services, real estates, food and beverages, industrial goods, travel and leisure, and healthcare and pharmaceuticals sectors. The Egyptian exchange has several indices that track its performance, EGX 30, EGX 70, EGX 100, Dow

Jones EGX Egypt Titan 20 index, and S&P/ESG index. EGX 30 index, previously named CASE 30 index, is the most popular benchmark free-float capitalization weighted index of the 30 most highly capitalized and liquid stocks traded on the Egyptian exchange. The index was developed in 1998 with a base level of 1000. This study used this index to test the random walk behavior and the weak-form of efficiency of the Egyptian stock market.

3. Literature Review

There have been an extensive number of empirical researches investigating the weak-form of market efficiency for different financial markets around the world.

For instances, several studies were performed on industrialized countries financial markets. Lee (1992) tested the weak-form efficiency for 10 industrialized countries (Austria, Belgium, Canada, France, Italy, Japan, the Netherland, Switzerland, U.K. and Germany) using the variance ratio test and the weekly stock returns for the period 1967-1988. His findings indicate that the random walk hypothesis (RWH) is not rejected concluding weak-form efficiency for these markets. Also, Choudhry (1994) examined the stochastic trends of individual stock indices in seven OECD countries (U.S., U.K., Canada, France, Germany, Japan and Italy), using Augmented Dickey-Fuller (ADF), KPSS unit root test and Johansen's cointegration test. The results show that these stock markets are efficient during the sample period. On the other hand, Al-Loughani and Chappel (1997) studied the U.K. market using Financial Times Stock Exchange (FTSE) 30. They conclude that FTSE 30-share index does not follow a random walk. Worthington and Higgs (2006) examined the weak-form market efficiency for twenty-seven emerging markets. The serial correlation and runs tests conclude that most emerging markets are weak-form inefficient. However, when multiple variance ratio tests are utilized, results were in general consistent with the serial correlation and runs tests. Also, Worthington and Higgs (2004) tested twenty European countries from August 1995 to May 2003, utilizing serial correlation test, run test, Augmented Dickey-Fuller test and variance ratio test. They found that only five countries Germany, Ireland, Portugal, Sweden, and the U.K. meet the most stringent criteria for random walk, while France, Finland, the Netherland, Norway, and Spain meet only some requirements for a random walk. Similarly, Karemera et al., (1999) studied the random walk hypothesis for fifteen emerging stock markets using monthly index data expressed in both U.S. and domestic currencies. The conclude that when utilizing the multiple variance ratio and using the U.S. and domestic currencies, 10 out of 15 emerging stock markets are consistent with the random walk hypothesis.

Some other studies related to European emerging equity markets were also accomplished. Guidi, Gupta, and Maheshwari (2010) found that stock markets for Central and Eastern European countries do not follow a random walk. Similarly, Smith and Ryoo (2003) used the variance ratio tests to examine the RWH for five European emerging equity markets. The results indicate that the hypothesis is rejected for the markets of Greece, Hungry, Poland, and Portugal because returns have autocorrelated errors, in Turkey; the Istanbul stock market follows a random walk. On the other hand, Hassan et al., (2006) conducted a test of efficiency on seven European emerging markets using data from December 1988 through August 2002 and utilizing several methods including Ljung-Box Q statistic, runs and variance ratio tests. Their results, except Greece, Slovakia, and Turkey, markets in Czech Republic, Hungry, Poland, and Russia are found unpredictable. Gilmore and McManus (2003) concluded that the markets for the Czech Republic, Hungry, and Poland are not yet weak-form efficient. On the other hand, Abrosimova et al., (2005) examined the Russian stock market using data from September 1995 to May 2001. They concluded that evidence supports weak-form efficiency in the Russian stock market. Also, Borges (2007) studied the Lisbon stock market from January 1993 to December 2006. His results indicate that the Portuguese stock market index has been approaching a random walk behavior since year 2000. Panas (1990) reveals that Athens stock market is an efficient at the weak-form level. This contradicts the results of Dockery and Kavussanos (1996) who investigated the efficiency of the Athens stock market (ASM) using roots test. Their findings show that ASM is informationally inefficient. Results on Turkey stock markets were mixed. Zychowicz et al., (1995), Antoniou et al., (1997) and Tas and Dursonglu (2005) rejected the random walk hypothesis confirming that Istanbul stock exchange (ISE) is weakly inefficient. On the other hand, Buguk and Brorsen (2003) could not reject the random walk hypothesis concluding that ISE is weak-form efficient.

Several studies also conducted on some African countries stock markets. Rapuluchukwu (2010) and Olowe (2002) found that Nigerian stock market follows a random walk behavior and is weak-form efficient. On the other hand, Dickinson and Muragu (1994) tested the Nairobi stock exchange (NSE) using the autocorrelation and runs tests. The results support the weak-form efficient market hypothesis implying that NSE is weak-form efficient. Contrary results were obtained by Parkinson (1987) where the runs test rejected the RWH indicating that NSE is not weak-form efficient. Akinkugbe (2005) examined the weak-form efficiency in Botswana stock market for the period June 1989 to December 2003 using unit root tests. The results indicate that Botswana market is weak-form efficient. Batuo Enowbi, Guidi, and Mlambo (2009) evaluated the efficient market hypothesis for four African stock markets, Egypt, Morocco, South Africa, and Tunisia, utilizing parametric and non parametric tests. Results show that only South Africa stock market exhibited a random walk. Also, Smith (2008) tested 11 African equity markets from 2000-2006 and found that they are not weak-form efficient. Similarly, Jafferis and Smith (2005) tested seven African Stock markets, South Africa, Egypt, Morocco, Nigeria, Zimbabwe, Mauritius, and Kenya starting in the early January 1990s and ending in June 2001. The results indicate that South Africa stock market is weak-form efficient during the entire period while Egypt, Morocco, and Nigeria became weak-form efficient towards the end of the period. Similar study conducted by Smith, Jafferis and Ryoo (2002) on eight African stock markets using multiple ratio tests. For seven markets, Botswana, Egypt, Kenya, Mauritius, Morocco, Nigeria and Zimbabwe, the hypothesis is rejected. However, South Africa stock market found to follow a random walk.

Other studies related to Latin American emerging equity markets were also performed. For instance, Ojah and Karemera (1999) found that markets for Argentina, Brazil, Chile, and Mexico exhibited a random walk behavior and they are weak-form efficient. On the other hand, Grieb and Reyes (1999) utilized the variance ratio tests to examine the equity markets of Brazil and Mexico. Their findings indicate that Brazil market exhibited a greater tendency towards random walk. However, Urrutia (1995) rejected the RWH for the equity markets of Argentina, Brazil, Chile, and Mexico when the variance ratio test was used, while the runs test shows weak-form of efficiency.

The Asian countries stock markets also have been tested for the weak-form efficiency of the efficient market hypothesis. Hoque, Kim and Pyun (2006) studied the random walk validity for eight emerging equity markets in Asia including, Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand. They found that stock prices of the eight Asian countries do not follow a random walk with the possible exception of Taiwan and Korea. Similarly, Islam and Khaled (2005) and Mobarek and Keasey (2002) rejected the RWH indicating that Dhaka stock market in Bangladesh do not follow a random walk. Also, Abeysekera (2001) reached the same conclusion for Colombo stock exchange indicating that Sri Lanka stock Market is weak-form inefficient. Poshakwale (1996) found that the results of runs and serial correlation tests exhibited a non-random behavior in Bombay stock exchange, concluding that the Indian stock market is not weak-form efficient. Also, Mookerjee and Yu (1996) concluded that Shanghai stock exchange and Shenzhen stock exchange in china exhibited significant inefficiencies. Laurence (1986) utilized the runs test and the autocorrelation test on Kuala Lumpur stock exchange and the stock exchange of Singapore. They found that both markets are not weak-form efficient. This is contrary to Banes (1986) where he found that Kuala Lumpur stock exchange in Malaysia is weak-form efficient. Similar results were reached by Chang et al., (1996) and Chang and Ting (2000) rejecting the RWH and concluding that Taiwan stock market is weak-form efficient. Also, Cheung and Coutts (2001) used the variance ratio methods to examine the efficiency of Hang Seng index in Hong Kong covering the period from January 1985 to June 1997. Their results confirm that Hang Seng index follows a RWH. Groenewold (1997) examined the weak-form efficiency for Australia and New Zealand covering a full sample period of 1975-1992. The results of the unit root tests show that both indices were consistent with non-stationary implications of the weak-form of the efficient market hypothesis. The autocorrelation test provides evidence of return predictability.

Also, several studies were performed on the Middle Eastern stock markets. Al-Jafari, (2011-1) and Al-Jafari (2011-2) found that both Bahrain and Kuwait equity markets are informationally inefficient at the weak-form level. On the other hand, Jaradat and Al-Zeaud (2011) found that Amman stock exchange (ASE) is inconsistent with the RWH and is not weak-form efficient. Similar results were obtained by Maghyereh (2003) who found that ASE does not conform to random walk model and informationally inefficient. This contradicts Civelek (1991) who found that the industrial sector of ASE is weak-form efficient. Also, Awad and Daraghma (2009) concluded that the Palestinian securities market is inefficient at the weak-form level. On the other hand, Omran and Farrar (2006) investigated the RWH for five Middle Eastern countries. Their finding rejected the RWH for all markets. Also, Abdmoulah (2009) tested the weak-form efficiency for 11 Arab stock markets using GARCH-M (1,1) and found that all markets are weak-form efficient. Similarly, Marasheh and Shrestha (2008) examined the United Arab Emirates securities market. They found that data contains unit root and follow a random walk meeting the criterion of weak-form market efficiency. Similar results were obtained by Mustafa (2004) who concluded that the UAE market is weak-form efficient. Butler and Malaikah (1992) examined stock returns behavior in Saudi Arabia and Kuwait during 1985-1989. They found that the Saudi stock market is inefficient, while the Kuwaiti stock market is efficient. This is contrary to Hassan, Al-Sultan and Al-Saleem (2003) which they found that Kuwaiti stock exchange is weak-form inefficient. Similarly, Abraham et al., (2002) examined the weak-form efficiency for Bahrain, Saudi Arabia and Kuwait markets using the variance ratio test and the runs test for the period October 1992 to December 1998. Results of both tests rejected the RWH in all three markets concluding that they are weakly inefficient markets.

4. Data and Methodology

Lo and MacKinlay (1988) suggest the use of a variance-ratio (VR) statistic to test the random walk hypothesis. However, this procedure is not sufficient on its own to assess weak-form efficiency. In fact, when the random walk hypothesis is rejected, the alternative hypotheses are that the series analyzed are serially correlated. Therefore, further testing must be completed to provide an accurate assessment of weak-form efficiency. This has been commonly done with unit root tests and runs test.

4.1. Data

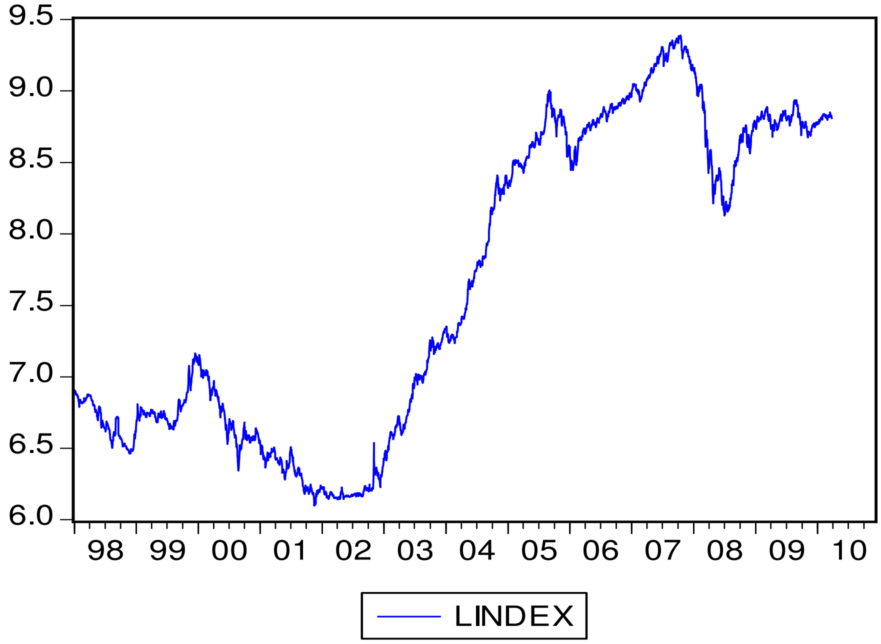
The dataset of daily stock returns of Egypt equity market represented by the EGX 30 index was obtained from the official web site of the Egyptian exchange (www.egptse.com). The data consist of 3189 observations covering the period from January 1998 until December 2010. Returns are calculated by the difference of two successive log daily price of the Egyptians index:

$$R_t = \ln P_t - \ln P_{t-1} \quad (1)$$

Where P_t and P_{t-1} re the closing prices of stock index at time t and $t-1$, espectively and $\ln$ is natural logarithm.

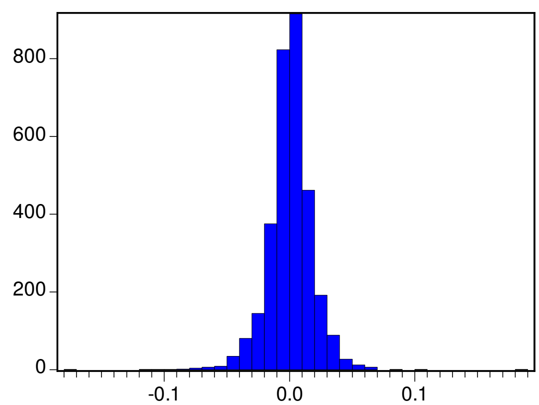
In order to obtain a better understanding of the behavior of stock prices, a preliminary analysis of the data is carried out in this section. Figure 1 shows the plot of the return data based on the index covering the aforesaid period. It is clear from this plot that the data exhibit strong volatility. Figure 1 shows the time series plots of the Egypt market index where the log of daily closing prices are used. As we can see the market experienced positive return until the end of the year 2008 where the impact of the global financial crisis started to show.

Figure 1: Time Series Plots of Egypt Stock Market Index in logarithm.



Summary statistics of stock price index series of Egypt stock market are presented in Table 1, using Eviews7. These include mean, maximum, minimum, standard deviation, skewness, kurtosis, Jarque-Bera, and probability value.

Table 1: Descriptive Statistics for Stock Price Index of Egypt Stock Market



Series: RT	
Sample 1 3189	
Observations 3189	
Mean	0.000597
Median	0.000262
Maximum	0.183770
Minimum	-0.179860
Std. Dev.	0.017818
Skewness	-0.255117
Kurtosis	12.36469
Jarque-Bera	11687.39
Probability	0.000000

Estimates are given for the period 1998-2010. The returns are negatively skewed which means that large negative returns tend to be larger than the higher positive returns. The level of kurtosis is higher than three. The negative skewness implies that the stock index returns are flatter to the left compared to the normal distribution. However, negative skewness and high kurtosis indicate that there is strong departure from normality in the unconditional distribution of the return. The Jarque-Bera statistic rejects the hypothesis of a normal distribution of returns, at a significance level of 1%.

4.2. Research Methodology

As mentioned above, the present study employs unit root tests, run test and variance ratio test. A brief description of these tests is provided in this section.

4.2.1. Unit Root Tests

Unit root tests are commonly used to test the stationary property of a time series data. In this study three different unit root tests are employed to test the null hypothesis of a unit root. These tests are the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test. However, under the assumption of the random walk, the price series must have a unit root while the return series must not.

4.2.1.1. Augmented Dickey-Fuller (ADF) Test

The augmented Dickey-Fuller (ADF) test is used to test the existence of a unit root in the series of price changes in the stock index series, by estimating the following equation through the ordinary least squares.

$$\Delta P_t = \beta_0 + \beta_1 t + P_{t-1} + \sum_{i=1}^{q} \rho_i \Delta P_{t-i} +_t \qquad (2)$$

where P_t is the price at time t , ρ_I are coefficients to be estimated, q is the number of lagged terms, t is the trend term, $\beta_1$is the estimated coefficient for trend, β_0 is the constant, and ε_t is a pure white noise error term. The null hypothesis is that $\delta = 0$; that is, there is a unit root, the time series is nonstationary. The alternative hypothesis is that δ is less than zero. Failing to reject H_0 implies that we do not reject that the time series has the properties of a random walk.

4.2.1.2. Phillips -Perron (PP) Tests

PP tests are proposed by Phillips and Perron (1988). These tests are similar to ADF tests. The difference between the PP and the ADF tests is in how they deal with serial correlation and heteroskedasticity in the errors. The idea of the Phillips-Perron tests is to run a non-augmented Dickey-Fuller regression, and then to adjust for the bias that might occur due to correlation in the innovation term. Phillips-Perron test is a non parametric test with the following specifications:

$$P_t = \ + \delta P_{t-1} + \varepsilon_t \qquad (3)$$

$$P_t = \mu + \beta + \left(t - \frac{1}{2} T \right) + \alpha P_{t-1} + \varepsilon_t \qquad (4)$$

where P_t is the natural logarithm of the price index at time t, μ is a constant, α and β are parameters to be estimated within the model and ε_t is pure white noise error term. Equation (3) includes only the constant term, whereas equation 4 contains a constant term μ and a linear trend term $\beta\left(t - \frac{1}{2} T \right)$ . .

The hypotheses Phillips-Perron (PP) tests are represented as follows:
H_0: there is a unit root in the series
H_1: there is not any unit root in the series (stationary)

4.2.1.3. The Kwiatkowski, Phillips, Schmidt and Shin (Kpss) Test

Since the publication of the seminal paper by Kwiatkowski, Phillips, Schmidt and Shin (1992), there has been an increasing interest in testing for stationarity in economics time series. The KPSS test represents a useful alternative to hypothesis, and may conflict with tests that assume nonstationarity as a null hypothesis. Thus, indicating that there may be real doubt as to the properties of the time series. The KPSS test accounts for the problem of autocorrelation in a similar (although parametric) way to PP test.

To perform the test, we first obtain the residual ε from the regression of *y* on a constant and a trend. It was found that standard unit root tests are not very powerful against relevant alternatives and fail to reject the null for many economic series. KPSS (1992) consider the problem of testing for stationarity around a level or a time trend against the alternative of a unit root. Under the null hypothesis, the model is represented as follows:

$$P_t = \delta t + \gamma_t + \varepsilon_t \quad (5)$$

With auxiliary equation for γ_t

$$\gamma_t = \gamma_{t-1} + \mu_t \quad (6)$$

where ρ_t denotes series of observations of variable of interest, t-deterministic trend, γ_t – random walk process, t – error term of equation (5), by assumption is stationary, μ_t denotes the error term of equation (6), and by assumption is a series of identically distributed independent random variables of $E(\mu_t) = 0,$ and constant variance, $\hat{\sigma}^2$. A test for σ^2_μ =0 is a test for stationarity (Maddala and Kim, 1998).

The KPSS statistic is based on the residuals e_t from the OLS regression of P_t on the exogenous variables. The test statistic is defined as:

$$KPSS = T^{-2}\sum_{i=1}^{T} S_t^2 / \sigma_T l \quad (7)$$

Where $s_t = \sum_{i=1}^{t} \varepsilon_i$ the partial sum of residuals is, T is the number of observations, and the $\sigma_T l$ represent an estimate of the long run variance of residuals. Large value of KPSS lead to rejection of the stationarity null hypothesis, since that means the series deviate from its mean. In the (KPSS) unit root test hypotheses are stated as follows:

H_0: there is not any unit root in the series (stationary).

H_1: there is a unit root in the series.

4.2.2. The Runs Test

Until Wright's (2000) work on the rank and sign VR test, the runs test was the most commonly used non-parametric test of the RWH. It does not require that return distributions are normally or identically distributed and, the condition that most stock return statistics cannot satisfy. At the same time, it eliminates the effect of extreme values often found in the return data.This provides a solid alternative to parametric serial correlation tests in which distributions are assumed to be normally distributed.

Runs test is a non-parametric test that is designed to examine whether successive price changes are independent. A run can be defined as a sequence of consecutive price changes with the same sign. The non-parametric run test is applicable as a test of randomness for the sequence of returns. Accordingly, it tests whether returns in Egyptian market index is predictable.

To perform this test, let, n_a and n_b respectively represent observations above and below the sample mean (or median), and r represents the observed number of runs, with $n=n_a+n_b$.

$$Z(r) = \frac{r - E(r)}{\sigma(r)} \quad (8)$$

The expected number of runs can therefore be calculated by employing the following formula:

$$E(r) = \frac{n + 2n_a n_b}{n} \quad (9)$$

The standard error is represented by:

$$\sigma E(r) = \left[\frac{2n_a n_b(2n_a n_b - n)}{n^2(n-1)}\right]^{1/2} \quad (10)$$

Because returns are not normally distributed, the presence of structural breaks or outliers in the series can bias the test results. To control for such issues, we complete the runs test using a mean and a median as a base. However, using the median can yield more reliable results when there are outliers. The null hypothesis for this test is for temporal independence in the series.

4.2.3. Variance Ratio Test

This test developed by Cochrane, (1988) and Lo and MacKinlay (1988, 1989) for testing the randomness of stock prices. The VR approach has gained popularity and has become the standard tool in random-walk testing. We can apply the test to both, the stock price index and to the individual stocks (Urrutia, 1995). Lo and MacKinlay (1988) show that the variance ratio test is more powerful than the unit root test. We use overlapping (as opposed to non-overlapping) *q*-period returns in estimating the variances in order to obtain "a more efficient estimator and hence a more powerful test," Campbell et al., (1997, p. 52).

The variance ratio (VR) methodology tests whether the ratio of the variance of q-period returns by q times the variance of 1-period returns is statistically not differ from one. The Variance ratio test under homoscedasticity, using overlapping observations is defined as:

$$VAR(q) = \frac{\sigma_C^2(q)}{\sigma_a^2(q)} \tag{11}$$

Where $\sigma_c^2(q)$ is an unbiased estimator of 1/q of the variance of the q^{th} – difference and $\sigma_a^2(q)$ is an unbiased estimator of the variance of the 1^{st}-difference. The standard normal test-statistics under homoscedasticity $Z(q)$ is:

$$Z(q) = \frac{VR(q)-1}{\left[\varnothing(q)\right]^{1/2}} \sim N(0,1) \tag{12}$$

Where:

$$\varnothing(q) = \frac{2(2q-1)(q-1)}{3q(nq)} \sim N(0,1) \tag{13}$$

Variance ratio test under hetroscedasticity is:

$$Z^*(q) = \frac{VAR(q)-1}{\left[\varnothing^*(q)\right]^{1/2}} \sim N(0,1) \tag{14}$$

Where:

$$\varnothing^*(q) = \sum_{j=1}^{q-1}\left[\frac{2(q-j)}{q}\right]^2 \widehat{\sigma}(j) \tag{15}$$

$$with\, \hat{\sigma}(j) = \frac{\sum_{t=j+1}^{nq}(P_t + P_{t-1} - \widehat{\mu})^2 (P_{t-j} - P_{t-j-1} - \hat{\mu})^2}{\sum_{k=1}^{nq}\left(P_t - P_{t-1} - \widehat{\mu}\right)^2} \tag{16}$$

For performing this test, we first calculate the compounded daily returns on the Egypt index, find its variance and repeat the procedure for 2, 4, 8, 10, 16 and 32-day returns. We then calculate the variance ratios for all five times intervals, and test the following null hypothesis:

H_0: The VR at lag *q* is defined as the ratio of the variance of the *q*-period return to the variance of the one-period return divided by q, which is unity under the random walk hypothesis.

An estimated variance ratio of less than one implies negative serial correlation, while a variance ratio of greater than one, or high *Z* value implies positive serial correlation. The rejection of single or more therefore rejects the null hypothesis of the random walk. To assist contrast with preceding researches, Lo & MacKinlay, (1988), and Campbell, Lo & Mackinlay, (1997), on other equity markets, the q is chosen as 2, 4, 8, 10, 16, and 32.

5. The Empirical Tests Results

5.1. The Results of the Unit Root Tests

ADF, PP, and PKSS tests were carried on the log of the index using the package Eviews7. The tests were performed in levels, and first differences, and trend. The results of ADF and PP tests are reported in Tables 2 and 3, while the results of KPSS are reported in Table (4).

Table 2: ADF and PP Unit Root Tests Results on the Logarithm of the Egyptian Exchange Index at Level.

Type of test	t-statistics	Critical value at 5%	Inference
ADF without intercept	1.070485	-1.940986	Do not reject
ADF with intercept	-0.065341	-2.862248	Do not reject
ADF with intercept and trend	-1.426552	-3.411216	Do not reject
PP without intercept	1.879347	-1.940923	Do not reject
PP with intercept	-0.065341	-2.862248	Do not reject
PP with intercept and trend	-1.426552	-3.411216	Do not reject

Table 3: ADF and PP Unit Root Tests Results on the Logarithm of Egyptian Exchange Index at First Difference.

Type of test	t-statistics	Critical value at 5%	Inference
ADF without intercept	-47.02920	-1.940923	reject
ADF with intercept	-47.06749	-2.862249	reject
ADF with intercept and trend	-47.06762	-3.411216	reject
PP without intercept	-47.11170	-1.940923	reject
PP with intercept	-47.16982	-2.862249	reject
PP with intercept and trend	-47.16424	-3.411216	reject

The empirical results of the KPSS test on logarithm of the Egyptian exchange index at level and first difference are reported in Table 4.

Table 4: KPSS Unit Root Test Results on the Logarithm of Egyptian Exchange Index at Level and First Difference.

KPSS tests	LM-STAT	Critical value at 5%	Inference
Level			
with intercept	5.980737	0.463000	reject
with intercept and trend	0.825201	0.146000	reject
first difference			
with intercept	0.360378	0.463000	reject
with intercept and trend	0.315563	0.146000	do not reject

The results in Table 4 indicate that the null hypothesis of stationary in the daily Egyptian exchange index at level is rejected. Whereas stationary of stock prices series is confirmed at first difference. In other words, the empirical results from KPSS unit root test at first difference imply the difference stationary process in Egyptian exchange index in the case of trend and intercept specification only.

The results of ADF, PP, as well as that of KPSS provide evidence that the Egypt index are nonstationary at level and stationary for the first and second differences. Therefore, the results are consistent with the random walk hypothesis. The KPSS tests offer conflicting results with those of ADF and PP only in the trend and intercept specification at the first difference.

5.2. The Results of the Runs Test

As evidenced in Tables 5 and 6. The runs test clearly shows that Egyptian equity market is weak-form inefficient. The estimated Z-values are significant at the 1% level.

Table 5: Runs Tests with the Mean as a Base*

n	n_a	n_b	$E(r)$	r	σ_r	$Z(r)$	Sig(2 tailed)
3189	1587	1602	.0006	1341	0.0178	-9.014	0.000

**SPSS19 software is used to obtain the results in this table as well as those in Table (6).*

Table 6: Runs Tests with the Median as a Base

n	n_a	n_b	$E(r)$	r	σ_r	$Z(r)$	Sig(2 tailed)
3189	993	964	.00016	1339	0.00871	-9.086	0.0000

5.3. The Test Results of the Variance Ratio Test

Table 7 reports the test results of the variance ratio test.

Table7: Variance Ratio Test at Return Series for the 2,4,8,10,16 and 32 day returns.

period	Time horizon q	Var. Ratio	Z_q	Z_q*
Jan. 1998- Dec. 2010	2	1.180281	10.17908	4.950335
	4	1.300409	9.066457	4.846415
	8	1.402701	7.686657	4.597579
	10	1.394620	6.599123	4.079801
	16	1.470429	6.034376	3.963060
	32	1.647767	5.733866	4.061910

*q is the number of daily intervals aggregated to compute variance ratios. Z_q Statistics are the asymptotic normal test statistics under homoskedasticity. Z_q^* statistics are the asymptotic normal test statistics under heteroskedasticity, and * indicates rejection of the null hypothesis of no autocorrelation at the 0.01 significance level.*

Table 7 displays the values we obtained for the variance ratio, as well as for the Z and Zq* statistics. From Table 7, it can be seen that all variance ratios significantly differ from 1 at 1% significance level. This means that the variance increases more than proportionately in time indicating the presence of positive serial correlation in the daily returns. Thus, we have to reject the null hypothesis that the values of Egypt exchange index changed randomly in the studied period. This would lead to the conclusion that the Egyptian stock market could be inefficient for all investment horizons up to 32 days.

The findings of this study are similar to those found in Smith, Jafferis and Ryoo (2002), Jafferis and Smith (2005), Smith (2008), Batuo Enowbi, Guidi, and Mlambo (2009), and Abdmoulah (2009).

6. Conclusion

This study examined the random walk behavior and efficiency of the Egyptian equity market using unit root test, run test, and variance ratio tests. The variance ratio tests show that the variance increases more than proportionately in time indicating the presence of positive serial correlation in the daily returns. The results of ADF, PP, and KPSS provide evidence that the Egyptian exchange EGX 30 index is nonstationary at level and stationary for the first and second differences. The run tests with similar results as those of other tests. This implies that the Egyptian stock market did not follow a random walk and informationally inefficient at the weak-form level. Therefore, prudent investors will realize abnormal returns by using historical sequences of stock prices, data related to trading volumes and other market generated information.

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