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RANDOM WALK IN THINLY TRADED STOCK MARKETS: THE CASE OF KUWAIT

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A previous weak-form efficiency study that utilised conventional testing procedures found that the majority of Kuwaiti listed company shares appear to follow a random walk (Butler and Malaikah, 1992). Our study uses weekly market index data and a combination of traditional and modern testing procedures to examine whether the previous results may be sample and/or methodology specific. The results of traditional tests were consistent with previous findings. However, when more robust econometric techniques were employed, the results consistently favoured stationarity but not a random walk. Furthermore, the results indicate that the Kuwaiti stock price series are non-linear and can be described by a Generalised Autoregressive Conditional Heteroscedasticity (GARCH) Model.

Introduction

Several studies have empirically examined the validity of the weak form of the Efficient Market Hypothesis (EMH) with respect to stock markets in developing economies. In its weak form, the EMH postulates that successive one-period price changes are both independent and identically distributed (iid), i.e., resemble a "random walk", (Fama,1970). This, in turn, implies that future price changes cannot be predicted using past price changes as a forecaster. Recent work in this area includes Cooper (1982), Sharma (1983), Al-Mudhaf (1983), Parkinson (1984, 1987), Laurence (1986), Butler and Malaikah (1992), Dickinson and Muragu (1994). With the exception of Cooper (1982) and Laurence (1986), these studies merely apply tests based upon serial correlation and run analyses on the first differences of the natural logarithms of stock price indices and/or samples of individual company shares. Cooper (1982) supplements these two tests with spectral analysis, while Laurence (1986) checks the normality of price changes, which has important bearing on the choice of appropriate statistical tests.

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Mixed evidence has been reported by these studies. Cooper (1982) found that the serial correlation coefficients of developing countries' stock price changes tend to be small, although they are greater than those of industrial countries. Sharma (1983) on the other hand, found evidence suggesting that the random walk model is an adequate representation of stock price changes on the Bombay Stock Exchange. Al-Mudhaf (1983) applied the serial correlation test on the percentage change of the share prices of thirty Kuwaiti companies. He found evidence indicating that the Kuwaiti stock market is not only quite efficient but also more efficient than the London, German, Swedish and Norwegian markets. Al-Mudhaf, however, considers this finding highly unreasonable and attributes it to the low power of the test used. Laurence (1986) demonstrates that share price changes in Kuala Lumpur and Singapore stock markets are serially independent. Nonetheless, his examination of the distribution of share price changes indicates a departure from normality. He, consequently, concludes that the results of the serial correlation test may not be meaningful. Dickinson and Muragu (1994) found evidence for the Nairobi Stock Exchange that does not contradict the weak-form of the EMH. Finally, Butler and Malaikah (1992), who used a sample of individual company daily and weekly share prices, found that sixty percent of the Kuwaiti listed company shares were serially independent. They also showed that none of the 35 Saudi stocks conform to the random walk.

There are three major deficiencies associated with these studies. First, with the exception of Laurence (1986), none of these studies examine the shape of the distribution of share price changes. Employing statistical tests of significance that assume normality, when in fact it does not exist, can only produce questionable results. Second, even the most recent of these studies do not employ well known econometric techniques such as the Dickey-Fuller (1979) and Phillips-Ouliaris (1990) unit root procedures to test the single unit root implication of the random walk hypothesis. Finally, none of these studies explicitly test for the (iid) assumption implied by the random walk hypothesis. They simply carry out tests of serial independence and establish the absence of serial correlation which does not in itself imply independence. Yet, it is quite possible that any non-linearity within the data may remain undetected under these tests. The empirical analysis carried out in this paper attempts to avoid the shortcomings of previous research.

This paper is concerned with the efficiency of the thinly traded Kuwaiti stock market[1]. The weak-form efficiency of the Kuwaiti stock market has been studied, inter alia, by Al-Mudhaf (1983), Butler and Malaikah (1992) who tested for one of the assumptions of the RWH, namely the serial independence assumption, and reached the conclusion that the market is weakly efficient. The argument put forward in this paper is that this conclusion may be misleading since its validity depends on the power of the conventional tests used in these studies. This point will be verified by showing that this result holds when the same conventional tests are applied to a different set of data (Al-Shal stock price index). However, the novel contribution of this study is demonstrating that when more sophisticated techniques and more powerful tests are applied to the same data set to test all the assumptions implied by the RWH, it is revealed that the market is actually inefficient. This paper is organized as follows: the following section reviews the concept of weak-form efficiency and the random walk model. Section three contains a description of the methodology of econometric testing used in this study. Section four describes the data used in this study, presents the results and discusses their interpretation. Finally, section five draws some conclusions and summarises the findings.

Weak Form Efficiency and Random Walk

Fama (1965) argued that share prices in an efficient stock market fully reflect all relevant and available information and, hence, no profit opportunities are left unexploited. The information set considered relevant to weak form efficiency is historical prices or returns. This type of efficiency implies that current prices fully reflect historical prices or returns and, so, the information in past prices or returns is not useful in predicting future prices/returns.

The notion that the current price of a share fully reflects available information was taken to imply that successive price changes (or returns) are independent. Consequently, there must be no serial correlations between the returns at different times. Furthermore, it was also assumed that successive changes are identically distributed. This requires that the stock prices change distribution be stationary over time [i.e., stock prices are I(1) whilst stock returns are I(0)]. These two requirements constituted the corner stones of the random walk model (Fama, 1970).

The logarithmic random walk model is given by

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

Where P_t is the price of a stock at time t, P_{t-1} is the price of the stock in the immediately preceding period and ε_t is a random error. Randomness requires that $E(\varepsilon_t) = 0$, $E(\varepsilon_t, \varepsilon_{t-s}) = \sigma^2_\varepsilon$ for $S=0$ and $E(\varepsilon_t, \varepsilon_{t-s}) = 0$ for $S \neq 0$. As such, the stock price change, log P_t - log P_{t-1} is equal to ε_t, which being white noise, is unpredictable from previous stock price changes.

The most obvious and important consequence of the model is that the best predictor of tomorrow's stock price is today's stock price. This, is in turn, implies that the expected gain or loss for any holding period is zero. A further implication of the model is that the stock price series does not contain any purely cyclical or other deterministic components, such as a seasonal pattern or trend.

Methodology

The objective here is to introduce some tests of the random walk hypothesis. These tests include a zero mean check, tests of serial independence, tests for a unit root, a normal distribution test and a test for linearity.

Zero-mean Check

We initially test whether stock price changes have zero mean. The most frequently used sample mean t-test will be used for this purpose. The t distribution formula is given by

$$t = \frac{\bar{x} - \mu}{s / \sqrt{n}} \qquad (2)$$

Where x is the sample mean, μ the (unknown) population mean, s is the standard deviation of the population or sample, n is the number of observations and $s/\sqrt{n}$ is the standard error of the mean.

The calculated t statistic is said to be significant if its value lies in the critical region. Hence, the zero mean null hypothesis cannot be rejected if the calculated absolute t value is below the critical value for a given significance level. A zero mean on its own does not, however, imply that log prices follow a random walk.

Tests of Serial Independence

Another requirement of the random walk is that successive differences in the logarithm of stock prices are independent random variable. If the independence property does not hold for the stock price series, its past history can then be used to make successful predictions of future behaviour. Five measures of dependence are used to test for autocorrelation among stock prices.

The first measure tests if individual correlation coefficients are significantly different from zero. Let $\varepsilon_1, \varepsilon_2, \varepsilon_3, \ldots, \varepsilon_n$ be any time series. The serial correlation coefficient r_k of lag k may be defined as

$$r_k = \frac{1/(n-k)\sum_{i=1}^{n-k}[\varepsilon_i - 1/(n-k)\sum_{i=1}^{n-k}\varepsilon_i][\varepsilon_{i+k} - 1/(n-k)\sum_{i=1}^{n-k}\varepsilon_{i+k}]}{\{1/(n-k)\sum_{i=1}^{n-k}[\varepsilon_i - 1/(n-k)\sum_{i=1}^{n-k}\varepsilon_i]^2\sum_{i=1}^{n-k}[\varepsilon_{i+k} - 1/(n-k)\sum_{i=1}^{n-k}\varepsilon_{i+k}]^2\}^{1/2}} \tag{3}$$

If the distribution of ε_t has finite variance, then for large samples, the standard error of r_k may be computed as $[1\text{-}(n\text{-}k)]^{1/2}$. For a random walk series, the serial correlation at all lags is zero (i.e., $r_k = 0$ for $k = 1$ to n). To test if the sample correlation coefficients are statistically different from zero, we compare their values to their respective standard errors. If a coefficient is no more than two standard errors from zero, the null hypothesis that r_k is equal to zero cannot be rejected.

The next two measures, the Box-Pierce Q statistic and Ljung-Box Q* statistic, are used to test the joint hypothesis that all of the autocorrelation coefficients up to a certain order are zero.

Box and Pierce (1970) demonstrated that, under the null hypothesis, all serial correlations up to order n are zero, the portmanteau Q statistic is given by

$$Q = N\sum_{k=1}^{n} r_k^2 \tag{4}$$

Where N is the number of observations, n is the number of lags taken and r_k is the sample serial correlation coefficient at lag K. The Q statistic is distributed as chi-square with n degrees of freedom. The null hypothesis that the true autocorrelation coefficients $r_1, \ldots, r_k$ are not all equal to zero cannot be rejected if the calculated value of Q is greater than χ^2 with n degrees of freedom at, say, the 5% significance level. In other words, the null hypothesis of no serial correlation is rejected.

Ljung and Box (1978) provided an overall test to serial correlation that is believed to perform better in small samples. The Ljung-Box Q* is given by

$$Q^* = N(N+2)\sum_{k=1}^{n}(N-k)^{-1}r_k^2 \qquad (5)$$

The Q^* statistic is approximately distributed asymptotically as chi-square with n degrees of freedom. If the computed value of Q^* is greater than the critical value, the null hypothesis of serial independence is rejected.

Serial independence between different lags of stock price changes can be examined further by estimating the equation:

$$\Delta p_t = \text{constant} + u_t \qquad (6)$$

using ordinary least squares. Under the random walk hypothesis, the constant term should be insignificantly different from zero and the resultant residuals should be uncorrelated. To test this latter property, the residuals will be subjected to the Lagrange Multiplier (LM) test of serial correlation for various lags.

Finally, the non-parametric runs test can be used alternatively in cases when the stock price changes are not distributed normally. A run is defined as a sequence of consecutive stock price changes of the same sign. Clearly, for stock price changes there are three possible types of price change, positive, negative and zero, and therefore three possible types of run. Under the assumption of independence, the total expected number of runs of all three types for a stock price change may be computed as

$$m = [N(N+1) - \sum_{i=1}^{3} n_i^2] / N \qquad (7)$$

Where N is the total number of price changes and n_i is the number of price changes of each type. The standard error of m is

$$\sigma_m = \left\{ \frac{\sum_{i=1}^{3} n_i^2 [\sum_{i=1}^{3} n_i^2 + N(N+1)] - 2N\sum_{i=1}^{3} n_i^3 - N^3}{N^2(N-1)} \right\}^{1/2} \qquad (8)$$

For large values of N, the sampling distribution of m is approximately normal and the standardised variable may be written as:

$$Z = (R - m \pm 0.5) / \sigma_m \tag{9}$$

Where R is the total number of runs actually observed and the sign of the adjustment 0.5 is negative if $R>m$ and plus otherwise. Because the distribution of Z is $N(0,1)$, then the critical value of Z at the 5% level of significance is ±1.96.

Tests for Unit Roots

An implication of the random walk hypothesis is that a "unit root" component exists in the stock price series. To investigate this, four unit root tests are applied to the stock price index. The Augmented Dickey-Fuller (1979) ADF unit root test is performed by estimating the regression.

$$\Delta p_t = \alpha + \beta t + \gamma p_{t-1} + \sum_{i=1}^{m} \delta_i \Delta p_{t-i} + u_t \tag{10}$$

Where ΔP_t is the first difference of stock price index P_t and m is chosen to be large enough to ensure that u_t is white noise. For this purpose the Lagrange Multiplier (LM) test is employed to check whether the chosen m is sufficiently large. A time trend, t, is included only if its coefficient, β, is non-zero. The null hypothesis that P_t has a unit root (non-stationary) is supported if γ is insignificantly different from zero. However, the distribution of the t-test for γ is not standard, rather, it is that given by Fuller (1976).

The calculation of the Phillips-Ouliaris (Phillips, 1987) $\hat{Z}_a$ and $\hat{Z}_t$ test statistics requires the estimation of the auxiliary regression.

$$p_t = \alpha\, p_{t-1} + v_t \tag{11}$$

The $\hat{Z}_a$ statistic is calculated according to the following formula

$$\hat{Z}_\alpha = N(\hat{\alpha} - 1) - (1/2)(s_T^2 - s_V^2)(N^{-2} \sum_{2}^{N} v_{t-1}^2) \tag{12}$$

Where N is the number of observations and α is the estimated value of the coefficient α in the auxillary regression. For a window choice such as $W_{SK} = 1 - s/(k+1)$, S_v^2 and S_T^2 are calculated as follows

$$s_V^2 = N^{-1}\sum_{1}^{N} v_t^2 \qquad (13)$$

and

$$s_T^2 = N^{-1}\sum_{1}^{N} v_t^2 + 2N^{-1}\sum_{s=1}^{k} w_{sk} \sum_{t=s+1}^{N} v_t v_{t-s} \qquad (14)$$

The $\hat{Z}_t$ statistic is given by

$$\hat{Z}_t = \left(\sum_{2}^{N} u_{t-1}^2\right)^{1/2} (\hat{\alpha}-1)s_T - (1/2)(s_T^2 - s_V^2)\left[s_T\left(N^{-2}\sum_{2}^{N} v_{t-1}^2\right)^{1/2}\right]^{-1} \qquad (15)$$

The null hypothesis of unit root is not rejected if the calculated value of the test statistic is less than the critical value. The critical values are tabulated in Phillips and Ouliaris (1990).

The Variance Ratio test of the random walk hypothesis, which was developed by Lo and MacKinlay (1988), is robust with respect to heteroscedasticity and non-normal disturbances and is thought to be more powerful than the traditional Dickey-Fuller (1979, 1981) tests. The rationale behind the variance ratio test is the following. If the natural logarithm of a time series denoted P_t, is a pure random walk of the form:

$$p_t = \mu + p_{t-1} + \varepsilon_t \qquad (16)$$

then, the variance of its *K*- differences grows linearly with the difference *K* (that is, the variance increases proportionally with time). For example, the variance of annually sampled series must be 12 times as large as the variance of a monthly sampled series. Thus, if the series follows a random walk, it must be the case that the variance of the *k*- differences is *k* times the variance of the first differences:

$$\mathrm{var}(p_t - p_{t-k}) = k.\mathrm{var}(p_t - p_{t-1}) \qquad (17)$$

Therefore, a test of the random walk hypothesis is equivalent to testing the null hypothesis that (1/k) times the variance of the k'th-differences divided by the variance of the first difference, that is, the variance ratio, is equal to unity:

$$H_0 : (1/k)\,\mathrm{var}(p_t - p_{t-k}) / \mathrm{var}(p_t - p_{t-1}) = 1 \qquad (18)$$

In order to simplify this notation let us define:

$$(1/k)\,\mathrm{var}(p_t - p_{t-k}) = \sigma_k^2$$

and

$$\mathrm{var}(p_t - p_{t-1}) = \sigma_1^2$$

Thus, our null hypothesis of random walk becomes:

$$H_0 : \sigma_k^2 / \sigma_1^2 = 1 \qquad (19)$$

Therefore,if σ_k^2 / σ_1^2 turns out to be less than unity, then the price series must be stationary.

The measurement of the variance of the k'th-difference is subject to one source of bias. Fuller (1976) demonstrated that the estimator given in (18) will be biased when the mean of the variable is unknown and must be estimated. To correct for this bias, the variance of the k'th-difference must be multiplied by a factor, λ , which is given by

$$\lambda = (n-k) / \left[(n-k) - k + (k^2 - 1) / 3(n-k) \right] \qquad (20)$$

This correction generates unbiased estimates of the variance when the true process is a random walk.

Finally, the Sims (1988) unit root test which is based on Bayesian statistics is relatively more powerful in discriminating between a true and a near random walk. This test is based on the following equation:

$$(p_{t+1} - \mu) = \rho(p_t - \mu) + \omega_t \qquad (21)$$

Where μ is the long-run value of the stock price index and $\omega \sim (0, \sigma_\omega^2)$ is the error term which is independent of past values of p. Whether or not the stock price will revert to its long-run (mean) value over time depends on the autoregression coefficient, ρ. If 0 <ρ <1, then the stock price is me. . reverting, implying stationarity.

To perform this Bayesian test of the random walk, the γ statistic is computed as follows

$$\gamma = 2\log\left[\frac{1-\alpha}{\alpha}\right] - \log\left[\sigma_\rho^2\right] + 2\log\left[1-2^{1/n}\right] - 2\log\left[\Phi(\tau)\right] - \log\left[2\pi\right] - \tau^2 \quad (22)$$

Where $\tau = (1-\hat{\rho})/\sigma_p$ is the conventional t-statistic for $\rho = 1$, $\sigma_\rho = \sqrt{\sigma_w^2 / \sum p_t^2}$ is the standard error, $\Phi(\tau)$ is the cumulative distribution function for the standard normal distribution evaluated at τ and n is the number of periods per year (e.g. 4 for quarterly data). α is set by Sims at 0.80. The null hypothesis of random walk (ρ =1) is rejected if γ is significantly less than zero.

Alternatively, it is possible to test the random walk hypothesis by calculating (1-α^*) which is given by

$$(1-\alpha^*) = 1 - \frac{1}{\left[1+\exp\left\{\ln(\sigma_\rho) - \ln(1-2^{1/n}) + \ln(\Phi(\tau)) + (1/2)\ln(2\pi) + (1/2)\tau^2\right\}\right]} \quad (23)$$

The value of (1-α^*) must be close to one in order to reject the random walk hypothesis.

Normal Distribution Test

Detection of non-normality in the stock price change series calls for caution to be exercised when applying standard statistical methodology to make inference about weak-form efficiency. To test if the stock price changes are normally distributed, regression (7) is again estimated using ordinary least squares. A test of normality that is based on the examination of skewness and kurtosis is then applied to the residuals of the equation (Bera and Jarque, 1982). If the residuals turn out to be normally distributed, then the stock price changes will also be normally distributed.

Testing for Non-Linearity

In the preceding parts of this section, tests of serial independence and unit root tests were described. However, finding a unit root and uncorrelated stock price changes does not imply independence, and some non-linearity may remain undetected under these tests. In the stock market under investigation, which is characterised by thin trading, it is quite conceivable that some form of non-linear structure is present and it is of interest to test whether this is, in fact, the case.

The BDS statistic, proposed by Brock, Dechert and Scheinkman (1987) provides a statistical test of non-linearity within a time series, based upon the correlation dimension (Grassberger and Procaccia, 1983). Brock et al. (1987) show that for a time series which is independently and identically distributed (iid), the BDS statistic is asymptotically N(0,1). Let

$$W_m(\varepsilon) = \frac{\sqrt{n}\{C_m(\varepsilon) - C_1^m(\varepsilon)\}}{\sigma_m(\varepsilon)} \qquad (24)$$

Where $C_m(\varepsilon)$ represents the fraction of all m-tuples in the series which are 'close' to (within ε of) each other and $\sigma_m(\varepsilon)$ is an estimate of the standard deviation. $W_m(\varepsilon)$ is the BDS statistic and provides a formal test of non-linearity. Under the null hypothesis of iid, $W_m(\varepsilon) \sim N(0,1)$. If the series is iid then the first difference of the series is also iid. However, if non-linearity is detected in the series, this implies a violation of the iid assumption, and we will try to determine the nature of this non-linearity. We show that this may be achieved by fitting a GARCH-M (1,1) model to the stock price changes:

$$\Delta p_t = a_0 + \delta h_t^2 + \varepsilon_t \qquad \varepsilon_t|\Omega_{t-1} \sim N(o,h_t^2) \qquad (25)$$

$$h_t^2 = b_0 + b_1 h_{t-1}^2 + b_2 \varepsilon_{t-1}^2 \qquad (26)$$

The standardised residuals from this model are then subjected to the BDS tests in order to determine whether there remains any unexplained non-linear structure .

Data and Empirical Results

The sample data set used in this study consists of 205 weekly values of the Al-Shal composite index of Kuwaiti stock prices[2]. The sample covers the period 27 August 1986 to 1 August 1990. With the exception of the Dickey-Fuller, the Phillips-Ouliaris, the variance ratio and the Sims tests, the series of tests described in the previous section are performed on first differences of the natural logarithms of the stock price index. The Dickey-Fuller and Phillips-Ouliaris tests are performed on both the levels and first difference of the series, while the Sims and the variance ratio tests are applied to the levels only.

Table 1 reports the empirical results of the zero mean test and the descriptive statistics of the first differences of the logarithms of the stock price index. The descriptive statistics indicate that the distribution of stock prices changes is clearly skewed to the right as it has a relatively high and positive value for the coefficient of skewness. In addition, the kurtosis of the distribution of the Kuwaiti stock price changes (7.4350) is more than twice that of the normal distribution (3.0), indicating that the distribution is leptokurtic, i.e., the distribution is more peaked and has longer tails and narrower shoulders than the normal distribution. Finally, since the t-value of 0.0348 is less than the critical value, both at the 5% and 1% levels, it is concluded that the null hypothesis of a zero mean cannot be rejected.

Table 1
Zero Mean Test for Weekly Stock Price Changes

Sample Size	204
Minimum	-0.066845
Maximum	0.12022
Mean (μ)	0.00005187
Standard Deviation	0.021267
Skewness	1.6969
Kurtosis	7.4350
t ($\mu = 0$)	0.0348
Critical Value	
at 5% level	$\pm$ 1.97
at 1% level	$\pm$ 2.59

Table 2 reports the results of testing for serial correlation in the stock price change series using the autocorrelation function, the Box-Pierce, the Ljung-Box and Lagrange Multiplier tests. The results of all these tests were highly consistent, indicating the non-existence of serial correlation across all but the first lag. For lag four, all tests indicated the non-existence of serial correlation except for the auto correlation function test.

Table 2
Parametric Tests of Serial Correlation in the Kuwait Stock Price Change Series

Lag	r_k	(±) 2 S.E.	Box Pierce (Q)	Ljung Box (Q*)	LM
1	0.143*	0.140	4.17*	4.23*	4.20*
2	-0.028	0.142	4.33	4.40	4.68
3	0.041	0.142	4.67	4.74	5.25
4	0.145*	0.142	8.95	9.15	8.84
5	0.036	0.146	9.21	9.42	8.84
6	-0.073	0.146	10.30	1.055	9.85
7	-0.125	0.146	13.49	13.89	12.68
8	-0.058	0.148	14.17	14.60	13.28
9	-0.046	0.148	14.60	15.06	13.64
10	-0.073	0.158	15.69	16.22	13.96
11	-0.099	0.150	17.69	18.36	14.43
12	-0.110	0.150	20.15	20.99	15.65

* Significant at the 5% level.

Table 3 displays the results of the non-parametric runs test of serial independence. Unlike the serial correlation tests used earlier, this test is not based on the assumption of normality. The table shows that the Z value for stock price changes is -1.3330, which is greater than the critical value of -1.960, and thus the successive stock returns appear to be independent at the 5% level. The overall evidence of testing for serial independence suggests that Kuwaiti stock returns follow a random walk.

Table 3
Runs Test of Serial Independence in the Stock Price Change Series

N	204
n(+)	87
n(-)	117
n(0)	0
Total expected runs, m	100.79
Total actual runs, R	91
Standard Error, σ_m	6.9690
Z	-1.3330
Critical Value	
at 5% level	±1.960
at 1% level	±2.576

Table 4 reports the results of the Dickey-Fuller and Phillips-Ouliaris unit root tests on the levels and first difference of Kuwaiti stock price series. Stock prices series are non-stationary (have a single unit root) in levels and stationary [(i.e., I(0)] in first differences - results which are consistent with the random walk hypothesis.

The results of estimating a regression of the change in the stock price index on a constant along with Bera-Jarque (1982) test of normality are shown below

$$\Delta p_t = \underset{(0.03)}{0.0001} + u_t$$

$$\chi^2(2) = 567.78$$

The extremely large value of the test statistic confirms the findings of the analysis of skewness and kurtosis that the Kuwaiti stock price changes are not normally distributed. Accordingly, the results of the majority of tests performed earlier should be interpreted with caution.

Table 4
Testing for Unit Root in the Kuwaiti Stock Price Index Series

Test Statistic	Level	First Difference
ADF (m)	-2.46(0)	-12.23(0)*
LM(12)	16.67	12.31
$\hat{Z}_{\alpha}$	-13.50	-146.57*
$\hat{Z}_{t}$	-2.65	-12.15*

* significant at the 5% level.

Table 5 presents the results of the variance-ratio test of a unit root for several different lags. Almost all the variance ratios reported in the table are not significantly greater than unity at the 5% level. This indicates that Kuwaiti stock prices contain a dominant stationary component and a small random walk component. This property can also be seen in figure 1 which plots the variance ratios against the lag. The figure clearly indicates that the variance ratios are decreasing at almost all lags. One implication of the random walk is that variance ratios are exploding over time. These findings imply that the stock price series is not a random walk. These findings are also confirmed by the results of the Sims (1988) unit root test. As can be seen from table 6, the value (1-a*) is close to unity, while γ assumes a negative value. These results imply that the null hypothesis ($P = 1$) is rejected, i.e., the Kuwaiti stock price index does not follow a random walk.

The results of applying the BDS test to the Kuwaiti stock price change series are presented in table 7. The calculated test statistics are quite high, indicating that the null hypothesis of independently and identically distributed stock price changes is rejected at the 5% level. This finding suggests that there are non-linear effects in the series.
The results of fitting a GARCH-M (1,1) model to the first difference of the stock price series are shown below.

$$\underset{}{\Delta p_t} = \underset{(-0.3337)}{-0.0007} - \underset{(-0.004)}{1.4964 h_t^2}$$

$$h_t^2 = \underset{(0.008)}{0.0000019519} + \underset{(16.189)}{0.68965 h_{t-1}^2} + \underset{(0.008)}{0.01509 \varepsilon_{t-1}}$$

Table 5
Testing for Unit Root in the Kuwaiti Stock Price Index Series

K	σ^2_k / σ^2_1	5% Critical Values	K	σ^2_k / σ^2_1	5% Critical Values
2	1.151168*	1.129	50	0.634329	2.438
4	1.222485	1.258	52	0.606443	2.457
6	1.380837*	1.347	54	0.577064	2.4991
8	1.412542	1.432	56	0.567701	2.537
10	1.390846	1.502	58	0.53943	2.584
12	1.326306	1.562	60	0.520189	2.621
14	1.242646	1.625	62	0.47762	2.610
16	1.199697	1.686	64	0.427467	2.613
18	1.153046	1.736	66	0.389644	2.643
20	1.134548	1.775	68	0.389446	2.683
22	1.130817	1.826	70	0.402334	2.740
24	1.146579	1.867	72	0.428700	2.788
26	1.151345	1.927	74	0.519261	2.774
28	1.147904	1.979	76	0.622214	2.773
30	1.098418	2.032	78	0.706184	2.804
32	1.020000	2.076	80	0.695688	2.828
34	0.941731	2.096	82	0.604186	2.796
36	0.858523	2.098	84	0.456124	2.809
38	0776359	2.161	86	0.327768	2.784
40	0.719887	2.224	88	0.228331	2.674
42	0.687386	2.241	90	0.148662	2.603
44	0.665567	2.293	92	0.090272	2.527
46	0.655675	2.337	94	0.050396	2.421
48	0.636445	2.365	96	0.024988	2.239

$H_0 : \sigma^2_k / \sigma^2_1$ is equal to 1

Figure 1
Variance Ratios of Kuwaitis Stock [illegible]

Table 6
Testing for Unit Root

ρ	0.94277
σ_ρ	0.023310
τ	2.4551694
$\Phi(\tau)$	0.9929
n	1
Sims $(1-\alpha^*)$	0.703
Sims γ	-7.223

The t-statistic of the estimated coefficient of h^2_{t-1} is quite high indicating that the stock price changes series is characterised by a volatility that is reflected in heteroscedasticity.

Table 7
BDS tests on the Kuwait stock price changes

ε	M				
	2	3	4	5	6
0.217886	3.696*	3.790*	3.810*	3.917*	4.006*
0.140978	3.194*	3.543*	3.745*	3.919*	4.171*
0.091217	2.980*	2.808*	3.157*	3.582*	4.159*
0.059020	2.893*	2.950*	3.623*	5.069*	6.157*

*Significant at the 5% level.

Table 8 reports the results of performing the BDS test on the standardised residuals of the GARCH-M-(1,1) model. As can be seen from the table, almost all the test statistics were insignificant at the 5% level. This finding confirms that the conditional heteroscedasticity in the GARCH model is indeed the source of non-linearity in the series.

Table 8
BDS tests on Standardised Residuals

ε	M				
	2	3	4	5	6
0.272355	0.225	-0.122	0.066	0.142	0.116
0.135200	-0.273	-0.610	-0.298	-0.259	-0.133
0.067115	0.489	0.611	1.180	2.112*	3.647*

*Significant at the 5% level.

Conclusion

This paper applies traditional as well as modern testing methods to investigate the weak-form efficiency in the Kuwaiti stock market. Like much previous research, this study failed to reject the random walk hypothesis when traditional statistical tests were used. However, when the distribution of the sample data was examined it turned out to be significantly non-normal. As such, the results of the majority of traditional tests are highly misleading. In contrast, when relatively modern measures like the variance ratio, the Sims and BDS tests are employed, then the random walk hypothesis is easily rejected. The results of the study also indicate the presence of some non-linear structure within the stock price series. Finally, it is concluded that a more complicated model, such as GARCH-M (1,1) is more appropriate for the Kuwaiti stock market than a simple random walk.

Footnotes

1. For a detailed description of the operational and institutional backgrounds of the Kuwaiti stock market see Gandhi *et al.* (1980), Butler and Malaikah (1992).

2. Al-Shals stock price index is calculated in a fashion similar to that of Standard and Poors according to the following formula:

$$SPI_t = \frac{(P_t \times S_t) \text{ for sector X} + (P_t \times S_t) \text{ for sector Y} + \ldots\ldots\ldots}{(P_b \times S_b) \text{ for sector X} + (P_b \times S_b) \text{ for sector Y} + \ldots.} \times 100$$

Where

SPI_t : stock price index at time t,

P_t : stock price at time t,

P_b : Stock price at base day,

S_t : number of shares outstanding at time t,

S_b : number of shares outstanding at base day.

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التعاون

مجلة فصليــة فكـريـة شاملة محكَّمـة تصـدر عن الشئـون الاعـلامية
بالامــانــة الـعــامــة لمجلس الـتـعــاون لدول الخليــج العــربيــة

صدر العدد الأول في ربيع الآخر ١٤٠٦هـ - يناير ١٩٨٦م

- تخدم قضايا دول المجلس واهتماماتها الاقليمية والعربية بصورة عامة.
- تقبل الدراسات والبحوث والمقالات المعمقة ذات الصلة بهذه القضايا في جميع المجالات السياسية والاقتصادية والاجتماعية والثقافية والاعلامية.
- تشمـل على بحث أو دراسـة محكمـة تثرى بتعليقـين لباحثـين متخصصين، اضافة الى الابواب الثابتة الأخرى تحت عنوان/ آراء ووجهـات نظر/ تقارير/ وثائق/ عرض كتب/ اصدارات الامانة العـامـة/ يوميـات مجلس التعـاون/ ببليـوغـرافيا مجلس التعاون/ احصاءات مجلس التعاون.

يحررها نخبة من الباحثين والمتخصصين

كما يمنح المشارك مكافأة مالية وفق نظام المكافآت الخاصة بالمجلة.

المشرف العام

الدكتور / عبدالله الجاسر

الامانة العامة - ص.ب ٧١٥٣ الرياض ١١٤٦٢ هاتف ٤٨٨٠٤١٢