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RE-EXAMINE THE WEAK FORM MARKET EFFICIENCY

THE CASE OF AMMAN STOCK EXCHANGES

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Abstract

This research examines the weak form of efficient market hypothesis on Amman stock exchanges (ASE); investigates the random walk hypothesis to determine the validity of the weak form efficiency. For this parametric test of serial correlation and non-parametric tests (run test, length of run test and a variance ratio test) are used. The statistical tests are conducted for full sample period from 1999 to 2016. The collection period for this study is the daily closing prices for the ASE in which daily reports from 1 January 1999 to 31 December 2016, Excluded holidays, in which provide 3914 daily closing prices. The empirical results of this study support previous studies that ASE inefficient at the weak form of efficiency. The fourth statistical test used supports the result in which authors reject random walk hypothesis for ASE.

Keywords: Amman stock market, Efficiency, Weak form, Random walk hypothesis

INTRODUCTION

In the efficient stock market; stock prices should fully reflect any new information immediately without bias, for that stock price adjusted to be equal its intrinsic market value. No one can beat the market by monopolizing information to achieve a competitive advantage over other participants, and no one can determine a regular pattern in stock prices to obtain abnormally high. Otherwise, if the market mechanism handles the new information slowly, the stock prices will not respond to the new information immediately and there will be a trading rule in the stock market that could allow traders to use this information in order to generate abnormal profits. In this case, some stocks traders will buy stocks immediately after a company announces unanticipated 'good' news, or they will sell the stocks immediately after a company announces unanticipated 'bad' news. After a period, stock prices will eventually fully reflect the news, allowing stock traders to trade in the opposite way to gain profits (Fama, 1970).

The vital assumption for a perfectly efficient stock market is that the market equilibrium prices should be independent of the distribution of existing information between market participants. Thus, all factors that drive market participants to value stocks differently are treated as insignificant issues, as all participants have the same information and all of them are trying to maximize their profit according to the information set. Under this assumption, there are several conditions, according to Fama (1970): no transactions cost, all relevant information is freely and easily available to all market participants, all market participants are the same in their preference for profit maximization, risk aversion and appropriate knowledge of the market.

The level of efficiency in the market is determined by the degree of accuracy, as analyzed through statistical testing. Moreover, if the market participants made less effort gathering and analyzing the market information, the stock prices would not reflect the accurate prices, resulting in a reduction in the level of efficiency in the market (Boudreaux, 1975).

Worthington and Higgs (2003) examined market efficiency in European equity markets for daily returns for sixteen developed markets (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom) and four emerging markets (Czech Republic, Hungary, Poland and Russia). The results of the tests of serial correlation are in broad agreement and conclusively reject the presence of random walks in daily returns for all markets save Germany, Ireland, the Netherlands, Portugal and the United Kingdom. The multiple variance ratio procedure rejects the random walks in most European markets; only Germany, Ireland, Portugal, Sweden and the United Kingdom are random walk markets. Among the emerging markets, only Hungary is a random walk market. The results of this analysis are consistent with the view that emerging markets do not follow the random walk hypothesis, which is required for the assumption of weak form market efficiency. In Middle East and North Africa (MENA) markets, Azzam (1997), Darrat and Hakim (1997) and El-Erian and Kumar (1995) suggest that these markets have three main characteristics:

- Stock markets in these countries are sensitive to the country's political changes.
- Stock markets in these countries have considerable growth potential.
- These markets need to develop structural relations with major foreign and regional stock markets.

Furthermore, Harvey (1995) reported that developing markets have high average returns, low overall volatility, low exposure to world risk factors, and little integration. He concludes that these markets are less efficient than developed markets. Nevertheless, Darrat and Zhong (2000) mentioned that established research has shown that low-volume, thinly traded markets are inappropriate for testing efficiency since the lack of liquidity and poor provision of smooth transfer of information cause inefficiency in these markets.

Omet et al. (2002) examined the random walk hypothesis and weak-form efficiency of the Amman Stock Exchange, for the period 1992–2000, using the AR(1)-GARCH(1,1)-M model. The results indicate that the Amman Stock Exchange is not weak form efficient. On the other hand, Karemera et al. (1999) examined the random walk hypothesis and weak form efficiency of several emerging markets including the Amman Stock Exchange. Using multiple variance ratio and runs tests, the results show that the Amman Stock Exchange follows the RWH and weak form efficiency. The difference in findings between Omet et al.'s (2002) study and Karemera et al.'s (1999) study can be attributed to both the different time spans and different tests used.

A comprehensive review of the literature illustrates that, even when one sort of test (serial correlation coefficient test, runs test, variance test, GARCH test, etc.) fails to reject the random walk hypothesis, the others may actually reject it. When the main sample data follow the random walk hypothesis the sub-samples may not follow the random walk hypothesis. Therefore, applying a variety of tests to different types of data and comparing the results on the bases of similar sorts of data and tests implemented improves the accuracy of a study.

METHODOLOGY

In this study we combined the period before the recent financial crisis (1999 to 2007) with the period within and after financial crisis (2007 to 2016) in order to identify whether rational investors in the ASE do outbalance the irrational ones. The collection period for this study is the daily closing prices for the ASE in which daily reports from 1 January 1999 to 31 December 2016, Excluded holidays, in which provide 3914 daily closing prices. Returns were calculated as the first differences in the natural logarithms of the stock market prices.

Table 1: Descriptive Statistics of Daily Returns

Sample Period	Number of Observations	Mean	Std. Deviation	Skewness	Kurtosis
01/01/1999 to 31/12/2016	3912	0.0005139	0.00914534	0.114	4.405

Lehmann and Romano (2005) show that, asymptotically, t-statistics are relatively insensitive to non-normality. Thus, both statistics are valid regardless of the underlying distribution. This does not imply, however, that the t-statistics will necessarily have more power than other statistics because, as Lehmann notes, the t-statistic is optimal only when the underlying sample distribution is normal. As a result, when the underlying sample distribution is non-normal, the performance of the t-statistic becomes an empirical question.

Runs Test

This study utilizes the Wald-Wolfowitz (1940) runs test to test for the randomness of the series..Given a sequence of observations, the runs test examines whether the value of one observation influences the values taken by later observations. If there is no influence (the observations are independent), the sequence is considered random. For example, the sequence "+ + + + - - - - + + + - - + + + + + + - - -" consists of six runs, three of which consist of +'s and three of −'s.

The runs test is based on the null hypothesis that the two elements + and - are independently drawn from the same distribution. Under the null hypothesis, the number of runs in a sequence of length N is a random variable whose conditional distribution given the observation of N+ positive values and N− negative values (N = N+ + N−) is approximately normal. The expected number of runs is calculated as follows:

$$E(R) = \frac{2 * N_1 * N_2}{N} + 1$$ Equation 1

Where:

N_1 : Number of positive changes taken into account length of runs

N_2 : Number of negative changes taken into account length of runs

N: Sum of N_1 and N_2

In addition, standard deviation is calculated as follows:

$$\sigma_R = \sqrt{\frac{2 * N_1 * N_2 * (2 * N_1 * N_2 - N)}{N^2 * (N - 1)}}$$ Equation 2

The test statistics Z for the runs test is used as follows:

$$Z_1 = \frac{R_1 - E(R)}{\sigma_R}$$ Equation 3

Serial Correlation Test

In finance, this correlation is used by technical analysts to determine how well the past price of a security predicts the future price. Fama (1965) recommends that the most direct and intuitive test for a random walk in a time series is to check for serial correlation. Serial correlation tests are used to further examine the ASE for a random walk. The statistical significance of any first order serial correlation is identified using t-tests. Serial correlation tests with a lag of up to 5 were examined. Serial correlation is calculated as:

$$\alpha_k = \frac{\sum_{t=k+1}^{n}\left(Y_t - \bar{Y}\right).\left(Y_{t-k} - \bar{Y}\right)}{\sum_{t=1}^{n}\left(Y_t - \bar{Y}\right)^2}$$

Equation 4

Where:

Y_t : is the current rate of return.

$\bar{Y}$: is the mean rate of return,

K: is the number of lags.

T-tests are estimated by:

$$t_I = \frac{\alpha_k.\sqrt{n-2}}{\sqrt{1-\alpha_k^2}}$$

Equation 5

The serial correlation (or autocorrelation or lagged correlation) tests the relationship between returns in the current period and those in the previous period. If no significant correlation is found, the series is assumed to follow a random walk. If the serial correlation is significantly positive, it means that a trend exists in the series, and that future observations are affected by past values. Essentially, a variable that is serially correlated has a pattern and isn't random. whereas a negative serial correlation indicates the existence of a reversal in price movements.

Variance Ratio Test

The variance ratio test (VR) a technique for comparing the spreads or variability of two sets of figures to determine whether the two sets of figures were drawn from the same population. Also known as F test. the Lo and MacKinlay (1988, 1989) overlapping variance ratio test, examines the predictability of time series data by comparing variances of differences of the data (returns) calculated over different intervals. If we assume the data follow a random walk, the variance of a q-period difference should be q times the variance of the one-period difference. Evaluating the empirical evidence for or against this restriction is the basis of the variance ratio test.

According to Lo and MacKinlay (1989), the main theme of VR is: "*that if a stock's return is purely random, the variance of k-period return is k times the variance of one-period return. Hence, the VR, defined as the ratio of 1/k times the variance of the k-period return to the variance of the one-period return, should be equal to one for all values of k.*"

The VR test is based on the idea that if the logarithm of a stock price follows a random walk then the variance of the return over k period must be equal to($k \cdot \sigma^2$). The variance ratio of q-differenced series is given by:

$$VR(q) = \frac{\sum \sigma^2 c(q)}{\sum \sigma^2 a(q)}$$ Equation 6

Where:

- The numerator is an unbiased estimator of 1/q of the variance of the qth differenced series.
- The denominator is an unbiased estimator of the first-differenced series.

The standard test statistic is:

$$Z(q) = \frac{VR(q) - 1}{[\theta\theta(q)]^{1/2}}$$ Equation 7

With

$$\theta(q) = \frac{[2(2q-1)(q-1)]}{[3q(nq)]}$$ Equation 8

A refined test statistic, Z*(q) which adjusts for heteroscedasticity proposed by Lo and McKinley (1989), is:

$$Z^*(q) = \frac{VR(q) - 1}{[\varphi^*(q)]^{1/2}}$$ Equation 9

Where:

$$\varphi^*(q) = \sum_{j=1}^{q-1} \left[\frac{2(q-j)}{q} \right] \delta(j)$$ Equation 10

And:

$$\delta(j)=\frac{\sum_{t=j+2}^{nq+1}\left(p_t-p_{t-1}-\mu\right)^2\left(p_{t-j}-p_{t-j-1}-\mu\right)^2}{\left[\sum_{t=2}^{nq+1}\left(p_t-p_{t-1}-\mu\right)^2\right]^2}$$ Equation 11

Both Z(q) and Z*(q) are asymptotically distributed with mean zero and unit standard deviation.

Length-of-Runs Test (Chi-Square Test)

A chi-square test also written as χ2 test is used to test if a sample of data is derived from a population with a specific distribution and is used to examine whether a series follows this type of random walk by using the following equation:

$$\chi^2=\sum\left(Q_i-E_i\right)^2/E_i$$ Equation 12

Where:

χ^2 : is the chi-square test

Q_i : is the observed frequency count for the ith lagged of returns.

E_i : is the expected frequency count for the ith lagged of returns.

And:

$$E_i=n\times p_i$$ Equation 13

Where:

p_i : is a proportion of population with value i.

n: is the number of observations in the sample.

RESULTS AND DISCUSSION

Table 2 compares the actual runs with the expected runs, the results show that, the total number of runs (actual number of runs) varies from the expected number of runs. The results of these differences are statistically significant.

Table 2: Comparing Actual Runs with Expected Runs of Daily Returns

	1999–2016
Total runs	2393
N1 (positive returns)	1959
N2 (negative returns)	1955
N (total returns)	3914
E (R)	1957

Table 3 below compares the observed runs with expected runs for each length. The result shows that, the expected number of runs is different from the observed number of runs for all the lengths. Furthermore, for the 1st , 2nd length, the expected number of observations is greater than the observed number. For the 3rd, 4th and 5th lengths, the observed number is greater than the expected number.

Table 3: Length-of-Runs Test of Daily Returns

Length-of-Runs Test		
	1999–2016	
Run Length	Expected	Observed
1	1631.33	1329
2	717.51	714
3	206.49	270
4	45.01	58
5	9.29	22

Table 4 below shows the VR based on weekly returns of the ASE. In addition, it shows the corresponding z statistics for the null hypothesis that the ratio has a value of 1. If the value supports the random walk hypothesis, the VR (q) has a value close to 1 for values of q assigned.

Table 4: Variance Ratio and Z Statistics of Weekly Returns

	1999–2016	
VR(q)	Value	Z-Test
2	0.82793	-0.5317
4	0.513	-0.8044
8	0.65706	-0.3583
16	0.03087	-0.6804

The result shows that, the VR (q)s have values not close to 1, leading to the rejection of the null hypothesis for the three samples. The z statistics confirm the result obtained from the variance ratio tests. Overall, the results obtained from variance ratio tests confirm that the ASE does not follow a random walk for VR (2), VR (4), VR (8) and VR (16) at 95% confidence.

To summarize, on the basis of the non-parametric tests (runs test, length-of-runs test and variance ratio test), the returns of the ASE during the period 1999–2016 moved contrary to the RWH, with 95% confidence.

This finding is consistent with other studies of emerging markets such as that of Abraham et al. (2002), which examined the random walk of three major Gulf stock markets (Kuwait, Saudi Arabia and Bahrain) using the VR and runs tests for the period 1992–1998. They rejected the random walk hypothesis for the three markets. They asserted that infrequent trading is widespread in most emerging markets and this could cause rejection of the RWH. However, even after they corrected the data for thin trading in the three markets, the Kuwaiti market still did not follow a random walk, although the Saudi and Bahraini markets did.

Table 5 below presents the serial correlation for the first lag and the statistical significance of any first order serial correlation.

Table 5: Serial Correlation Test of Daily Returns

Serial Correlation Test	
	1999–2016
Serial Correlation of 1st lag	0.203301411
t test	14.24235307
Critical Value	+/- 2.62

The results show that, the serial correlation of the 1st lag is different from zero. The null hypothesis of no correlation between the return in time *t* and the return in time *t*-1 with 99% confidence is rejected. The result shows a positive serial correlation, which indicates that a trend exists in the series.

This finding is consistent with other studies of emerging markets such as that of Poshakwale (1996); he examined the random walk hypothesis in the context of the India Stock Market, using the serial correlation and runs tests for the period 1987–1994. He found that the India Stock Market does not follow the RWH.

Omran and Farrar (2006) investigated the validity of the RWH in five major Middle Eastern emerging markets (Egypt, Morocco, Turkey, Jordan and Israel) from January 1996 to April 2000; they tested for serial correlation over time between returns based on 6, 12 and 24 lags using a Box-Pierce test. They found highly significant autocorrelation with 99% confidence at all lags for Egypt and Morocco, implying that the series is not completely random. However, for Turkey, Jordan and Israel they could not reject the null hypothesis that the series is random with 90% confidence.

Their findings in Jordan are not consistent with the finding in this research; this could possibly have occurred because they did not examine the first lag, as the first lag produced the strongest evidence of correlation. Furthermore, El-Erian and Kumar (1995) examined the random walk for Jordan and Turkey. Their results show highly significant first-order serial correlations for both Jordan and Turkey.

However, in Jordan, it is possible that autocorrelations in stock returns may result, for example, from infrequent trading (Poterba and Summers, 1988). Hence, rejection of the RWH does not necessarily imply that these markets are not weak form efficient.

On the basis of the parametric test of serial correlation it can be concluded that the returns of the ASE during the period 1999–2016 indicate that the market does not follow a random walk. This is a confirmation of the results from the non-parametric tests (runs test, length-of-runs test and VR test).

CONCLUSION

In a practical sense, the EMH has been built under the assumption that rational investors dominate the stock market; even if it does not require all investors to be rational, it does require that the rational investors outbalance the irrational ones.

In our discussion on the weak-form EMH, we stated that the weak-form EMH assumes that the rates of return on the market are independent. Given that assumption, the tests used to examine the weak form of the EMH test for the independence assumption. The autocorrelation tests (returns are not significantly correlated over time) and runs tests (stock price changes are independent over time). Another point we discussed regarding the weak-form EMH is that past returns are not indicative of future results, therefore, the rules that traders follow are invalid.

The results of parametric and non-parametric tests have shown that the ASE does not follow a random walk. This finding highlights that the rational investors in the ASE do not outbalance the irrational ones, especially when the 1^{st} lag serial correlation was found. The irrational investors manipulate the stock market prices to obtain abnormal returns. This is particularly so for the results obtained from the variance ratio, which confirm that the ASE does not following the random walk for VR (2), VR (4), VR (8) and VR (16) at 95% confidence, indicating that there are trading patterns using previous trading prices in the ASE. This may allow market traders who know this information and have experience of Jordanian firms to set stock prices above or below their fundamental value, resulting in an inefficient market. Therefore, further research should focus in market anomalies and the profitability of trading rules in ASE.

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