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Testing the Weak Form of Efficient Market Hypothesis: Empirical Evidence from Jordan

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Abstract
Efficient Market Hypothesis (EMH) implies that the future price of a stock is unpredictable with respect to currently available information; our study conducted in order to test efficiency of the Amman stock market (ASE) returns at the weak-form, by using daily observations for the Amman Stock Exchange. Parametric and nonparametric tests e utilized for examining the randomness of stock prices for ASE. The Jarque-Bera test show evidence for normality that the daily returns of the ASE are not normally distributed, and the runs tests both detect that the daily returns are inefficient at the weak form. In addition, the unit root tests (Augmented Dickey-Fuller (ADF) unit root test and Phillips-Peron (PP) unit root test) suggest the weak-form inefficiency in the return series. In general, we can conclude that the ASE stock market is inefficient at the weak form level.

Key words: Weak-form efficient market hypotheses; Runs test; Unit root tests

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INTRODUCTION

Efficient market hypothesis (EMH) has been a lot of the discussion in the financial literature because of its important implications; EMH firstly developed by Paul Samuelson (1965) and Fama (1970).

And both researchers point out that the EMH assumes that share price adjust rapidly for any new information consequently, the current prices fully reflect all available information's and should follow a random walk process, which means sequential stock price changes (returns) are independently and identically distributed (IID).

Fama (1970) published a reassessment of efficient market hypotheses theory with an empirical base, and distributed market efficiency into three levels based on information: weak, semi-strong and strong form.

Weak-form of efficient market hypotheses assumes that the current stock prices fully reflect all historical market information such as: (historical sequence of prices, trading volumes, and any market generated information).

Semi strong-form efficient market hypotheses, assumes that the current stock prices reflect not only the historical information but also new publicly available information such as: dividend announcements, and economic and political news. Third, the strong-form efficient market hypotheses assume that stock prices reflects all information from both public and private sources, so that no one investor can reap abnormal rate of return.

Regulatory authorities in all countries are looking in all times to the best policies in order to decrease the market interferences to the minimum level, EMH and random walk theory remained popular for the last decades. It is impossible to get any outstanding return unless if there is a gap between market information and efficiency. Academicians, investors and regulatory are willing to explore the behavior of stock prices, basis of risk return models. Finally if a stock market is inefficient, (the pricing system may not assure the efficient allocation of capital in an economy which effects negatively to the aggregate economy), Hamid and Akash (2010).

This study came to test the weak-form market efficiency of the stock market returns of Jordan by using daily observations for Amman Stock Exchange (ASE).

In order to conduct the test; parametric and nonparametric tests of Random Walk Model (RWM) that will provide clear evidence the efficiency of ASE at the weak level.

This study is, however, organized in six sections as follows: Section 2 literature review; section 3 data and methodology; Section 4 presents empirical results; and Section 5 reports conclusion.

1. LITERATURE REVIEW

Due to the huge implications of the EMH in the operations of financial markets is still constantly been examined, Over the years a number of researchers have examined the existence of the theory in various markets developed or undeveloped, and different results have been found.

Samuelson (1965) introduced the effective efforts in this field, by developed the theoretical framework of the Random Walk Model (RWM) that used to test the efficiency of capital market at the weak-level.

Fama (1970) suggest three models in order to testing the market efficiency, and defined a market as being efficient if prices fully reflect all available information's. Also Fama (1970) divided the empirical tests of the hypothesis into three forms based on the given information set, namely weak form, semi-strong form, and the strong form.

Granger (1975), Fama (1991), Lo (1997), Abeysekera (2001), and Groenwold et al. (2003), tested empirically the Random walk model and the weak form of EMH.

In order to test the efficiency at the weak-form several statistical techniques have been used such as runs test, unit root test, and spectral analysis.

For instance, Shamma and Kennedy (1997), Karemera et al. (1999), and Abraham et al. (2002) adopted run test, While Moorkerjee and Yu (1999), Groenwold et al. (2003), and Seddighi and Nian (2004) conducted both run test and unit root test in their studies.

A number of researcher's applied otherwise tests for market efficiency in the weak form the serial correlation test, including the correlation coefficient test, Q-test which is adopted by Dickinson and Muragu, (1994), Fawson et al. (1996), and Groenwold et al. (2003).

Also, Sharma and Kennedy (1977), and Fawson et al. (1996) used spectral analysis, and Seddighi and Nian (2004) used autoregressive conditional heteroscedasticity (ARCH) test.

The empirical evidence on developed markets confirming the weak-form efficiency of the EMH, for instance, Cootner (1962), Fama and Blume (1966), Williamson (1972), Nicolaas (1997), and Sungs and Johnson (2006).

In contrast, the empirical evidence conducting studies in emerging markets has been mixed results, between accept or reject the null hypothesis of weak form EMH. For instance, Dahel and Laabas (1999) reported that the Kuwait stock market is strongly support the weak form of EMH, and reject the weak form of the EMH for Bahrain, Kuwait, Saudi Arabia and Oman. Wheeler et al. (2002) not success to support the weak form of EMH for the stock market of Warsaw (Poland).

Also, Abeysekera (2001) and Abraham (2002) their empirical finding reject the hypothesis of weak form efficiency for stock markets in Sri Lanka, Bahrain Kuwait, and Saudi Arabia.

On the other hand, Karemera et al. (1999) strongly support the weak form of EMH for the stock market in Turkey.

However, the previous studies cannot give us a clear support for the weak form efficiency in emerging markets, and much work must be conduct to explore price dynamics in emerging markets. For our country, it is interesting to find if ASE is efficient at level weak form or not.

2. DATA AND METHODOLOGY

2.1 Data

The sample period for our study, span from Jan 2000 to Dec 2013 for 3441 observations, and the data set is comprised of closing daily return for stock market index of Amman Stock Exchange (ASE) weighted index.

The market returns calculated by the following formula:

$$r_t = Ln(P_t / P_{t-1}) \quad (1)$$

Where P_t represent the end-of-day closing price of the ASE index, P_{t-1} represent the previous day closing price.

3.2 Methodology

The market efficiency under the RWM (weak form EMH) reveals that historical prices cannot be used to predict future prices of a stock, Therefore the movements of a stocks price are independently and identically distributed (Fama, 1970). In the empirical works, in order to determine patterns in time series there are many techniques available. Under the RWH, a market is efficient at the weak form if most current prices fully reflect all information contained in past prices, and the form reveal that past prices cannot be used as a predictive tool for future stock price movements.

We employed econometrics methods which are used in the literatures to test the independence of prices data.

The problem is to see whether the stock prices is predictable or not by exploring serial dependence of stock returns, in order to test the random walk hypothesis (RWH) we used parametric and non-parametric methods, through employing three different procedures autocorrelation test, run test, and unit root tests.

3.2.1 Autocorrelation Function Test (ACF)

Firstly, in order to detect the random walk of the stock returns we employ autocorrelation function test (ACF).

Autocorrelation function (ACF) measures the correlation between the stock return at current period and its value in the previous period which given by:

$$\rho_k = \sum_{t=1}^{n-k}(r_t - r)(r_{t+k} - \bar{r}) / \sum_{t=1}^{n}(r_t - \bar{r})^2 \quad (2)$$

Where k is the number of lags, and r represents the real rate of return calculated as:

$$r_t = \ln\left(\frac{p_t}{p_{t-1}}\right) \times 100 = \alpha + \mu \quad (3)$$

We apply this test in order to identify whether the serial correlation coefficients are significantly different from zero or not, and in order to test the joint hypothesis that all autocorrelations are simultaneously equal to zero, The Ljung–Box (Q) statistic is used which given by:

$$Q_{LB} = n(n+2)\sum_{t=1}^{k}(\rho_t^2 / n - t) \quad (4)$$

ρ is the jth autocorrelation and n is the number of observation, under the null hypotheses of zero autocorrelation at the first k autocorrelations which is distributed as chi-sequared. $(\rho_1 = \rho_2 = ... = \rho_n)$

3.2.2 Unit Root Tests

Testing non-stationarity is necessary for random walk hypotheses, in this paper we used two unit root tests: (parametric) the Augmented Dickey-Fuller (ADF) (1979), and (nonparametric) Phillips-Peron (PP) unit root test (1988).

Firstly ADF test is based on the estimation on the following formula:

$$\Delta r_t = \alpha_0 + \alpha_1 r_{t-1} + \alpha_2 T + \sum_{i=1}^{n}\alpha_i \Delta r_{t-i} + \gamma_t \quad (5)$$

Where r_t = the time series; t= time trend; Δ= first difference operators; γ_t = error term with zero mean and constant variance. The null hypotheses of the unit root α_1=0. Phillips and Perron (1987) made a modification for Dickey-Fuller *t-statistic* with Z_t statistic, which allows for autocorrelation and conditional heteroscedasticity in error term of Dickey- fuller regression, which based in the following estimation. Campbell and MacKinlay (1997):

$$\Delta r_t = \alpha \ + \beta(r_{t-1}) + \varepsilon_t \quad (6)$$

The model can be give with the above specification of constant and trend, PP test ensures that the test results are potent in the existence of drifts and trends, and if auto correlation in the series under investigations is suspected the PP test is more appropriate.

3.2.3 Run Test

Run test is a nonparametric test for serial dependence in the stock Returns, which designed to examine whether or not an observed sequence is random. The run test, (also called Geary test, is a non-parametric test whereby the number of sequences of consecutive positive and negative returns is tabulated and compared against its sampling distribution under the random walk hypothesis) (Campbell et al. 1997; Gujarati, 2003). A run: Is the frequent occurrence of the same value of a variable.

Stock return runs can be negative, positive, or have no change, the length is number of times a run type occurs in succession. Under the null hypothesis that sequential outcomes are independent, the total expected number of runs distributed as normal with the following mean (Gujarati, 2003):

$$\mu = N(N+1) - \sum_{i=1}^{3} n_i^2 \Big/ N \quad (7)$$

N: is the total number of observations, and n_i is the number of price changes (returns) in each category.

When the observation larger than 30 observations the sampling distribution of μ is approximately normal and the standard error of $\mu(\sigma\mu)$ is given by:

$$\sigma_\mu = \left[\sum_{i=1}^{3}\left[\sum_{i=1}^{3} n_i^2 + N(N+1)\right] - 2N(\sum_{i=1}^{3} n_i^3 - N^3) \Big/ N^2(N-1)\right]^{1/2} \quad (8)$$

In order to implement run test we can use standard normal Z-statistics whether the actual number of runs is consistent with the hypothesis of independences. The formula of standard score given by:

$$Z = (r \pm 0.05 - \mu) / \sigma_\mu \quad (9)$$

Where r: actual number of runs, μ: expected number of runs, and 0.5 is a continuity adjustment (Wallis and Roberts, 1956).

3. EMPIRICAL RESULTS

We started our investigation with some basic descriptive statistics of the stock returns for ASE which in Table 1; Mean returns is positive with positive kurtosis, which means that the distributions of stock returns are leptokurtic indicating higher peaks than expected from normal distributions.

In order to test the hypothesis of normal distribution, table 1 results provide evidence of non-normality in daily stock returns for ASE depending on Jarque-Bera test results.

Table 1
Descriptive Statistics for Daily Index Returns of ASE

Date: 08/07/14 Time: 16:52	
Sample: 1 3441	
	RT
Mean	0.000211
Median	0.000389
Maximum	0.046857
Minimum	- 0.045255
Std. Dev.	0.009326
Skewness	- 0.308806
Kurtosis	6.850535
Jarque-Bera	2180.456
Probability	0
Observations	3441

In this paper serial autocorrelation (ACF) used, and Ljung-Box Q-statistics to expand our analyses for randomness.

Table 2 present test of autocorrelation test using up to 10 lages depending upon akaike criterion, the null hypothesis of there is no autocorrelation for stock returns of ASE.

The significance of autocorrelation coefficient which present in Table 2 detect that the null hypothesis of weak-form market efficiency is rejected at 0.01 level of significance, which is mean that the ASE is inefficient at the weak-form; Therefore it is inferred that the historical returns for ASE cannot be used to predict future returns.

Table 2
Autocorrelation and Q-statistics for Daily Index Returns of ASE

Date: 08/24/14 Time: 15:16						
Sample: 1 3441						
Included observations: 3441						
Autocorrelation	**Partial Correlation**		**AC**	**PAC**	**Q-Stat**	**Prob**
|** |	|** |	1	0.225	0.225	174.98	0.00
| |	*| |	2	-0.027	-0.082	177.47	0.00
| |	| |	3	0.01	0.037	177.79	0.00
| |	| |	4	0.031	0.019	181.17	0.00
| |	| |	5	0.015	0.005	181.98	0.00
| |	| |	6	-0.02	-0.023	183.33	0.00
| |	| |	7	-0.006	0.005	183.44	0.00
| |	| |	8	0.019	0.017	184.75	0.00
| |	| |	9	-0.014	-0.024	185.42	0.00
| |	| |	10	-0.015	-0.003	186.24	0.00

As a necessary condition for Random walk, we apply unit root tests Augmented Dickey-Fuller test (ADF) parametric test, and Phillips-Peron test (PP) non-parametric test. Optimal lag length for the ADF test selected with Akaike info criteria and maximum lag is set to 10. Upon the Random walk hypothesis, the stock price series must have a unit root whereas the returns series must be nonstationary. The results of two unit root tests presented in Table 3 conclude that unit root is absent from all the return series, which indicating that the stocks return series for ASE are stationary, and inefficient at the weak-level.

Table 3
Unit Root Test for Daily Index Returns of ASE

Unit Root Tests	*T*-Stat	*P*-Value
Augmented Dickey-Fuller (ADF) test	- 24.59199	0.0000
Phillips-Peron (PP) test	- 46.6434	0.0000

Finally, we apply another non-parametric test (run test), the results of the runs test for daily stock return present in Table 4.

The results indicate that the actual runs of stock returns for ASE are significantly smaller than their corresponding expected runs at 1% level, so that the null hypothesis of independence among stock returns ASE is rejected for these series.

Table 4
Runs Test for Daily Index Returns of ASE

Runs Test	
Test Value[a]	.00
Cases < Test Value	1720
Cases ≥ Test Value	1721
Total Cases	3441
Number of Runs	1402
Z	- 10.895
Asymp. Sig. (2-tailed)	.000

All the tests of efficiency at the weak level showed that the stock returns for ASE are not random over the time of the study. Therefore, the stock returns display predictable (or nonrandom walk) behavior.

The parametric and nonparametric tests were drawn the same conclusion that the stock returns of the ASE is inefficient at the weak level.

CONCLUSION

This study examines random walk hypothesis and tests the weak-form efficiency of the of the stock market returns of our country Jordan, by using daily observations for the Amman Stock Exchange (ASE). Parametric and nonparametric tests employed for examining the randomness of stock prices for ASE.

The results of serial correlation reject the presence of random walks in daily returns of the ASE Index. In addition, the runs tests conclude that the ASE at the weak form is inefficient. The unit root tests also conclude the weak-form inefficiency in stock return series for ASE.

Our findings are consistent with other similar research Frennberg and Hansson (1993), Abeysekera (2001), Abraham (2002), and Borges (2010).

In addition, our empirical finding consistent with the results achieved by studies conducted in emerging markets El-Erian and Kumar (1995), Nourrendine and Kababa (1998), Mobarek (2000), Tas and Dursonoglu (2005), and Pradhan et al. (2009).

We propose further studies in the future to test EMH in emerging markets as does the endeavor to examine whether market efficiency improved over time in these markets.

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