The Investigation of the Efficient Market Hypothesis: Evidence from an Emerging Market

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Abstract: This study examines the weak-form efficiency of the Iranian capital market after changes in market regulations. Some events after 2005 have fundamentally changed the environment of the Iranian capital market, and we expect those reforms to increase its market efficiency. Therefore, this study examined the behavior of daily returns in Tehran Stock Exchange (TSE) utilizing autocorrelation and augmented Dickey-Fuller for the period of 2005-2013. The results of all the tests do not support that TSE daily returns follow a random walk. Therefore, we conclude that it is possible to use technical skills to attain abnormal gains.

Key words: Capital market efficiency, random walk theory, augmented Dickey-Fuller test, autocorrelation test, runs test

JEL classification: G14

1. INTRODUCTION

An efficient stock market is vital for economic development. With an efficient market, financial resources are allocated economically. Efficient stock markets also encourage individuals to invest in stocks and help firm managers maximize the wealth of stockholders. The “market efficiency” hypothesis was developed by Fama (1970) in his original work. He considered the informational efficiency of financial markets and stated that there is no opportunity for an investor to outperform the market since all available information is already reflected in stock prices. The efficient market hypothesis has been one of the most intensely researched topics in previous decades and continues to be a topic that has both
advocates and opponents. Market efficiency falls under the effect of the traders’ capability in gathering and disseminating information. Stock markets that are more efficient will attract more investors and in turn, market liquidity will increase. Market efficiency is important for investors because their wealth depend on stock price changes. Generally, the inefficiency of the stock market might impact consumption and investment spending and hence affect the performance of the overall economy (Adelegan, 2003).

The efficient market hypothesis (EMH) implies that price changes in the stock market follow a random walk model. This means that changes in stock prices are independent and daily stock prices in the market reflect real-time information announced on the same day. Since news is not predictable by the market, stock prices that do reflect unpredictable news are random (Malkiel, 2003). According to the efficient market hypothesis, current prices reflect the available information about the future profitability of companies. When new information reaches the market, stock prices rapidly adjust to the information received. Thus investors in the market cannot take advantage of available information to attain an abnormal gain (Pearce, 1987). The efficiency of stock markets implies that there is a positive relationship between expected returns on stocks and their systematic risks (Beneda, 2005).

Fama (1970) in his seminal work categorized the EMH into the three groups: weak-form, semi-strong-form and strong-form. Following his work, many studies have investigated the randomness of stock price changes to demonstrate the efficiency of capital markets. In this paper, we concentrate on the weak-form category, which postulates that all past stock prices are fully reflected in the current stock price. The Iranian capital market is expected to be efficient and attract individuals in investing their funds in viable investment opportunities to further economic development. A lot of research looked at the levels of efficiency and problems that prevent the development of the market for effective regulations. The aim of this study was to evaluate the behavior of daily returns in Tehran Stock Exchange (TSE), focusing on the weak-form version of EMH. Literature indicates that the weak-form version of market efficiency will be accepted if the stock market daily returns follow a random walk model. In other words, whenever daily returns follow the random walk theory, then the weak-form version of efficient market is accepted (Namazi and Shoushtarian, 1996). This study employed the more popular tests: Autocorrelation, runs, and augmented Dickey-Fuller tests to examine the TSE weak-form efficiency.

A number of studies (for example, Nasrollahi, 1992; Fadaenejad, 1994; Namazi and Shoushtarian, 1996; Allahyari, 2009) have looked at the efficiency of Iranian stock market but, these were done before 2005. Some events after 2005 have fundamentally changed the environment of the Iranian capital market. These events refer to the passages of Securities Market Act of the Islamic Republic of Iran, and the bylaw governing foreign investment in the exchanges and OTC markets. Privatization and market reforms might have an impact on the functioning of the capital market as research findings from other markets show that financial liberalization, privatization, and market reforms increase capital market efficiency (Singh, 2010; Majnoni and Massa, 2001; Richards, 1996). The objective of this study is to examine the Iranian capital market efficiency after changes in the market because we expect them to affect the stock market efficiency. We used the daily returns for the time period of 13/3/2005-13/3/2013 to test the research hypothesis, that is, TSE daily returns follow a random walk model. The research data were extracted from the TSE website (www.irbourse.com). The results reveal that TSE daily returns do not follow a random walk model.
The remainder of the paper proceeds as follows. The next section reviews the literature on capital market efficiency as well as provides a discussion of some of the empirical evidence. Section 3 discusses the research methodology while Section 4 presents the empirical results. Section 5 provides the summary and conclusions.

2. LITERATURE REVIEW

The primary function of the capital market is the allocation of financial resources. An efficient market will allocate financial resources in an economic way. Efficient stock markets also encourage individuals to invest in stocks and help firm managers maximize the wealth of their stockholders. There are two kinds of traders: informed and uninformed. Informed traders have access to valuable information about the fundamental value. They sell/buy over-/under-priced stocks making a gain and driving back the price quickly toward its fundamental value. Uninformed traders do not invest their resources in gathering information, but they know that current prices reflect the information from informed traders. Fama (1970) categorized the EMH into the three groups: weak-form, semi-strong-form and strong-form.

In the weak-form of market efficiency, no investor is able to earn abnormal returns using historical prices or return information. According to Fama (1991), the weak-form version of market efficiency implies the predictability of future returns using past returns. If prices follow random trends, stock price changes are independent; otherwise, they are dependent. The semi-strong-form efficiency infers that no trader is able to earn abnormal returns using any publicly available information. The strong-form efficiency implies that no trader is able to earn abnormal returns based on any type of information (Adelegan, 2003).

Following Fama (1970), many capital market researchers investigated the random walk behavior of stock price changes to demonstrate capital market efficiency. Other researchers studied market inefficiencies by recognizing systematic and permanent variations in stock market returns (Jarrett, 2008). There is a voluminous literature on weak-form tests in USA and early tests strongly support the hypothesis. Most of the earlier studies used serial correlation (autocorrelation) to examine the linear dependency of lagged price changes or returns. Additionally, some researchers used Runs tests to determine the duration of upward and downward changes (Singh, 2010). The results have been mixed. Magnusson and Wydick (2002) examined the weak-form efficiency of eight African countries and their results indicate that there is greater support for the African stock markets compared to other emerging stock markets. Alam Hasan & Kadapakkam (1999) tested the random walk hypothesis for five Asian stock markets. Their results showed that all the stock return indices except the Sri Lankan index follow a random walk. Squalli (2006) tested the weak-form efficiency of two stock exchanges in the United Arab Emirates: the Dubai Financial Market (DFM) and the Abu Dhabi Securities Market (ADSM). The results from variance ratio tests showed that all the sectors in the financial markets of UAE are inefficient except the banking sector of the DFM. They showed that stock returns are negatively serially correlated in the two financial markets which indicate the inefficiency of the markets. Jarrett and Kyper (2006) investigated the time series characteristics of daily stock prices for 62 firms listed on NYSE and NASDAQ. The results of the study indicate that stock prices do not follow a random walk model. Lo and MacKinley (1988) employed variance-ratio statistical tests, and the results rejected the random walk hypothesis for daily and weekly returns. However, for
monthly returns, they were not able to find any evidence against the random walk hypothesis. This is contrary to Fama and French (1987) who demonstrated negative serial correlation for longer horizon returns and found significant, and positive serial correlation for weekly and monthly holding-period returns. Poterba and Summers (1988) used monthly returns for a NYSE value-weighted index for a different period (1926-1985) and found negative serial autocorrelation which is different from the results provided by Lo and MacKinley (1988).

The unit root test is another type of statistical test utilized for examining the weak-form efficiency. In this test, if the data are non-stationary, the random walk hypothesis is supported and if otherwise, mean reversion is evident. The findings of previous studies on the random walk hypothesis that used various approaches of unit root test are mixed. Cooray and Wickremasinghe (2005) investigated the weak-form stock market efficiency in India, Sri Lanka, Pakistan and Bangladesh. The researchers found that for all the countries, the classical unit root tests supported weak-form efficiency. Narayan and Smyth (2005) applied the ADF unit root test to stock market indices from 22 OECD countries. Overall, the results of their study supported strongly the random walk hypothesis for all countries except New Zealand. Further on, Narayan and Smyth (2006) extended their previous study by applying multiple trend break unit root tests to investigate the random walk hypothesis for 15 European stock markets and documented strong support for the random walk hypothesis. Narayan and Smyth (2004) also applied the conventional ADF unit root test with one and two structural breaks to the stock price index of South Korea. The results indicate that stock prices in South Korea are consistent with the efficient market hypothesis. Jarrett and Kyper (2005) examined the efficient market hypothesis utilizing index numbers of daily stock market prices in USA. They found that the ADF test showed a unit root for many time series of closing prices. Chaudhuri and Wu (2003) studied 17 emerging markets and their results showed that the ADF unit root test rejected the random walk hypothesis for 10 out of 17 emerging markets observed. Lu and Ito (2010) used the unit root test to test the efficiency of Chinese stock markets. Their findings revealed some evidence that did not reject the random walk hypothesis.

Previous studies also employed runs test which determines the duration of upward and downward changes. Karemera, Ojah & Cole (1999) investigated the random walk properties of equity returns in 15 emerging capital markets. The results of the runs test show that most of the examined markets display weak-form efficient. Butler and Malaikah (1992) examined the Saudi and Kuwaiti markets using serial correlation and runs tests. They found that those markets are not efficient in the weak-form. Urrutia (1995) tested the random walk hypothesis for Latin American emerging markets and the runs test results showed that the markets are efficient in weak-form. Fuss (2005) examined the random walk hypothesis for seven Asian emerging markets. He provided evidence that showed stock indices became efficient after market liberalization. Squalli (2006) using runs test, investigated the weak-form efficiency of two exchanges in the United Arab Emirates: the Dubai financial market (DFM) and the Abu Dhabi securities market (ADSM). The findings of the study provided evidence for weak-form efficiency in the insurance sector of the ADSM only. Kompa and Matuszewska-Janica (2009) examined the weak-form efficiency in the Warsaw Stock Exchange (WSE) by employing runs test and proved that the WSE is efficient in weak-form.

The published literature on weak-form efficiency in Iran is relatively limited. Nasrollahi (1992) examined the weak-form of efficiency in the Tehran Stock Exchange (TSE) for the
period 1989-1991. Using runs test, the author provided evidence that indicate TSE is not efficient in weak-form. Similarly, the market was investigated for the period 1989-1993 by Fadaenejad (1994) using autocorrelation and runs tests. The findings revealed that TSE is not efficient in the weak-form. Namazi and Shoushtarian (1996) studied TSE using daily and weekly prices for the period 1988-1994 and found no evidence of weak-form efficiency. Allahyari (2009) using autocorrelation and runs tests, examined the weak-form efficiency of TSE for the period 1999-2005. His results did not support weak-form efficiency. All these previous studies show that TSE is not efficient in weak-form. This study focuses on the weak-form of the efficient market theory and tries to examine the market efficiency after the 2005 reforms and fundamental events.

3. RESEARCH METHODOLOGY

We carried out autocorrelation, augmented Dickey-Fuller, and runs tests to examine the market efficiency over the period of 2005-2013.

3.1 Serial Correlation

Serial correlation is one of the statistical tools used for measuring the dependence of a variable on its past values. In other words, this test measures the relationship between the stock return in the current period and its value in the previous period, which is defined as follows:

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

where $\rho_k$ is the serial correlation coefficient of daily returns of lag $k$; $n$ is the number of observations; $r_t$ is the stock return over period $t$; $r_{t-k}$ is the stock return over period $t-k$; $\bar{r}$ is the mean of stock returns, and $k$ is the lag of the period. $r_t$ is measured as follows:

$$r_t = \frac{\ln r_t - \ln r_{t-1}}{\rho_{t-1}} = \ln \rho_t - \ln \rho_{t-1}$$

Where, $\rho_t$ is the index of stock market in the period $t$, and $\rho_{t-1}$ is the index of stock market in the period $t-1$.

This test is frequently performed to test the joint hypothesis that all the $\rho_k$, up to certain lags, are simultaneously equal to zero, instead of testing the statistical significance of any individual autocorrelation coefficient (Gujarati, 2003). Statistically, the hypothesis of weak-form efficiency should be rejected if stock returns (price changes) are serially correlated ($\rho_k$ is significantly different from zero). Positive or negative results indicate that there might be potential, profitable trading strategies. A zero correlation is consistent with the random walk hypothesis. This was performed by using the Q statistic developed by Box and Pierce (1970), which is as follows:
Where, $n$ is the sample size and $m$ is lag length. In large samples, it has a chi-square distribution with $m$ d.f. (Al-Jafari, 2011). In addition, to test the joint hypothesis that all correlations are simultaneously equal to zero, the study used the Ljung-Box Q-statistic (1978) as a variant of Box-Pierce’s Q statistic ($Q$), which is as follows:

$$Q_{LB} = n(n+2)\sum_{j=1}^{b} \frac{\hat{\rho}^2(j)}{n-j}$$

Where, $n$ is the sample size, $\rho(j)$ is the autocorrelation at lag $j$, and $b$ is the number of lags being tested. Under the null hypothesis of zero autocorrelation at the first $k$ autocorrelations ($\rho_1 = \rho_2 = \rho_3 = \ldots = \rho_k$), the Q-statistic is distributed as a chi-square with degrees of freedom equal to the number of autocorrelation ($k$). If the Q-statistic is significantly different from 0, this indicates that the series is serially correlated. Such a result would allow rejecting the null hypothesis that returns are independent (Guidi, Gupta & Maheshwari, 2010).

### 3.2 Augmented Dickey-Fuller test

We used the augmented Dickey-Fuller (ADF) test because it is still the most common procedure for testing unit root. This unit root test provides evidence of whether the prices in the stock market follow a random walk. Hence, it can be used as a test for the weak-form market efficiency. If the stock market is inefficient in the weak form, then it is implied that market prices do not follow a random walk. Random walk requires that the time series must contain a unit root. Therefore, we tested daily returns for the presence of a unit root in them (Al-Jafari, 2011).

The original version of the Dickey-Fuller test assumes that there is no correlation between error terms. If this assumption is incorrect, then, the limiting distributions and critical values obtained by Dickey and Fuller cannot be assumed to hold. When a serial correlation is present, the ADF version of the test proposes to include in the regression, several lags of the difference of the series to account for the serial correlation. Dickey and Fuller (1981) illustrated that the limiting distributions and critical values that they obtained under the assumption that $\epsilon_t$ is a random sequence, are also valid when $\epsilon_t$ is autoregressive if the ADF regression is run. Therefore, we assume that the data generated according to $y_t = \rho y_{t-1} + \epsilon_t$, $t = 1, 2, \ldots$ with $\rho=1$, that, $\epsilon_t$ is a stationary autoregression of order $p$:

$$\epsilon_t = \theta_1 \epsilon_{t-1} + \theta_2 \epsilon_{t-2} + \ldots + \theta_p \epsilon_{t-p} + \epsilon_t$$  \hspace{1cm} (5)

Where, $\epsilon_t$ is an Independent Identically Distribution (IID) process and considers the reparameterized version of $y_t = \alpha + \beta t + \rho y_{t-1} + \epsilon_t$ as follows:

$$\Delta y_t = \alpha + \beta t + \phi y_{t-1} + \epsilon_t$$  \hspace{1cm} (6)

Where $H_0: \phi = 0$ is to be tested against $H_1: \phi < 0$. Given the equation for $\epsilon_t$ in (5), we can write as follows:
\[ \Delta y_t = \alpha + \beta_t + \phi y_{t-1} + \theta_1 e_{t-1} + \theta_2 e_{t-2} + \ldots + \theta_{p} e_{t-p} + \varepsilon_t \quad (7) \]

Since \( y_t = \rho y_{t-1} + e_t \), \( t = 1, 2, \ldots \) with \( \rho = 1 \) gives \( e_t = y_t - y_{t-1} \), equation (7) can be rewritten as follows:

\[ \Delta y_t = \alpha + \beta_t + \phi y_{t-1} + \theta_1 (y_{t-1} - y_{t-2}) + \theta_2 (y_{t-2} - y_{t-3}) + \ldots + \theta_{p} (y_{t-p} - y_{t-p-1}) + \varepsilon_t \]

\[ = \alpha + \beta_t + \phi y_{t-1} + \sum_{i=1}^{p} \theta_i \Delta y_{t-1} + \varepsilon_t \quad (8) \]

We are unlikely to know the correct value of \( p \) to be used in the ADF regression and will need to be determined based on the available data. In practice, it is usual to include terms with a lag to the extent that \( \varepsilon_t \) has no correlation and to use Lagrange multiplier tests for a serial correlation to check whether the chosen \( p \) is adequate. In our test, the null hypothesis is \( \phi = 0 \); this indicates that there is a unit root, in other words, the time series is non-stationary. The alternative hypothesis is \( \phi < 0 \). Rejecting \( H_1 \) implies that we do not reject that the time series has the properties of a random walk (Noferesti, 2000; Harris, 1992; Al-Jafari and Altaee, 2011).

### 3.3 Runs Test

The runs test, as a non-parametric test, is used to detect the frequency of changes in the direction of a time series. Runs test is a strong test for randomness in examining serial dependence in asset price movements. Runs are defined here as the number of sequences of consecutive positive and non-positive (negative or zero) returns. The number of runs is computed as a sequence of the price changes of the same sign (++, -, 00). When the expected number of runs is significantly different from the observed number of runs, the test rejects the null hypothesis that returns are random (Gu and Finnerty, 2002). To perform this test, we compared the number of actual runs (R) and expected runs (m), which is as follows:

\[ m = \frac{N(N+1)}{2} - \sum_{i=1}^{3} n_i^2 \quad (9) \]

Where, \( N \) is the number of observations (daily returns), \( i \) is the sign of +, -, or 0, and \( n_i \) is the number of observations in each run. For large sample sizes (\( N>30 \)), expected runs are approximately normally distributed with a standard deviation = \( \sigma_m \) as follows:

\[ \sigma_m = \sqrt{\frac{\sum_{i=1}^{3} n_i^2 (n_i^3 + N(N+1)) - 2N \sum_{i=1}^{3} n_i^3 - N^3}{N^2(N-1)^2}} \quad (10) \]

Then, we used the standard normal \( Z \)-statistic to test whether the actual number of runs is consistent with the random walk hypothesis. The standard normal \( Z \)-statistic is calculated as follows:

\[ Z = \frac{R - m \pm 0.5}{\sigma_m} \sim N(0,1) \quad (11) \]
Where R is the actual number of runs, and 0.5 is continuity adjustment. When the actual number of runs exceed (fall below) the expected runs, the result will be a positive (negative) Z value. A positive (negative) Z value indicates negative (positive) serial correlation in the return series (Abraham, Seyyed & Alsakran, 2002). Since Z statistic is normally distributed, $N(0,1)$, the critical value for Z statistic at a significant level of 0.05 is ±1.96.

4. EMPIRICAL RESULTS

The daily stock returns of the Iranian equity market represented by TEPIX were obtained from the Tehran Stock Exchange website (www.irbourse.com). The dataset consisted of 1937 daily observations for the period of March 2005 to March 2013. We employed autocorrelation, augmented Dickey-Fuller, and runs tests to examine the market efficiency using daily returns for the stated research period. Figure 1 shows the trend of daily returns for the market.

**Figure 1.** The trend of daily stock returns for Tehran Stock Exchange (for 1937 days)

Table 1 presents the descriptive statistics of the daily returns for TSE. The results show that the daily returns are positively skewed, which implies that the returns are flatter to the right and have an asymmetric distribution. The results of descriptive statistics based on positive skewness, high kurtosis and Jarque-Bera reject the hypothesis of normally distributed daily returns.
Table 1. Descriptive statistics for TSE stock price index

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>16086.93</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>11811.39</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>38739.40</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>7955.400</td>
<td></td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>8089.542</td>
<td></td>
</tr>
<tr>
<td>Skewness</td>
<td>0.992164</td>
<td></td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.725435</td>
<td></td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>323.8782</td>
<td>0.000000</td>
</tr>
</tbody>
</table>

4.1 Results of Autocorrelation Test

We used the autocorrelation test with 25 lags to examine the weak-form of market efficiency. Table 2 shows the autocorrelation coefficients, Ljung-Box and Box-Pierce statistics. The autocorrelation coefficients (Table 2) are significant and indicate the daily returns of TSE are serially correlated. The other statistics, Ljung-Box, and Box-Pierce, support that the returns are serially correlated. Therefore, the results do not support the weak-form efficiency.

Table 2. Autocorrelation function, Ljung-Box and Box-Pierce statistics for daily stock returns

<table>
<thead>
<tr>
<th>Order</th>
<th>ACF</th>
<th>Box-Pierce Statistic</th>
<th>Ljung-Box Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.41115</td>
<td>(0.000) 194.7392</td>
<td>(0.000) 195.2468</td>
</tr>
<tr>
<td>2</td>
<td>0.25308</td>
<td>(0.000) 268.5268</td>
<td>(0.000) 269.2910</td>
</tr>
<tr>
<td>3</td>
<td>0.20270</td>
<td>(0.000) 315.8583</td>
<td>(0.000) 316.8285</td>
</tr>
<tr>
<td>4</td>
<td>0.17053</td>
<td>(0.000) 349.3606</td>
<td>(0.000) 350.5059</td>
</tr>
<tr>
<td>5</td>
<td>0.13563</td>
<td>(0.000) 371.7007</td>
<td>(0.000) 372.9823</td>
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<tr>
<td>6</td>
<td>0.13563</td>
<td>(0.000) 392.8920</td>
<td>(0.000) 394.3216</td>
</tr>
<tr>
<td>7</td>
<td>0.09570</td>
<td>(0.000) 403.4436</td>
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<td>0.12053</td>
<td>(0.000) 420.1782</td>
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<tr>
<td>9</td>
<td>0.15222</td>
<td>(0.000) 446.8711</td>
<td>(0.000) 448.7868</td>
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<tr>
<td>10</td>
<td>0.17378</td>
<td>(0.000) 481.6608</td>
<td>(0.000) 483.9421</td>
</tr>
<tr>
<td>11</td>
<td>0.14254</td>
<td>(0.000) 505.0657</td>
<td>(0.000) 507.6136</td>
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<td>12</td>
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<td>(0.000) 563.8746</td>
<td>(0.000) 567.1842</td>
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<tr>
<td>15</td>
<td>0.12166</td>
<td>(0.000) 580.9256</td>
<td>(0.000) 584.4910</td>
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</table>
Results of Augmented Dickey-Fuller test

The Augmented Dickey-Fuller test is another method to examine the weak-form efficiency of TSE. In the ADF test, the null hypothesis is that the series is non-stationary. We determined the significant level of this test to be 5% and the related critical value as -2.8635. The results of the test (Table 3) indicate that on the basis of the Schwarz Bayesian and Hannan-Quinn criteria, the white noise of the error term (ε_t) occurs in the first lag. In other words, the error term has the highest value (6452.1) in the first lag. The absolute value of the Dickey-Fuller statistic in the first lag is -26.0258, which is greater than the critical value (-2.8635) at the 95% significant level. The results are identical for the Dickey-Fuller regressions including and excluding a linear trend. Therefore, we reject that the daily stock returns for TSE have the properties of a random walk.

Table 3. Unit root tests for variable DLP

The Dickey-Fuller regressions include an intercept but not a trend

1923 observations were used in the estimation of all ADF regressions Sample period was from 15 to 1937

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>LL</th>
<th>AIC</th>
<th>SBC</th>
<th>HQC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF -35.9651</td>
<td>6459.3</td>
<td>6457.3</td>
<td>6451.8</td>
<td>6455.3</td>
</tr>
<tr>
<td>ADF (1) -26.0258</td>
<td>6463.4</td>
<td>6460.4</td>
<td>6452.1</td>
<td>6457.3</td>
</tr>
<tr>
<td>ADF (2) -21.2473</td>
<td>6465.9</td>
<td>6461.9</td>
<td>6450.8</td>
<td>6457.8</td>
</tr>
<tr>
<td>ADF (3) -18.6922</td>
<td>6466.3</td>
<td>6461.3</td>
<td>6447.4</td>
<td>6456.2</td>
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<tr>
<td>ADF (4) -16.5454</td>
<td>6467.7</td>
<td>6461.7</td>
<td>6445.0</td>
<td>6455.6</td>
</tr>
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<td>ADF (5) -15.0162</td>
<td>6468.6</td>
<td>6461.6</td>
<td>6442.1</td>
<td>6454.4</td>
</tr>
</tbody>
</table>

95% critical value for the augmented Dickey-Fuller statistic = -2.8635

LL = Maximized Log-Likelihood  AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion  HQC = Hannan-Quinn Criterion
The Dickey-Fuller regressions include **an intercept and a linear trend**

1923 observations were used in the estimation of all ADF regressions  
Sample period was from 15 to 1937

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>LL</th>
<th>AIC</th>
<th>SBC</th>
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</thead>
<tbody>
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<td>6461.1</td>
<td>6452.8</td>
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<tr>
<td>ADF (1)</td>
<td>-26.2368</td>
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<td>ADF (2)</td>
<td>-21.4629</td>
<td>6469.7</td>
<td>6464.7</td>
<td>6450.8</td>
</tr>
<tr>
<td>ADF (3)</td>
<td>-18.9188</td>
<td>6470.0</td>
<td>6464.7</td>
<td>6447.4</td>
</tr>
<tr>
<td>ADF (4)</td>
<td>-16.7767</td>
<td>6471.2</td>
<td>6464.2</td>
<td>6444.7</td>
</tr>
<tr>
<td>ADF (5)</td>
<td>-15.2526</td>
<td>6471.8</td>
<td>6463.8</td>
<td>6441.6</td>
</tr>
</tbody>
</table>

95% critical value for the augmented Dickey-Fuller statistic = -3.4147

LL = Maximized Log-Likelihood  
AIC = Akaike Information Criterion  
SBC = Schwarz Bayesian Criterion  
HQC = Hannan-Quinn Criterion

### 4.3 Results of Runs Test

This section reports the results of the runs test as a non-parametric test, since the daily stock returns for TSE do not conform to the normal distribution. Table 4 shows the results of the runs test for daily returns. The results show that the Z statistic is -43.568 and greater than ±1.96, the critical value. The negative value for Z statistic indicates a positive serial correlation. Therefore, the runs test shows that TSE is inefficient in weak-form.

<table>
<thead>
<tr>
<th>Test value</th>
<th>Observations</th>
<th>Observations</th>
<th>Total</th>
<th># of</th>
<th>z-stat</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Median)</td>
<td>&gt;test value</td>
<td>≥ test value</td>
<td>Observation</td>
<td>runs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11811.39</td>
<td>968</td>
<td>969</td>
<td>1937</td>
<td>11</td>
<td>-43.568</td>
<td>0.000</td>
</tr>
</tbody>
</table>

### 5. SUMMARY AND CONCLUSIONS

This study examined the Iranian capital market efficiency following changes in the market regulations which were expected to affect the stock market efficiency. We used the daily returns of the research period to test the research hypothesis. For the purpose of hypothesis testing, we employed autocorrelation, augmented Dickey-Fuller, and runs tests. The results of all the tests do not support that TSE daily returns follow a random walk model and have the properties of mean reversion. Therefore, we conclude that it is possible to use technical skills to attain abnormal gains because the effects of price shocks converge in the stationary processes and it can be expected that implementing technical skills can cause abnormal returns.

The tests implemented at the aggregate level of the TEPIX do not support the hypothesis of weak-form efficiency following fundamental changes and reforms in the market. Since the stock market is under the effects of various factors, it is difficult to determine exactly
the causes of improvement in the market efficiency. Given the fundamental changes and reforms that took place in the mechanisms of Tehran Stock Exchange during the research period, it was expected that the market efficiency would shift to the weak-form of efficiency. However, our findings do not support that the market’s efficiency has increased despite the reforms that have taken place.

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References


