Investigation of Weak form of Efficiency Hypothesis in Tehran Stock Exchange

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Abstract: In an efficient market, prices 'fully reflect' available information. The aim of this paper is testing weak form efficiency in Tehran Stock Exchange (TSE) at 2010-2011 period with data of weekly returns of TSE. for do it, this paper has used Kalman Filter method for testing weakk form of efficiency in TSE. Results indicate that Tehran Stock Exchange is inefficient. Therefore predicting stock prices is possible by using past data and /or technical and financial surveys of the prices in this market.

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1. Introduction

There is a large literature about testing efficiency in stock markets. "An efficient capital market is a market that is efficient in processing information… In an efficient market, prices 'fully reflect' available information" (Fama 1976, p. 133).
Three types of efficiency are:

i. Weak form efficiency: the information set is that the market index reflects only the history of prices or returns themselves.
ii. Semi-strong form efficiency: the information set includes most information known to all market participants.
iii. Strong form efficiency: the information set includes all information known to any market participant.

Tehran Stock Exchange (TSE) opened in February 1967. During its first year of activity, only six companies were listed in TSE. Then Government bonds and certain State-baked certificate were traded in the market.

The Tehran Stock Exchange has come a long way. Today TSE has evolved into an exciting and growing marketplace where individual and institutional investor trade securities of over 420 companies.

The aim of this paper is testing weak form efficiency in TSE at 2010-2011 period. This paper is organized by five sections. The next section is devoted to prior studies. Section 3 presents research method. Section 4 shows empirical results and final section is devoted to conclusion.

2. Review of Literature

Fama (1965) and Samuelson (1965) concluded that most of the evidence seems to have been consistent with the efficient market hypothesis (EMH). Stock prices followed a random walk model and the predictable variations in equity returns, if any, were found to be statistically insignificant. Other studies in the US with similar findings included those of Sharpe (1966), Friend *et al*. (1970), and Williamson (1972).

Most empirical studies during 1980s focused on predicting prices from historical data, while also attempting to produce forecasts based on variables such as P/E ratios (Campbell and Shiller 1987), dividend yield (Fama and French 1989), term structure variables (Harvey 1991), and announcement of various events, i.e. earnings, stock splits, capital expenditure, divestitures, and takeovers (Jensen and Ruback 1983; McConnell and Muscarella 1985; Kettel 2001).

Some studies of efficiency test in Asian stock markets consist of: Nassir and Mohammad 1987; Ho 1990; Berument and Kayimaz 2001; Jaffe 1974; Jegadeesh and Titman 1993; Ikenberry *et al*. 1996; Michaely *et al*. 1995, etc.

Roberts' (1959) paper is one of the earliest papers on weak form market efficiency. He found that weekly changes of the Dow Jones Index behaved very much as if they had been generated by a simple chance model.

Danthine's (1977) model is an application of (sub-) martingale. He wanted to know (1) Under which conditions is it feasible to describe equilibrium in efficient spot commodity markets in terms of expected returns? (2) Is the expected return assumption necessary to test market efficiency and what alternative can be proposed? Following Fama (1970), Danthine conducted a test of efficiency checking the impossibility of various trading system. Based upon the assertion that the zero expected net profit rule translates itself into a relationship between any price and the expectation of its next period realization that can be described as $E[e^{-rt} P_t|\Omega_{t-1}]=P_{t-1}$, a conditional expectation on the information available in t-1, the discounted present value of P_t is the last observation on P_t. Making explicit the conditional nature of the expectation and the

information set, $E[P_t|\Omega_{t-1}, P_{t-1}, P_{t-2}, \dots] \geqq P_{t-1}$. The usefulness of this formulation is to transform price movements into a sub-martingale and a testable regression format

$$E[P_t|\Omega_{t-1}, P_{t-1}, P_{t-2}, \dots] = \alpha + P_{t-1},$$

where α is a constant and the covariance $(P_{t+\tau} - P_{t+\tau+1}, P_t - P_{t-1}) = 0$, for any $\tau \neq 0$. Danthine showed that if a stock price exists a pure martingale property, then $E[P_{t+1} - P_t|\Omega_t] = 0$, and $\text{cov}(P_{t+1} - P_t, P_t - P_{t-1}) = 0$.

3. Econometrics Methodology

This research has used Kalman Filter for testing efficiency in TSE. Kalman Filter is as following algorithm:

The Kalman filter was developed by Rudolph Kalman, although Peter Swerling developed a very similar algorithm in 1958. The filter is named after Kalman because he published his results in a more prestigious journal and his work was more general and complete. Sometimes the filter is referred to as the Kalman-Bucy filter because of Richard Bucy's early work on the topic, conducted jointly with Kalman.

Given the linear dynamical system:

$$x(k+1) = F(k)x(k) + G(k)u(k) + v(k)$$

$$y(k) = H(k)x(k) + w(k)$$

x(k) is the n-dimensiona l state vector (unknown)
u(k) is the m-dimensiona l input vector (known)
y(k) is the p-simensiona l output vector (known, measured)
F(k), G(k), H(k) are appropriately dimonsione d system matrices (known)
v(k), w(k) are zero – mean, white Gaussian noise with (known)
Covariance matrices Q(k), R(k)

The Kalman Filter is a recursion that provides the "best" estimate of the state vector x.

$$x(k+1) = F(k)x(k) + G(k)u(k) + v(k)$$

$$y(k) = H(k)x(k) + w(k)$$

Steps of estimation:

1. Prediction based on last estimate:

$$\hat{x}(k+1|k) = F(k)\hat{x}(k|k) + G(k)u(k)$$

$$\hat{y}(k) = H(k)\hat{x}(k+1|k)$$

2. Calculate correction based on prediction and current measurement:

$$\Delta x = f\left(y(k+1), \hat{x}(k+1|k)\right)$$

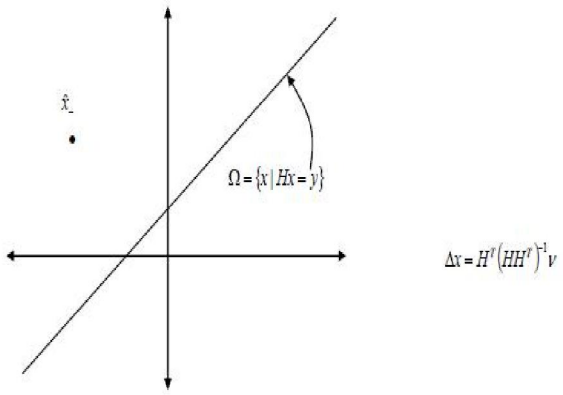
3. update prediction:

$$\hat{x}(k+1|k+1) = \hat{x}(k+1|k) + \Delta x$$

Finding the correction:

$$y = Hx$$

Given prediction $\hat{x}$ – and output y, find Δx so that $\hat{x} = \hat{x} + \Delta x$ is the "best" estimate of x.



This paper has used the following model for testing efficiency in TSE:

$r_t = \beta_{0t} + \sum \beta_{it} r_{t-i} + \delta h_t + e_t \quad e_t \sim N(0, h_t)$

$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 e^2_{t-1}$

$\beta_{it} = \beta_{it-1} + v_{it} \quad i = 0 \dots p \quad v_{it} \sim N(0, \sigma^2_i)$

Where r_t is rate of return, h_t is conditional variance of return and β_{it} is time varying parameter. If β_{it} set to 1, so r_t is nonstationary and market is efficient but when β_{it} set to zero, r_t is stationary and market is inefficient.

4. Empirical Results

Estimation the model base on Kalman Filter is as following table 1:

Table 1. Estimation Results

Parameter	Results
β_0	0.005 Z = 0.0001 Prob =0.99
$SV_1 = \beta_1$	0.46 Z = 5.997 Prob = 0.00
δ	0.00016 Z = 0.0005 Prob= 0.99
α_0	18.495 Z=7.24E-05 Prob= 0.99
α_1	0.0678 Z = 0.0002 Prob= 0.99
Log likelihood	180.069
AIC	-3.0011

Table 1 indicates that rate of return is stationary because β1 is less than 1. Therefore rate of return is stationary and TSE is inefficient.

Logarithm of likelihood is 180.069 an AIC criteria calculated -3.0011. Other parameters are insignificance.

5. Conclusion

The most important part of every country's investment market is it's stock exchange. The fundamental task of stock exchange is to dedicate the maximum financial sources of which are scarce. In this way the most profitable projects will absorb most of the investments. The efficiency of stock exchange is the most basic characteristic of stock exchange for this purpose to be achieved.

"An efficient capital market is a market that is efficient in processing information… In an efficient market, prices 'fully reflect' available information" (Fama 1976, p. 133).

The Tehran Stock Exchange has come a long way. Today TSE has evolved into an exciting and growing marketplace where individual and institutional investor trade securities of over 420 companies. The aim of this paper is testing weak form efficiency in TSE at 2010-2011 period. for do it, this paper has used Kalman Filter method for testing weakk form of efficiency in TSE. Results indicate that Tehran Stock Exchange is inefficient.

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