# Testing Weak Form Market Efficiency on the Istanbul Stock Exchange (ISE)

# Dr. Ayhan Kapusuzoglu

Faculty of Management - Department of Banking and Finance Yildirim Beyazit University Ankara / TURKEY

#### Abstract

The aim of this study is to examine under Istanbul Stock Exchange (ISE) National 100 index whether weak form market efficiency exists or not under efficiency market hypothesis. For this purpose, daily closing values of the related index during the period from 1996 to 2012 were used as data and 3943 pieces of daily data were provided from ISE. In order to test weak form market efficiency under this study, unit root tests were implemented. First of all, natural logarithms of data were taken before the analysis and then, it was proceeded to the analysis. Unit root tests were carried out under models which contain both constant and constant-trend components and in each two tests, it was precipitated that set is stationary at the level (H0 hypothesis rejected). The findings suggest that, it was determined that the related set not shows random walk and in other words, ISE National 100 market is not an efficient market in weak form.

Keywords: efficient market hypothesis, weak form efficiency, unit root test, ISE

## **1. INTRODUCTION**

One of the questions most frequently asked parallel to the development of the stock markets has been whether the future share prices could be predicted or not. Numerous research studies have been carried out on this subject in USA especially beginning from early 1900's onwards and it has been argued that the share prices have been formed at random. However no economic theories could have been put forward regarding the price movements in the capital markets until Samuelson (1965). In his study Samuelson has proved that the future commodity prices have a random character and subsequently Fama (1970) has expressed that theory in the form of Efficient Markets Theory by uniting it with his experiment (Adali, 2006).

An efficient market is a market in which the information that reaches the market is reflected on the prices of the securities instantly, exactly and correctly. In other words, if any information obtained in the market does not yield additional revenue for the investor then that market can be qualified as an efficient market. Fama (1970) has defined the Efficient Market as the exact reflection of all existing information on the prices. However a series of studies have shown that the use of definite techniques in various stock markets could yield an above normal earning for the investors. It was Fama (1970) who firstly discussed the differences of efficiency between the various markets and classified the efficiency of a market by the types of introduction of any information into the market. Weak form market efficiency, which is the lowest degree of the hypothesis, assumes that the investor cannot obtain a yield exceeding the normal level by using the past price movements. The semi-strong form which is the second degree of the hypothesis assumes that, in an efficient market, the investor would not be able to obtain a yield exceeding the normal level by using the publicly announced information besides the past prices. Strong-form efficient market, on the other hand, which is the highest degree of the hypothesis argues that the prices reflect all information which has been publicly announced or not announced. Markets which have different degrees of efficiency are not independent from each other. The market must be efficient in the weak form at the same in order to be efficient in the half-strong form while it must be efficient both in half-strong and weak forms at the same time in order to be efficient in the strong form (Karan, 2004). Weak form market efficiency which has been examined within the scope of the study is essentially directed to test the random walk. Random walk hypothesis argues that the share prices follow a course which can be predicted in advance, that they are totally random and move up and downwards at any moment, independently from the price changes in the past (Konuralp, 2005).

There are many studies in the field literature on testing the market efficiency, which shows that different findings may be obtained even for the same markets. The results obtained generally differ depending on the method applied and the period examined. For that reason it becomes possible to say that the findings obtained may be valid for the period which the study deals with and different results may be obtained for the same markets in different periods. In their research study Muradoglu and Unal (1994) examine the characteristic features of the distribution functions pertaining to the series of yields of ISE shares for 1988-1991 period and have conclude that the yield movements draw away from the random walk hypothesis and that ISE is not efficient in weak form. In their research study Ma and Barnes (2001) investigate the existence of the weak form market efficiency in Shanghai for 1990-1998 period and show that the market is not efficient in the weak form.

In their study Buguk and Brorsen (2003) measure the efficiency of the market taking into consideration the weekly closing prices of ISE and found that ISE was efficient in weak form. Zengin and Kurt (2004) have tested

ISE's weak form efficiency and strong form efficiency and used unit root tests for that purpose. Their research conclude that ISE was efficient in the weak form while not efficient in the half-strong form. In his study Moustafa (2004) conducts a research on the weak form efficiency in the stock exchange of the United Arab Emirates and concluded that the said stock Exchange is weak form efficient despite the fact that it is a newly developing market which is in the process of gaining a corporate identity.

Cornelis (2004) on the other hand performs non-parametric tests on the weekly index data in the far-east countries for 1986-1996 period and establishes that only the markets in Singapore are efficiency while market efficiency was out of the question for the other countries which were within the scope of the study. In their study Ozcan and Yilanci (2009) investigate market efficiency within the scope of ISE. They have concluded that the market was not efficient in the weak form since the relevant data contained linear unit root as well as showed that the residues of the random walk model have been distributed dependently.

Atan et al. (2009) investigate the existence of the weak form market efficiency in ISE for the period of 2003-2005 and conclude that ISE has market efficiency in the weak form. In their research study Demireli et al. (2010) test the random walk hypothesis within the scope of S&P 500 index for 1991-2010 period and investigate whether the market was efficient in the weak form. That research concludes that the said hypothesis is valid within the scope of the index and weak form efficiency exists. In his study Ergul (2010) investigates the existence of weak form efficiency within the scope of 12 different indexes in different periods for 1989-2009 period and have put forward that a weak form efficiency exists in the Turkish and American energy markets.

#### 2. DATA SET AND METHODOLOGY

The data set used in this study comprises the period 26.12.1996 - 30.11.2012 with regard to ISE National 100 index and analysis has been realized using 3943 data on a daily basis. The relevant data have been obtained from the Central Bank of Republic of Turkey (www.imkb.gov.tr). On the other hand, Eviews 7.0 program has been used for the econometric analysis. Natural algorithms of the data have been taken before they have been subjected to analysis. The graphic containing the data obtained from the natural logarithms is presented below. An increasing trend is observed for the analysis period in the graphic.



Firstly descriptive statistics related to the series have been calculated and it was examined whether the series had a normal distribution. A series which has a normal distribution has a variance of zero and a joint variance of zero. A series which has a normal distribution is randomly distributed around its average and leads to the acceptance of the weak form market efficiency (Uygur, 2001). Skewness (third moment) value must be zero (0) (not having crooked towards a definite direction) and kurtosis (fourth moment) value must be three (3) in order that a time series shows a normal distribution. Jarque-Bera must also be taken into consideration at the same time.

One of the most important characteristic features of the time-series is to be either stationary or non-stationary. Even if there may be deviations from the average value as a result of sudden shocks (which does not contain unit root) in a stationary series, the values approach to the average value in the course of time. This means that even if there may be provisional deviations from the trend, the series shall return to the trend value in the course of time and shocks shall disappear. However besides the provisional shocks of which effects on the variables disappear within a couple of periods, the existence of lasting shocks of which effects continue for a long time is also known. The existence of unit root points out to these lasting shocks because the trend formed by the lasting shocks prevents the series to approach towards a definite value. This trend bears a non-stationary characteristic from the point of view of stability, which is defined as the approach of the variables towards a definite value, and is named as a stochastic trend (Tari, 2002; Akal et al., 2012).

A series which contains a unit root may be called a time-series which has the characteristic of a random walk. This type of time series do not return to their average levels in the long term after a shock and follows a random course. Random walk hypothesis argues that the deviations observed in the real value of the analyzed series are random (Konuralp, 2005; Ergul, 2010).

In line with the explanations given above, an analysis of stability has been performed to test whether ISE is efficient in the weak form. Analysis of stationary is also called unit root analysis. A series which has no unit root problem is called a stable series (Gujurati, 1999). Various parametrical and non-parametrical tests have been developed in order to investigate whether a series is stationary or not, i.e. whether it contains unit root. In this study Augmented Dickey Fuller (ADF) (1979, 1981) and Phillips-Perron (PP) (1988) tests have been used in order to find out whether the series contain unit root. It is decided to accept or reject H<sub>0</sub> hypothesis as a result of the comparison of the t statistics obtained as a result of the test with the critical values (Enders, 1995). H<sub>0</sub> hypothesis shows that the series is not stationary and has the unit root while the alternative hypothesis shows that the series shall be rejected and it shall be decided that the series is stable. The results obtained both in ADF and PP test is compared with the MacKinnon critical values at 1%, 5% and 10% significance levels and it is decided whether the series are stable or not. Schwarz information criteria and Newey-West Bandwidth have been taken as a basis for ADF test and PP respectively with regard to determining the length of delay. Detailed explanations on the unit root analysis are not provided in the literature on the applied econometric analysis due to the fact that this form of analysis is applied very frequently.

Distribution theory of ADF test assumes that the errors statistically have an independent and constant variance. For that reason one must be sure that the errors has a constant variation without correlation when one uses that test. Assumptions of independence and constant variance are regarded as quite strong assumptions related to errors in most of the empirical econometrical studies (Phillips, 1987). PP test is a transformation of ADF test and this transformation removes the dependence of the problematic parameter asymptotically. It uses a non-parametrical method in doing this. In PP approach a transformation has been made not to the regression equalities in ADF procedure but only to the test statistics (Cabuk and Balcilar, 1998). In contrast to DF (1979) test, PP (1988) test permits a weak dependence and heterogeneity between the error terms and the delayed value of the dependent variable which is sufficient to remove auto-correlation is not added to the regression balance (Ergul, 2010).

In the final phase of the study, correlogram table of the series have been obtained in order to examine the autocorrelation values related to the series. If the observational values are influenced by the previous observational values, this situation means that there is an auto-correlation in the series and the random walk hypothesis shall not apply in that case. The absence of random walk, in turn, means that the market is not efficient. Basically AC (auto-correlation) and PAC (partial auto-correlation) values are obtained as a result of the correlogram graphics. If AC value goes beyond the confidence limits, this means that there is an auto-correlation in the series. If it decreases slowly beginning from a very high value this is interpreted as an indication that the series is not stable. On the other hand, PAC value expresses the relation between the delayed variables.

#### **3. EMPIRICAL FINDINGS**

The results of the descriptive statistics which have been realized in the first phase within the scope of the analysis are presented in the Table 1 given below. When the relevant table is examined, it is understood that the series has not a normal distribution. In line with this finding,  $H_0$  hypothesis which argues that the series are normally distributed shall be rejected and the alternative hypothesis which argues that the series are normally distributed shall be accepted. It is concluded that the market is not efficient in the light of this finding.

# ISE National 100 Index Mean 2.932 Median 3.179 Maximum 6.902 Minimum 0.034

Std. Dev.

**Kurtosis** 

Skewness

Jarque-Bera Probability

#### Table 1: Descriptive Statistics

The results of ADF and PP unit root tests performed within the scope of the scope are presented in the Table 2-5. When the related tables are examined, ADF and PP tests have been realized both at level and by taking its

1.065

<u>-0.687</u> 2.673

328.336

0.000

first difference. In line with the findings obtained, it has been concluded that the relevant series is stationary both at level and when its first difference is taken (that it contains no unit root), in other words, it does not contain unit root, rejecting the  $H_0$  hypothesis. As a result of that finding, it may be stated that the market is not weak form efficient and that a shock that had occurred in the past did not follow a course that draws away from the average value of the series in the future periods. And since the relevant value of the series does not draw away from the average value, the prediction of the future value is possible.

# Table 2: Augmented Dickey Fuller (ADF)-Level

ADF Test Statistic-I(0)		Constant		Constant and Linear Trend		
		t-Statistic	Prob.*	t-Statistic	Prob.*	
		-4.235	0.0006	-13.952	0.0000	
Test Critical Values	1% level	-3.431		-3.960		
	5% level	-2.862		-3.410		
	10% level	-2.567		-3.127		

\*MacKinnon (1996) one-sided p-values

# Table 3: Augmented Dickey Fuller (ADF)-First Differences

ADF Test Statistic-I(1)		Constant		Constant and Linear Trend		
		t-Statistic	Prob.*	t-Statistic	Prob.*	
		-63.006	0.0001	-63.026	0.000	
Test Critical Values	1% level	-3.431		-3.960		
	5% level	-2.862		-3.410		
	10% level	-2.567		-3.127		

\*MacKinnon (1996) one-sided p-values

# Table 4: Phillips-Perron (PP)-Level

PP Test Statistic-I(0)		Constant		Constant and Linear Trend		
		t-Statistic	Prob.*	t-Statistic	Prob.*	
		-4.265	0.0005	-16.128	0.000	
Test Critical Values	1% level	-3.431 -3.960		960		
	5% level	-2.862		-3.410		
	10% level	-2.567		-3.127		

\*MacKinnon (1996) one-sided p-values

## Table 5: Phillips-Perron (PP)-First Differences

PP Test Statistic-I(1)		Constant		Constant and Linear Trend		
		t-Statistic	Prob.*	t-Statistic	Prob.*	
		-63.008	0.0001	-63.026	0.000	
Test Critical Values	1% level	-3.431		-3.960		
	5% level	-2.862		-3.410		
	10% level	-2.567		-3.127		

\*MacKinnon (1996) one-sided p-values

Finally correlogram values obtained in relation to the series are presented in the Table 6 below. When the relevant table is examined, it is seen that AC values which show auto- correlation value are beyond the confidence limits. Likewise, the coefficients that PAC values have in the 1., 4., 7. and 10. delays are placed outside the confidence limit. In addition, when we also have a look at Q statistics, it is understood that there is a high degree of auto- correlation. It is concluded that the market is not efficient in the light of these findings.

٦

Г

Autocorrelation Partial Correlation		AC	PAC	Q-Stat	Prob
	1	0.992	0.992	3886.9	0.000
	. 2	0.985	-0.001	7716.5	0.000
	4 3	0.978	-0.002	11489.	0.000
	4	0.976	0.406	15253.	0.000
	• 5	0.975	-0.001	19007.	0.000
	· 6	0.974	0.000	22752.	0.000
	7	0.972	0.195	26487.	0.000
	8	0.971	0.002	30213.	0.000
	9	0.969	0.000	33929.	0.000
	10	0.968	0.097	37636.	0.000
	i∮   11	0.967	-0.000	41333.	0.000
	· 12	0.965	0.001	45021.	0.000
	13	0.964	0.049	48699.	0.000
	∲   14	0.963	-0.001	52367.	0.000
	∮ 15	0.961	0.010	56027.	0.000
	<b>I 1</b> 6	0.960	0.035	59679.	0.000
	∲   17	0.959	0.013	63324.	0.000
	18	0.958	-0.008	66961.	0.000
	19	0.957	0.018	70590.	0.000
	20	0.955	0.008	74209.	0.000
	4 21	0.954	-0.006	77821.	0.000
	22	0.953	0.005	81423.	0.000
	23	0.951	-0.007	85015.	0.000
	24	0.950	0.001	88597.	0.000
	<u> </u> 25	0.949	0.007	92171.	0.000
	III 26	0.948	-0.005	95737.	0.000
	27	0.946	0.001	99294.	0.000
	28	0.945	0.005	102842	0.000
	29	0.944	-0.006	106381	0.000
	30	0.942	-0.002	109912	0.000
	31	0.941	0.006	113433	0.000
	32	0.940	-0.001	116946	0.000
	33	0.939	0.002	120452	0.000
	34	0.937	0.002	123948	0.000
	35	0.936	0.001	127437	0.000
	∥  36	0.935	0.003	130918	0.000

Table 6: ISE National 100 Correlogram

#### 4. CONCLUSION

Markets are always in a state of balance according to the theory of efficient markets. In line with this fact, rapid adjustment of the prices and random movement of the prices is of great importance. In case the adjustment of the prices is slower in comparison with the information that are reflected in the market, the prices shall not reflect the information exactly and this situation shall in turn lead to abnormal yields exceeding the normal level being obtained by the investors who have access to a definite information. A market structure which has a high level of transaction volume and endowed with a tight supervision and oversight mechanism is required in order to prevent that process just as in the stock markets of the developed countries. There are numerous empirical studies on the market efficiency in the field literature due to the importance attributed to the subject.

Within the scope of this study, the existence of a weak form efficient market has been investigated within the scope of ISE National 100 index for 26.11.1996 - 30.11.2012 period. In line with that purpose, first of all the descriptive statistics related to the series have been calculated and it has been put forward whether the series has been distributed normally and then ADF and PP unit root tests have been realized in order to determine

whether the series is stationary or not. Finally correlogram analysis has been performed in order to examine the auto-correlation values pertaining to the series.

According to the results obtained from the research, the result of the descriptive statistics indicates that the index series does not have a normal distribution. However, it has been put forward that it is stationary, in other words does not contain unit root both at level and when its difference is taken, as a result of ADP and PP unit root analysis. Finally, the findings obtained from the correlogram table that examines the degree of auto-correlation related to the series state that the series contain a high degree of auto-correlation. In the light of all these data, it may be asserted that ISE is not a weak form efficient market, information is not completely and exactly reflected in the prices, there is no random walk and above normal yields may be obtained in this market. The studies realized to investigate market efficiency may yield different results depending on the period they cover and the method they use. For that reason it may be stated that the investors must not think that the results obtained from an inquiry which has been made on the basis of the period they are dealing with are valid for all periods.

#### REFERENCES

- Adali, S. (2006) "Market Efficiency and ISE: An Econometrical Analysis relating to Weak Form Efficiency", M.Sc. Dissertation, Kadir Has University, Istanbul.
- Akal, M., Birgili, E., Durmuskaya, S. (2012) "Testing Efficiency of Derivative Markets: ISE30, ISE100, USD and EURO", Business and Economics Research Journal, 3(4), pp. 1-20.
- Atan, S. D., Ozdemir, Z. A., Atan, M. (2009) "Weak Efficiency on the Stock Exchange Market: An Empirical Study on ISE", Journal of the Faculty of Economics and Administrative Sciences, Dokuz Eylul University, 24(2), pp. 33-48.
- Buguk, C., Brorsen, B. W. (2003) "Testing Weak-Form Market Efficiency: Evidence from ISE", International Review of Financial Analysis, 12, pp. 579-590.
- Cabuk, A., Balcilar, M. (1998) "What does a Unit Root? The Statistical and Economic Interpretation of Unit Root Processes with a Survey of Unit Root Test", *Journal of the Fcaulty of Economics and Administrative Sciences, Cukurova University, Special Issue on Econometrics*, 8, pp. 289-332.
- Cevik, F., Yalcin, Y. (2003) "Istanbul Menkul Kiymetler Borsasi (IMKB) Icin Zayif Etkinlik Sinamasi: Stokastik Birim Kok ve Kalman Filter Yaklasimi", *Journal of the Faculty of Economics and Administrative Sciences, Gazi University,* 1, pp. 21-36.
- Cornelis, A. L. (2004) "Valuation of Six Asian Stock Markets: Financial System", Center for Research in Financial Services, Working Paper No:97-02.
- Demireli, E., Akkaya, G. C., Ibas, E. (2010) "Financial Market Efficiency: An Application on S&P 500 Index", *Journal of the Faculty of Economics and Administrative Sciences, Cumhuriyet University*, 11(2), pp. 53-67.
- Dickey, D., Fuller, W. (1979) "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association*, 74(366), pp. 427-431.
- Dickey, D. A., Fuller, W. A. (1981) "Likelihood Ratio Statistics for Autoregressive Time Series with A Unit Root". Econometrica, 49(4), pp. 1057-1072.
- Enders, W. (1995) "Applied Econometric Time Series", John Wiley&Sons Inc., New York.
- Ergul, N. (2010) "Turk & Amerikan Enerji Piyasalarinda Piyasa Etkinliginin Test Edilmesi", *Maliye Finans Yazilari*, 24(86), pp. 101-120.
- Fama, E. F. (1970) "Efficient Capital Markets: A Review Theory and Empirical Work", *Journal of Finance*, 25(2), pp. 383-417.
- Gujurati, D. N. (1999) "Temel Ekonometri", Literatur Yayinlari, Istanbul.
- Karan, M. B. (2004) "Yatirim Analizi ve Portfoy Yonetimi", Gazi Kitapevi, Ankara.
- Konuralp, G. (2005) "Sermaye Piyasalari: Analizler, Kuramlar ve Portfoy Yonetimi", Alfa Yayinlari, Istanbul.
- Ma, B., Barnes, M. L. (2001) "Are China's Stock Markets Really Weak Form Efficient?", University of Adelaide, Australia.
- MacKinnon, J. G. (1996) "Numerical Distribution Functions for Unit Root and Cointegration Tests", Journal of Applied Econometrics, 11, pp. 601–618.
- Moustafa, M. A. (2004) "Testing the Weak-Form Efficiency of the United Arab Emirates Stock Market", International Journal of Business, 9(3), pp. 309-325.
- Muradoglu, G., Unal, D. (1994) "Weak Form Efficiency in the Thinly Traded Istanbul Securities Exchange", *The Middle East Business and Economic Review*, 6(2), pp. 37-44.
- Ozcan, B., Yilanci, V. (2009). "Turk Hisse Senedi Piyasasının Zayıf Formda Etkinliğinin Testi", *Journal of İktisat İsletme and Finans*, 24(274), pp. 100-115.
- Phillips, P. C. B. (1987) "Time Series Regression with a Unit Root", *Econometrica*, 55(2), pp. 277-301.
- Phillips, P. C. B. (1988) "Testing for Unit Root on the Time Series Regression", Biometrika, 75(2), pp. 335-346.
- Samuelson, P. A. (1965) "Proof That Properly Anticipated Prices Fluctuate Randomly", *Industrial Management Review*, 6(2), pp. 41-49.
- Shiguang, M. A., Barnes, M. L. (2004) "Are China's Stock Markets Really Weak Form Efficient?" CIES Discussion Paper, No:119.
- Tari, R. (2002) "Ekonometri", Alfa Basim Yayim, Istanbul.
- Uygur, E. (2001) "Ekonometri: Yontem ve Uygulama". Imaj Yayincilik, Ankara.
- Zengin, H., Kurt, S. (2004) "IMKB'nin Zayif ve Yari Guclu Formda Etkinliginin Ekonometrik Analizi", *Journal of Oneri*, 21(6), pp. 145-152.