Original Contribution

TESTING THE WEAK FORM MARKET EFFICIENCY ON ISTANBUL STOCK EXCHANGE

M. Korkmaz[1*] , G. Akman[2]

[1] Faculty of Economic, University of Anadolu, Eskisehir, Turkey,
[2] Department of Labour economics and industrial, Istanbul, Turkey

ABSTRACT
In this study, the efficiency concept was emphasized. Weak Form Market Efficiency of Efficient Market Hypothesis was tested in Istanbul Stock Exchange (ISE). For this purpose, an analysis was resorted by selecting 2 indices from Istanbul Stock Exchange. These indices are ISE 100 and ISE Industrial indices. It was concluded after the implementation that ISE was "Weak Form Efficient". Unit root and co-integration tests were used to be analyzed the efficiency in our study. Following the co-integration test implemented, it was resolved that there was not a co-integration among indices in the long term.

Key Words: ISE, Exchange, Money, Bank, Index, foreign exchange

1. INTRODUCTION
While the stock exchange market which also carries out its development in our country in recent years creates an alternative for investors who want to make good use of their investments in a way that can yield high return, it also creates a source from which the firms traded in stock exchange can get a long term fund. ISE strengthens the feature of being means of creating a source more in terms of firms with each passing day. Especially in our day the process of globalization quickens, when the volume and size of international capital mobility are taken into account, whether the market is efficient or not is important information not only for investors who want to make good use of their investments but also for the ones making technical analysis.

In markets where the competition is in the forefront in the process of globalization, the price of any goods or services show the agreement between the seller or buyer of this

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*Correspondence to: *Asst. Prof. Doc. Murat Korkmaz, Anadolu University School of Economics and Administrative Sciences , Department of Labor Economics and Industrial Relations, E-mail: eternalsoul_66@hotmail.com*

good by depending on public data and information in the market. When a new data or information comes to the market, this information is analyzed and assessed by the market actors and a new market price is created for the respective good. This new market balance price subsists until new interpretable information comes to the market. The markets in which securities react to new information immediately, exactly and correctly, the prices of securities change circumstantially, market rules hinder earnings beyond normal, generating an income beyond normal for professional investors individually or in group are impossible are called "efficient market".

When we discuss the economy as a whole, people take an important place as the basic building stone of both financial markets and real markets. Taking place of people element in these markets reveals the truth that we can not explain the markets with mathematical approaches as a whole.

Determination of security prices in financial markets and reflection of the real value of determined securities matter in terms of providing efficiency in markets. This situation is very important for investors to be able to do

risk, cost and price comparison which they will pay while taking investment decisions.

Efficiency concept stated generally was first mentioned by Eugene Fama in 1970 within the framework of "Efficient Market Hypothesis". According to the definition of Efficient Market Hypothesis, in case security prices reflect all information always accessible it is possible to mention an efficient market.

Researchers examine how the hypothesis results in a real market with the studies of Efficient Market Hypothesis. If it is gained a finding such as "Efficiency could not be provided"; the assumption, which the ones trying to predict the future share prices by doing technical analysis can yield high profit, survives. Accordingly, the chance of ones who search for low or high-valued stocks to gain non-coincidental high profit still survives.

In studies about the efficient market hypothesis in the past, some findings were made concerning that generally the markets of developed countries ensured weak form efficiency. In studies made in developing markets, it is discovered some studies concerning that weak form efficiency was provided but efficient market could not be provided. Studies are being carried out since the date of 12.08.2003 about the efficiency examination in ISE which is also the subject of our study.

The aim of our study is to test Weak Form Efficiency in Istanbul Stock Exchange by using the analyses of unit roots and co-integration. The study is composed of three chapters intended for this aim.

In the first chapter, efficiency and financial efficiency, basic assumptions of efficient market hypothesis were mentioned. The explanation of three chapters in which efficient market is analyzed and the difference among them are analyzed. It was given information about the weak, semi-strong and strong form efficiencies.

In the second chapter, information about methods with which we test the efficiency was collected and detailed explanations of methods were made. It was allowed for unit root test which will be used. Lastly, information about co-integration test which we will use was given. Johanson Cointegration Test from these methods will be used for our study.

Third chapter of study is aimed at the application of Istanbul Stock Exchange. Whether the measurement of Weak Form Efficiency is prevalent or not from Efficient Market Hypotheses on the ISE 100 and ISE Industrial indices taking part in Istanbul Stock Exchange will be tested. And then, test results will be associated with efficiency by looking whether it was affected or not from the previous period by implementing "Unit Root" on these indices. Co-integration test will be applied to test whether there is a long term relation among the indices that were chosen in this chapter. The result of co-integration is evaluated as an important criterion in determining whether there is weak form efficiency.

In the conclusive chapter of the study, efficiency concept analyzed within the framework of this study will be evaluated with introduced approaches and by taking into account the ISE application.

1. 1. EFFICIENT MARKET AND EFFICIENT MARKET HYPOTHESIS

First findings about efficient market fact were put forward by Maurice Kendall (1953). The subject of his study which he presented in Royal Statistical Association in London is about stock and the behaviour of basic product prices. According to the results of Kendall's study, prices tended to change randomly and the fluctuation probability of market in one day arises wholly independently from the previous day (1).

The results of Kendall's study had repercussions very much. Because it was hard to be accepted, a discourse such as the prices of shares is created randomly just like the probability in tossing a coin raised much doubt (1).

To be able to mention the efficiency in any market, distributional efficiency, operational efficiency and informational efficiency must be provided in that market. Having all three efficiencies for securities markets is very hard. So, more detailed information is given in explaining efficiency concept and efficiency is defined by benefiting from informational efficiency as: If the information coming to the

market reaches to all investors concurrently and the information of all companies in exchange is provided by all actors in market, this exchange is an efficient exchange (2).

Efficient Market Hypothesis (EMH) was put forward by Fama (1970) after the examinations about the efficiency in financial markets. According to this hypothesis, while the share price is formed in the market, all information related to securities affects the price composition and in the light of this information, price change occurs (3).

If any information that may affect the securities or price of securities reaches to all investors in exchange concurrently and again the information of companies which are traded in the exchange can be attained by all actors easily, it can be mentioned about the efficiency of market (2).

There are basic assumptions that form the basis of Efficient Market Hypothesis. Gitman (4) specifies these assumptions as below:

1. Securities are at balance typically, in other words securities pricing is done in the correct way.
2. Prices of securities at any time reflect the all public information of companies and securities. New information is reflected into prices quickly.
3. Because securities are priced completely and correctly, investors do not waste time about low or high pricing of stocks.

Fama (5) made three definitions of efficiency as weak form, semi strong form and strong form and featured the information while categorizing about the efficiency (6).

While categorizing about the efficiency; he used the past information which affect the prices of securities, information which was made public and information that can be learnt from insider and he stated that as the number of information increases, the degree of efficiency will also increase.

1. 1. 1. Weak Form Efficiency
The theory of weak form efficiency assumes that security reflect all information that may affect its price since the time of its public offering, so it argues that it can not be made an abnormal profit by examining the price of security (7).

Because all past information affects the price composition while the prices of securities are formed, it is concluded that it is unnecessary to search for price discrimination among these arguments in the market. Securities will move randomly and accordingly past data will not create the future prices (3).

Because predicting the securities prices is nothing but an unnecessary action, predictions of experts who are working as technical analysts in the market will not produce results which are beyond chance. In that case, such an effort will be waste of time.

While these data advocates that carrying out a technical analysis in weak form efficient market is impossible, it does not reject that carrying out a technical analysis may create meaningful information about pricing. In that case, there is a need for basic analysts in such a market and positioning after their observations may cause a profit beyond the accident (1).

1. 1. 2. Semi-Strong Form Market Efficiency
If we create a proposition such as: It has semi-strong form efficiency about the efficiency of market, this situation will tell us that both past information of market and all public information will be effective in formation of share prices. Because the predictions and explanations made about the company disperse to market immediately, share prices will find its new price in the light of these data and none of the investors in market will be able to get an abnormal profit (8).

In a market having semi-strong form efficiency, some of the information such as profit and loss situation of companies, divided distribution policies and integration plans if any are evaluated by academicians and analysts who make financial news and follow the market well. Accordingly, it can be easily reached to information which may cause a change in share prices of companies by means of newspapers and TVs. As a result, it will not be faced with an unexpected situation easily about the share prices. So, no one will get an abnormal profit because of the position they take.

Semi-strong form efficiency also includes the weak form efficiency. Analysts, who can not get an abnormal profit by doing technical analysis in a weak form efficient market, won't

also reach this aim in semi-strong form efficient market. Basic analysts who have the chance to get a high profit by doing technical analysis in weak form efficient market will lose this chance in semi-strong form efficient market.

1. 1. 3. Strong Form Efficiency

Prices reflect not only the public information but also all information gained from the company and economy in strong form efficient market. Prices will be equitable in markets where the efficiency is provided completely and no one in the market can get an abnormal and non-coincidental profit. Because all information forming the prices is on the market and new information coming to market is reflected to price formation quickly, security prices will never face with an over valuation or under valuation **(1).**

All information in the company in strong form efficient market was reflected to the market. So, doubts about valuation of security prices will be removed and neither technical analyst started with historical data nor basic analysts who will not be able to have the information which the public doesn't have will get an abnormal profit (2).

Additionally, because the information in the company will be reflected to market quickly and will disperse in the market immediately, everybody will have the same information at the same time. In that case, no one will be able to get the information of valuation difference which others don't know. Thus, the prices in the market will be overhauled immediately.

2. UNIT ROOT TEST

Statistics theory which lies behind the ARMA estimate management was based on stationary time series. If the average or auto covariance of a time serial doesn't change depending on time, this serial is called stationary. In this sense, time series not performing the characteristic in question are named as "non-stationary" time series.

Canonical example belonging to a non-stationary time serial is the process of random walk (9). There are two important reasons for whether the serial in the analysis of time series is stationary basically.

First one is, we can come across that variables have the same trend and there is a high level of relation while analyzing the relation between two or more variables in regression analysis. Whether the serial is stationary or not affects whether this relation is real or not.

Secondly, when a forward estimate is made with regression analysis, the stationarity of the serial affects the accuracy level of estimate.

There are many methods to test the model but it was demonstrated in the study of Dejong in 1992 and the studies of Schewrt in 1987 and 1989 that most common and most practical one of these tests is "Augmented Dickey Fuller" test **(10).**

2. 1. COINTEGRATION TEST

Co-integration analysis in time series began to be created in the mid 1980s and became one of the most important concepts by many econometricians in modelling of time series (11).

These variables must be co-integrated for the stable long term balance relation to be able to exist among the non-stationary time series. If it is ascertained that non-stationary time series are co-integrated, in other words a stable long term relation among these time series can be found, it is impossible to predict structural short term form of long term relation objectively in a way to include the adjustment mechanism in short term by starting from this long term relation. This estimate process is called as "error correction methodology" (9).

The first thing to do in the beginning of co-integration test is, to analyse whether the index which were composed of time series dealt in application as data is stationary or not at their logarithmical level.

If it is decided that co-integration relation between variables can be researched, regression equation concerning co-integration is estimated by being used "least squares method". It can be expressed as a result of estimates that there is at least one co-integrated vector between these non-stationary time series considering whether obtained residual terms are stationary or not. A method used with the aim of testing whether estimated residual terms of long term relation are stationary or not is ADF (Dickey-Fuller) test. Co-integration, in short, is the statistical

indication of existence of long term relation between economic variables (12).

Engle Johansen Co-integration Test (1988) is used for the co-integration analysis.

2. 1. 1. Johansen Co-integration Test
More than one co-integration relation can be found in cases where there are more than two variables. Johansen developed the maximum likelihood estimate method to remove this problem (13).

There are two basic reasons for being used the approach which was proposed by Johansen. First one is, to identify maximum number of co-integration vectors for the significant variables. The other one is, to obtain the highest likelihood estimates of related parameters and co-integration vector (14).

While Johansen was using his method;
- Selection of significant variables while the model is being established must be carried out in accordance with the economy theory.
- Integration degree of each variable must be determined by being used unit root tests and if some variables are I(2), it must be taken care that all variables will be I(1).
- After first two conditions are fulfilled, the number of co-integration vectors between variables should be determined and the estimates of values of these vectors should be made. When the long term relations are obtained, harmony of these relations with the rules of economy theory should be ascertained and by testing statistically, it must be paid attention that there is not a statistical problem.
- Lastly, error correction model is established and estimated with variable clusters in co-integration equitation. If the economy theory needs any variable or variables which may affect the short term movements, these variables should be included into the model at this last step. Besides, randomized control of stationarity and residuals must be made at each step (14).

3. THE APPLICATION OF TESTING WEAK FORM EFFICIENCY BY BEING USED COINTEGRATION and UNIT ROOTS IN ISE EXCHANGE
Istanbul Securities Market does not have a long past but because analyzing the efficiency of market is of capital importance especially in the sense that the market canalizes current investments in developing countries, the efficiency of market will be tested in this part.

3. 1. Data Structure
Data concerning ISE 100 (XU100), Industrial (XUIND) were used as data in this study. The analysis period used as belonging to data is the time slot between the dates of 08.12.2003 and 05.06.2009. Data acquired in the dates of 08.12.2003 and 05.06.2009 of analysis period is daily opening data.

E-Views 5,1 package program was used in statistical tests and applied econometric techniques in the following chapters.

3. 2. Hypothesis of the Study
The study was carried out under the hypothesis below.
- It was accepted that the data number used in the study was enough.
- It was accepted that there were no transaction costs in the market. Ignorance of transaction costs has importance in terms of reaching the results in the study entirely.

3. 3. Method
Distributions belonging to each market index were analyzed in "Basic Statistics Part" in the beginning of the study and; descriptive statistical results acquired in terms of markets which have normal distribution characteristics to be more close to an efficient market structure will be assessed in this respect with the help of "Jarque-Bera" test statistical results. Also, whether the distribution has a normal characteristic or not was stated in the interpretation part.

It was benefited from the "unit root test" in the implementation of weak form efficiency test; because unit root test is used to determine, whether the average or auto covariance of a time serial changes or not depending on time. In other words, it is to measure whether the serial is stationary or not.

Weak form efficiency is tested by applying unit root test to price index of stocks which are traded at ISE exchange. In that case, basic problem emphasized in the study is whether a predictable (deterministic) systematic trend is the subject or not in price series of shares.

The hypothesis of weak form market efficiency foresees that today's share prices reflect all information including prices of previous periods immediately and completely. In other words, prices of previous periods neither contain

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information which will help the investors to gain an abnormal profit, nor gives information about future prices. Accordingly, if the weak form market efficiency is acceptable, share price series will feature the random walk characteristic.

The model of random walk is the first degree difference stochastic process and it is a special feature of non-stationary series. Whether the serial is stationary or not appears after the result of unit root test.

3. 4. Basic Statistical Data

It is assumed that financial gaining generally disperses normally (15). It can be said with a general expression that a serial which features a normal distribution is close to efficient market criteria by looking at descriptive statistics results.

The statistical test which measures the distribution to be normal or not, is Jarque-Bera test statistics. We can decide the distributions of 5 index data belonging to ISE Exchange and used within the study to be normal or not according to test results of Jarque-Bera. Jarque-Bera test of normality is a statistics measurement which demonstrates skewnwss and kurtosis situations. Test statistics formula belonging to Jarque-Bera can be expressed in a way below.

$$JB = \frac{N-k}{6}\left(S^2 + \frac{1}{4}(K-3)^2\right) \qquad \textbf{(1)}$$

"s" value used in the Formula stands for skewness, "k" value is for kurtosis and "K" stands for approximate coefficient number used for creating the serial. It was observed that JB coefficient calculated in the formula under the null hypothesis in which residual terms disperse normally adjusts to chi-square distribution whose degrss of freedom in the big sample is 2 (16).

Within these information, we can make an assessment whether the series feature a normal distribution characteristic or not and depending on this an assessment about market indirectly by looking at index data.

3. 4. 1. Descriptive Statistics belonging to ISE 100 Index

Whether the serial belonging to ISE 100 index has the normal distribution or not was decided by looking at results of skewness, kurtosis and JB test statistic. Used observation number is 1383 for all tested indices. Observations which are being studied are composed of daily data. The chart showing the distribution about ISE 100 index and descriptive statistics belonging to index are like below.

Chart 1. The chart showing the distribution belonging to ISE 100 index and Jarque-Bera result

Series: XU100
Sample 12/08/2003 6/05/2009
Observations 1382

Mean	34235.99
Median	35317.82
Maximum	58191.67
Minimum	15896.00
Std. Dev.	10748.68
Skewness	0.127097
Kurtosis	2.010393
Jarque-Bera	60.11327
Probability	0.000000

Table 1. *Statistics Concerning Distribution Belonging to ISE 100 Index*

	XU100
Jarque-Bera	60.11327
Probability	0.000000
Sum	47314144
Sum Sq. Dev.	1.60E+11
Observations	1382

When an assessment is made concerning second situation according to the Jarque-Bera test statistics, calculated p value belonging to serial was found as p=0.000000. According to these results and Jarque-Bera statistic, the serial does not disperse normally.

Interpretation of distribution of ISE 100 serial

according to the acquired test results above:

3. 4. 4. Descriptive Statistics Belonging to ISE Industrial Index

The chart showing the distribution belonging to ISE Industrial index and descriptive statistics belonging to index are like below.

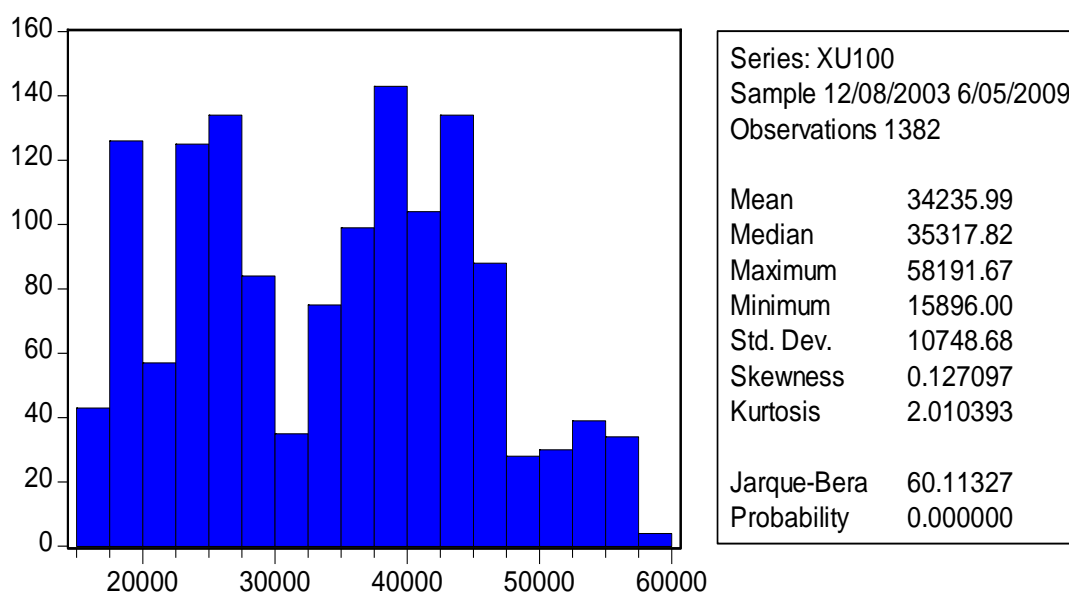**Chart 2.** The chart showing the distribution belonging to ISE Industrial index and Jarque-Bera result
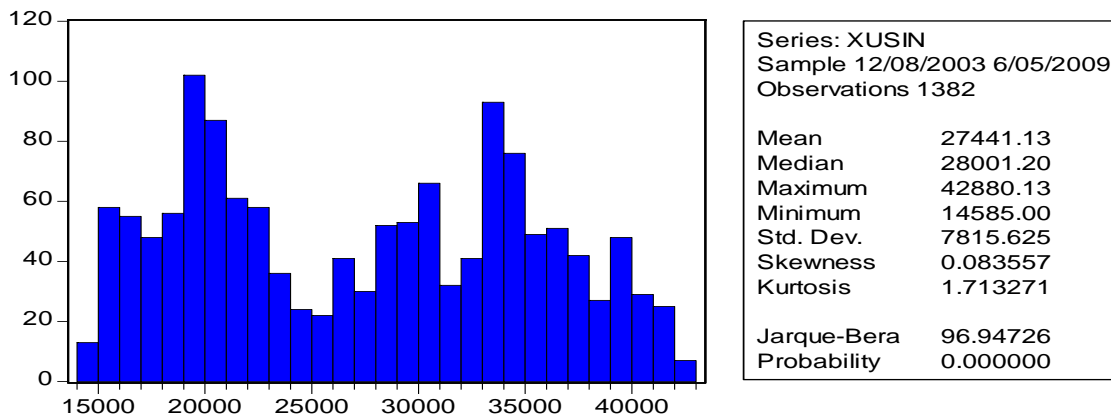

Series: XUSIN	
Sample 12/08/2003 6/05/2009	
Observations 1382	
Mean	27441.13
Median	28001.20
Maximum	42880.13
Minimum	14585.00
Std. Dev.	7815.625
Skewness	0.083557
Kurtosis	1.713271
Jarque-Bera	96.94726
Probability	0.000000

Table 2. *Statistics Concerning Distribution Belonging to ISE Industrial Index*

	XUSIN
Jarque-Bera	96.94726
Probability	0.000000
Sum	37923645
Sum Sq. Dev.	8.44E+10
Observations	1382

When an assessment is made concerning second situation according to the Jarque-Bera test statistics, calculated p value belonging to serial was found as p=0.000000. According to these results and Jarque-Bera statistic, the serial does not disperse normally.

3. 5. The Application of Weak Form Efficiency Test to Indices Selected in ISE

"Unit root test" was applied on ISE 100 and Industrial which were selected in ISE.

3. 5. 1. Dickey Fuller Results Belonging to ISE 100 Index and Testing the Hypothesis of Weak Form Market Efficiency

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The value of ADF (Augmented Dickey Fuller) test statistic belonging to ISE 100 index was calculated as -1,832247. The critical value calculated for 5% meaning level belonging to ISE 100 index is -2,863426 in ADF test statistic. Because absolute value of acquired numbers is taken into account, the value of ADF test statistic is smaller than the value of MacKinnon criteria which was calculated for 5% meaning level. The serial does not feature a normal distribution and it has auto correlation. Accordingly, it seems possible to predict future prices by benefiting from the past prices. In that case we can conclude that the market is not efficient.

The table showing the results of ADF test statistic for ISE 100 index is like below.

Table 3. *Unit root test results of ISE 100 index*

Null Hypothesis: XU100 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=23)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.832247	0.3650
Test critical values:	1% level	-3.434876	
	5% level	-2.863426	
	10% level	-2.567823	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(XU100)
Method: Least Squares
Date: 06/08/09   Time: 21:08
Sample (adjusted): 12/09/2003 6/05/2009
Included observations: 1381 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
XU100(-1)	-0.003486	0.001903	-1.832247	0.0671
C	132.5218	68.27697	1.940944	0.0525

R-squared	0.002429	Mean dependent var	13.16581
Adjusted R-squared	0.001705	S.D. dependent var	760.6825
S.E. of regression	760.0337	Akaike info criterion	16.10605
Sum squared resid	7.97E+08	Schwarz criterion	16.11362
Log likelihood	-11119.23	F-statistic	3.357130
Durbin-Watson stat	2.126768	Prob(F-statistic)	0.067130

4. 5. 3. Dickey Fuller Results Belonging to ISE Industrial Index and Testing the Hypothesis of Weak Form Market Efficiency

The value of ADF (Augmented Dickey Fuller) test statistic belonging to ISE Industrial index was calculated as -1, 719203. Because the MacKinnon critical value which was calculated

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for 5% meaning level and belonging to ISE Industrial index in ADF test statistic is small when its absolute value is taken from -2,863426, the serial is not stationary and it doesn't feature

a normal distribution, it has auto correlation. It is said that it isn't weak form efficient in the light of statistical data which were analyzed for ISE Industrial index. Related table is like below.

Table 4. *Unit root test results of ISE Industrial index*

Null Hypothesis: XUSIN has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic based on SIC, MAXLAG=23)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.719203	0.4213
Test critical values:	1% level	-3.434876	
	5% level	-2.863426	
	10% level	-2.567823	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(XUSIN)

Method: Least Squares

Date: 06.08.09 Time: 23.17

Sample (adjusted): 12.09.2003 6.05.2009

Included observations: 1381 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
XUSIN(-1)	-0.002882	0.001676	-1.719203	0.0858
C	87.54035	47.82950	1.830259	0.0674

R-squared	0.002139	Mean dependent var	8.456589
Adjusted R-squared	0.001415	S.D. dependent var	487.2063
S.E. of regression	486.8614	Akaike info criterion	15.21528
Sum squared resid	3.27E+08	Schwarz criterion	15.22286
Log likelihood	-10504.15	F-statistic	2.955661
Durbin-Watson stat	2.053349	Prob(F-statistic)	0.085802

3. 6. COINTEGRATION TEST IN ISE
If residuals belonging to the regression that is between two non-stationary but homogeneous serial at same grade is I(0) stationary, these are "co-integrated" series. Two series have the

same wave length and trends take one another. The method used in regression balance is "Least Squares" method.

Co-integration test was made between ISE 100 and ISE Industrial indices. Johansen Co-

integration Method will be used in co-integration test which will be made. Trace (λ_{trace}) and maximum eigenvalues (λ_{mak}) was given with test results to determine the existence of co-integration.

3. 6. 1. ISE 100 and ISE Industrial Cointegration:

It was accepted that there isn't any co-integration relation between variables according to trace statistic in Johansen Co-integration test made between ISE 100 and ISE Industrial. Because the trace value (11, 66284) is smaller than 5% critical value (15.41). In that case, it is concluded that there isn't co-integration relation between variables in 5% critical value. Related table is like below;

Table 5. ISE 100 and ISE Industrial Cointegration

According to Trace statistic,

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None	0.005309	11.66284	15.41	20.04
At most 1 *	0.003142	4.332958	3.76	6.65

According to the Maximum eigenvalue statistic

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None	0.005309	7.329879	14.07	18.63
At most 1 *	0.003142	4.332958	3.76	6.65

CONCLUSION

Efficient Market Hypothesis defends that investors don't have information about future share prices by looking at past data. Because according to this hypothesis, all information which may affect share prices was reflected to price before, there is not an opportunity to gain an abnormal profit. So it is argued that it won't be any rationalistic for investors to search for high or low valued share. According to this hypothesis again the view that making a direction projection by assessing share prices technically will not be racial is adopted.

In the study, weak form efficiency of banking sector were tried to be researched with analysis techniques of time series. For this purpose, daily opening prices of ISE 100 and ISE Industrial were examined. The tests used in the study are unit root test and co-integration test. Firstly, Basic statistical data of index were brought; these are composed of arithmetic

average, mode, skewness and kurtosis criteria. And then, test of normality was made, it was benefited from Jarque-Bera statistic for this. Positive skewness came out for all indices after the test of normality and it was observed that it was higher than arithmetic average. When it is thought that this situation plays an indicative role in prediction of economical indicators in financial markets, appreciation of securities in financial markets above the average enabled us to conclude that the market may show a rising trend.

Weak form efficiency was measured with unit root tests applied to indices in ISE. All selected indices were not weak form efficient. Accordingly, it seems possible to predict future prices by benefiting from past prices. In that case we can conclude that the market is not efficient.

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Co-integration tests were applied to indices in ISE. Double co-integration tests were applied and it was concluded that there wasn't any co-integration relation in applied double tests. Not being a long term balance relation after the co-integration test shows that these variables do not move together in long term. This situation shows that the market is not efficient in terms of efficiency.

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