Application of Markowitz Mean Variance Model in the Istanbul Stock Exchange

A THESIS

Deniz Çetin

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APPLICATION OF MARKOWITZ MEAN VARIANCE MODEL IN THE ISTANBUL STOCK EXCHANGE

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Submitted to the Faculty of Management

and the Graduate School of Business

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in Partial Fulfillment of the Requirements

For the Degree of

Master of Business Administration

Batu Çetin

August, 1998

I certify that I have read this thesis and in my opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Business Administration.

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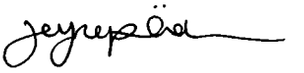

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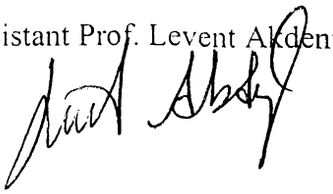

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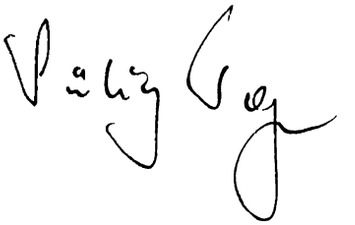

ABSTARCT

APPLICATION OF MARKOWITZ MEAN VARIANCE MODEL IN THE ISTANBUL STOCK EXCHANGE

BATU ÇETİN

M.B.A. THESIS

Supervisor : Assoc. Prof. Gülnur Muradoğlu

This main objective of this research work is to determine the efficient portfolio and construct the efficient frontier regarding the whole set of 129 stocks that have been traded in the ISE during the 1992 - June 1995 period. The analysis is based on the Markowitz's Mean Variance Portfolio Selection Model that has been devised by Harry Markowitz in 1952. The Markowitz's model is a quadratic optimization model that proves hard to implement as the number of data incorporated into the model increases. Hence, for the implemetation of the Markowitz's model for the 129 stocks, a program code has been written on GAMS, a special software package for the solution of quadratic optimization problems. The study is concluded by measuring the performance of the efficient portfolio constructed by utilizing the Sharpe's index performance measurement tool for the June 1995 - December 1995 period monthly data.

Key Words : Markowitz, Initial Public Offerings (IPO), Sharpe

ÖZET

MARKOWITZ OPTİMUM RİSKLİ PORTFÖY SEÇİM MODELİNİN İSTANBUL MENKUL KIYMETLER BORSASI'NDA UYGULANMASI

BATU ÇETİN

M.B.A. TEZİ

Tez Yöneticisi : Doç. Dr. Gülnur Muradoğlu

Bu araştırma çalışmasının amacı, İstanbul Menkul Kıymetler Borsası'nda (İMKB) 1992 - Haziran 1995 tarihleri arasında işlem gören 129 hisse senedini kullanarak etkin portföy setini bulmak ve 'etkin yay'ı çizdirmektir. Tez çalışması, 1952 yılında Harry Markowitz tarafından geliştirilen Markowitz Optimum Riskli Portföy Seçim Modeli dayanarak hazırlanmıştır. Markowitz modelinin çözümü, modelde kullanılan veri sayısının artışına paralel olarak zorlaşmaktadır. Dolayısıyla, çalışma esnasında, 129 farklı hisse senedi için Markowitz modelini çözmek için GAMS adlı ikinci dereceden diferansiyel denklem çözümünde kullanılan yazılım programından faydalanılmıştır. Çalışmanın son bölümünde, Haziran 1995 - Aralık 1995 aylık hisse senedi verileri ile Sharpe's Index adlı performans ölçüm denklemi kullanılarak portföylerin etkinliği ölçümlenmiştir.

Anahtar Kelimeler : Markowitz, Halka Arz, Sharpe

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I. INTRODUCTION

The advent of portfolio management theory is carried out by the Markowitz Mean Variance Model (Francis, 1991). Although several other models have found practical use in the stock exchange markets, the Markowitz Mean variance Model has been accepted to be the most influential one from the invention of the portfolio management.

The invention of computer sciences has a profound effect on the success of the model regarding the fact that the practical usage of the models only possible via computer usage. The reason for this is that the application of the model requires a throughout data analysis, and complex mathematical calculations.

In Turkey, most of the financial intermediaries utilize accounting methods for portfolio management. However the data obtained by utilizing the accounting methods include inaccurate and firm specific characteristics. The accounting method can acknowledge the investors about the information that are unique to the particular company, and are apart form communicating the factors that affect the performance of the stocks in a systematic manner (Valentine, 1975).

Therefore, an alternative way of investing in portfolios should be devised in order to have more efficient and sound outcome. This thesis attempts to bring a better approach to portfolio management by applying the Markowitz Mean Variance Model for the whole set of stocks that have been traded in the ISE during the 1992-1995 period. Markowitz has proved that it is possible to construct a portfolio of stocks that offers lower risk than the whole set of stocks entering the portfolio at a specified constant return. In this respect, Markowitz reflects the inherent aversion of the

rational investors to absorbing increased risk without compensation by an adequate increase in expected return.

Like any other forecasting method, the Markowitz Mean variance Model also utilizes past data for constructing efficient portfolios. However, in inconsistent economies like Turkey, the fluctuations in interest rates and the uncertainty in the financial intermediaries make the validity of the prediction in the financial markets totally arguable. In such an environment, the method of data collection and the suitability of the model to the financial environment that it is applied on, gains more importance. Therefore, in order to check the performance of the Markowitz Mean Variance Model as it is applied to the ISE, a particular performance measurement index, Sharpe's Index, has been used to evaluate the ultimate applicability of the method to the Turkish Stock Market.

II. LITERATURE REVIEW

The basis of modern portfolio theory relies on the theoretical framework brought by Harry Markowitz in 1952. The theory of Markowitz effectively reflects the behaviour of the rational investor by concentrating mainly on the inherent aversion of the investor to increased risk without being compensated with a sufficient expected return.

Despite its theoretical perfection, the Markowitz model necessitates the supply of huge number of data. In that respect, new approaches to portfolio modelling have been devised later, following the basic theory of Markowitz. The Single Index Model, developed by William Sharpe, Markowitz's former student brings an ease to computation of efficient portfolios covering great number of stocks. The Single Index model requires considerably less inputs with respect to the Markowitz model.

The restriction to borrowing and lending at the risk free rate by Markowitz has been removed by the development of the Capital Asset Pricing Model (CAPM) by John Mossin and William Sharpe. The capital market line approach of the CAPM model sustains the basis for the factor models. The factor models are beneficial for their property to be able contain other risk factors like interest risk, inflation risk and default risk in addition to the market risk.

The Arbitrage Pricing Theory, developed later in 1976 by Stephen A. Ross brought a new perspective to the CAPM model as it asserted that the risk elements which influence security returns are anticipated changes in four economic variables: inflation, industrial production, risk premiums, and the slope of the term structure of interest rates.

The other methods mentioned at the end of the chapter are the constrained versions of the Markowitz Mean Variance Model. These methods question the behaviour of the optimum portfolio theory under different assumptions.

II. 1. Markowitz Mean Variance Model

The basic elements of modern portfolio theory emanate from a series of propositions concerning rational investor behaviour set forth by Dr. Harry Markowitz (1952), and later in a complete monograph sponsored by the Cowles Foundation (Markowitz, 1959).

Essentially, the Markowitz model provided a theoretical framework for the systematic selection of optimum portfolios, once the level of risk willing to be assumed by the investor was established. Markowitz applied the complex mathematics of quadratic programming to the question of how most effectively to diversify portfolio holdings, given a free choice among hundreds of individual securities, and provided that certain basic information could be supplied by either security analysts or portfolio managers. In so directing the focus, Markowitz and others following the same line of reasoning, recognized the function of portfolio management as one of composition, and not individual stock selection (Francis, 1991). In this respect Markowitz made it clear that purchases and sales of individual securities are significant to the extend that they affect the overall risk and return characteristics of the entire portfolio.

The central theme of Markowitz's work is that investors conduct themselves in a rational manner which reflects their inherent aversion to absorbing increased risk without compensation by an adequate increase in expected return. As such, it was

stated that for any given expected rate of return, most investors will prefer a portfolio containing minimum expected deviation of returns around the mean over a determined period of time. Thus, it can be seen that risk was defined by Markowitz as the uncertainty, or variability of expected returns. The use of variance as a measure of portfolio risk also forces the investors to consider a fixed time horizon for investment calculations.

Having started with the conception of risk, and the investor's aversion to risk, Markowitz observed that investors try to minimize the deviations from the expected portfolio rate of return by diversifying their portfolios, holding either different types of securities and securities of different companies (Fischer, 1975). But he importantly pointed out that simply holding different issues would not significantly reduce the variability of the portfolio's expected rate of return if the income and market prices of these different issues contained a high degree of positive covariance. That is, if the timing, direction, and magnitude of their fluctuations were similar. Effective diversification is only achieved if the portfolio is composed of securities that do not fluctuate in a similar manner, so that the variability of the portfolio's rate of return becomes significantly less than the variability of the individual components of the portfolio.

In this respect, the Markowitz diversification model involves combining stocks with less than perfect positive correlation in order to reduce risk in the portfolio without sacrificing any of the portfolio's return. In general, the lower the correlation of the assets in a portfolio is, the less risky the portfolio will be.

According to Harry Markowitz (1952);

> Not only does portfolio analysis imply diversification, it implies the "right kind" of diversification for the "right reason". The adequacy of diversification is not thought by investors to depend on the number of different securities held. A portfolio with sixty different railway securities, for example, would not be as well diversified as the same size portfolio with some railroad, some public utility, mining, various sorts of manufacturing, etc. The reason is that, it is generally more likely for firms within the same industry to do at the same time than for firms in dissimilar industries.
>
> Similarly, in trying to make variance of returns small is not enough to invest in many securities. It is necessary to avoid investing in securities with high covariances among themselves. (Markowitz, 1952, p.47)

The major drawback of the Markowitz Mean Variance Model is that the model is practically almost impossible to implement, and very time consuming. The user of the model should be able to predict the n return terms and should also be able to predict the n number of return variation coefficients for an n asset case. In addition to these requirements, it is necessary to predict $(n^2-n)/2$ covariance terms or serial correlation coefficients between assets and securities which renders the model almost nonapplicable for increasing set of stocks.

The Markowitz Mean Variance Model's data requirement is as follows:

1. n return terms,
2. n variance terms,
3. $(n^2-n)/2$ covariance terms

II .2. Sharpe's Single Index Model

Sharpe's Single Index Model has been developed by William Sharpe in 1963 with an approach that provided substantial reductions in the effort required to prepare and process the data for a portfolio analysis.

The Single Index Model depends on the indices that measure the volatility in the stock market. The model is constructed on the following logical reasoning. The securities are affected by the overall fluctuations in the stock markets. However some stocks are more sensitive to the overall fluctuations in the markets with respect to the others, and the investors can forecast the fluctuations in stock returns as a function of the overall market fluctuations by means of a measure called as the Beta Coefficient (β_i). When the stock price movements are observed, they can be seen to move together. Therefore, the Single Index Model measures the price fluctuations in the market with an index which is an average of the stock returns, weighted with some other information content on the gain that was provided to the stock holders (Francis, 1971).

The Single Index Model utilizes the above mentioned relationship between the market fluctuations and the stock returns. Algebraically, the linear relationship between the stock returns on a given security R_i, and the market is given as follows:

$$R_i = A_i + \beta_i R_m + E_i \qquad (2.1)$$

where;

A_i : Constant term that is independent from the fluctuations in the market

R_i : Rate of return on the i^{th} asset

β_i : The beta coefficient

E_i : The random error term on the i^{th} asset

R_m : The return on the market index

Once the returns on the securities in the feasible set are expressed in terms of equation (2.1), variances of the stocks are given by the following relation:

$$\sigma(R_i)^2 = \beta_i^2 \sigma(R_m)^2 + \sigma(E_i)^2 \qquad (2.2)$$

where $\sigma(R_i)^2$ is variance of the stock's return, $\beta_i^2\sigma(R_m)^2$ is the systematic risk of the i^{th} stock, and $\sigma(E_i)^2$ is the stock specific risk.

Similarly, the covariance of the returns on two securities i and j, is given by:

$$\text{cov}(R_i R_j) = \beta_i \beta_j \sigma(R_m)^2 = \rho_{ij}\sigma(R_i)\sigma(R_j) \qquad (2.3)$$

where ρ_{ij} is the correlation between the returns i and j, and $\sigma(R_i)$ and $\sigma(R_j)$ are their respective standard deviation of returns.

One important advantage that the Single Index Model possesses over the Markowitz Mean Variance Model is that the Single Index Model of Sharpe provides substantial savings in terms of the data required to calculate the efficient frontier

(Valentine, 1975). The Markowitz Model requires $(N^2-N)/2$ covariance and N return values for the implementation of the method. Actually the main requirements as input for the Single Index Model are the estimates of expected return for each stock, the variance of the return on each stock, the beta coefficient for each stock, and the estimates of expected return for the market and the variance of the market return. Therefore, a total of $3N + 2$ number of data is required to calculate the efficient frontier. To give an example, in the case of a feasible set containing 200 stocks, the Markowitz analysis would require totally 20,100 pieces of information, including 19,900 covariance terms $((200^2-200)/2+200=20,100)$. By contrast, the Single Index Model would call for only 602 pieces of data (200*3+2=602).

II. 3. Capital Asset Pricing Model

The capital asset pricing model (CAPM) was developed on the basis provided by the portfolio theory that was pioneered by Markowitz. The CAPM was put forward by the studies of John Mossin and William Sharpe in 1967 (Valentine, 1975).

Although the CAPM is built on the Markowitz Mean Variance Model, it has additional assumptions:

1. Unrestricted borrowing and lending at the risk-free rate

2. Investors have homogenous expectations regarding the means , and covariances of security returns

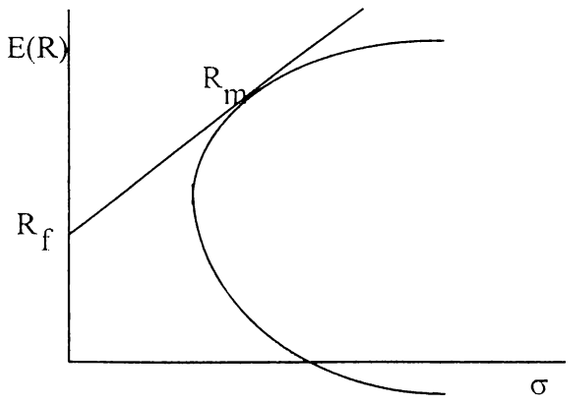
3. No taxes and no market imperfections such as transaction cost are taken into account

4. Individuals can not affect the price of a stock by their buying or selling action

Under the assumptions of the market portfolio, the only portfolio of risky assets that an investor will own is the market portfolio. The market portfolio is a portfolio in

which the fraction invested in any asset is equal to the market value of that asset divided by the market value of all risky assets. Each investor will adjust the risk of the market portfolio to his preferred risk return combination by combining the market portfolio with lending or borrowing at the riskless rate. This leads directly to the *two mutual fund theorem* (Francis, 1971). The two mutual fund theorem states that all investors can construct an optimum portfolio by combining a market fund with the riskless asset. Thus all investors should hold a portfolio along the line connecting R_f with R_m in expected return, standard deviation of return space as shown in the figure1.

Figure-1 CAPM



This line, usually called as the capital market line, describes all efficient portfolios, and is a pictorial representation of the following relation:

$$R_i = R_f + \frac{R_m - R_f}{\sigma_m} \sigma_i \qquad (2.4)$$

The term $((R_m - R_f) / \sigma_m)$ can be thought of as the market price of risk for all efficient portfolios. It is the extra return that can be gained by increasing the level of risk on an efficient portfolio by one unit (Sharpe, 1963). The second term on the right

hand side of the equation is due to risk. The first term is simply the price of time or the return that is required for delaying the potential consumption, one period given perfect certainty about the future cash flows. Thus, it can be concluded that the return on an efficient portfolio is given by the market price of time plus the market price of risk times the the amount of risk on an efficient portfolio.

II. 4. Factor Models

The security return relationship of the Single Index Model, and the capital market line of CAPM provides the basis for the factor models, and is, by itself, a *single factor model* as it contains only one source of systematic risk, R_m.

$$R_i = A_i + \beta_i R_m + E_i \qquad (2.5)$$

The *single factor model* can be decomposed into a *multi factor model* that includes interest rate risk, default risk, and other risk factors. The equation for the multifactor model is as follows:

$$R_i = A_i + \beta_{i1} F_{1,t} + \beta_{i2} F_{2,t} + \beta_{i3} F_{3,t} + \ldots\ldots + \beta_{ik} F_{k,t} + E_i \qquad (2.6)$$

The equation (2.6) is a capital market line that contains k different risk factors to explain the i^{th} asset's return. The random variables denoted $F_{k,t}$ represent k different risk factors that were observed over T different periods. The k regression coefficients represented by the symbols β_{ik} measure the sensitivity of the i^{th} asset's returns to the k^{th} risk factor.

The distinguishing features of the factor models can be summarized as follows:

1. Different securities have different sensitivities to different factors.

2. Covariances among securities can be attributed to the pull of some common "factors".

II. 5. Arbitrage Pricing Theory

While a number of multi-factor models have been developed after the CAPM, the arbitrage pricing theory proved to be the primary competitor. The arbitrage pricing theory has been formulated by Stephen A. Ross (1976). As it has evolved, arbitrage pricing theory asserts that the risk elements which influence security returns are anticipated changes in four economic variables: inflation, industrial production, risk premiums, and the slope of the term structure of interest rates. It is asserted that assets can have the same CAPM beta, yet have different patterns of sensitivities to these underlying economic factors.

It is important to note that both CAPM and APT share two basic tenets of modern portfolio theory. Security returns are believed to be related to systematic risk factors; and investors are believed to be risk averse. Also, both models assume that investors share fairly homogenous expectations about the future, and that security markets are relatively efficient. The major difference between the models revolves around definitions of systematic risk.

Because the systematic factors are the major sources of risk, it follows that they are the principal determinants of the expected, as well as the actual, returns on portfolios. It is possible to see that the actual return, R, on any security or portfolio may be broken down into three constituent parts, as follows:

$$R = E + bf + e \qquad (2.7)$$

where;

E = expected return on security

b = security's sensitivity to change in the systematic factor

f = the actual return on the systematic factor

e = returns on the unsystematic factors

Equation (2.7) states that the actual return equals the expected return, plus factor sensitivity times factor movement, plus residual risk.

Empirical study suggests that a three- or four-factor model adequately captures the influence of systematic factors on stock market returns. Equation (2.7) may thus be extended to:

$$R = E + (b1)(f1) + (b2)(f2) + (b3)(f3) + (b4)(f4) + e \qquad (2.8)$$

Each of the four middle terms in the above equation is the product of the returns on a particular economic factor and the given stock, sensitivity to that factor. Researches suggest that the most important factors are unanticipated inflation, changes in the expected level of industrial production, unanticipated shifts in risk premiums, and unanticipated movements in the shape of term structure of interest rates.

II. 6. Other Methods

II. 6. 1. The Black Model

The Black Model has been devised in 1972, and it is identical to the Mean Variance Model of Markowitz except that the nonnegaitivity constraints on security weights are removed. By the removal of the nonnegativity constraints, for a given set of securities, the optimal portfolio structure and the shape and structure of the efficient frontier becomes totally different (Samuelson,1974).

II. 6. 2. The Tobin Model

One of the important assumptions of both the Markowitz Mean Variance Model and the Black Model was that all of the stocks should have positive variance. The Tobin Model (1965) removes this assumption by allowing the existence of a security that possesses no risk; i.e., zero variance. On the other hand, in the Tobin Model, the nonnegativity constraint of the Markowitz Model is imposed on all securities except for the risk free asset. Short selling of the risk free asset is equivalent to borrowing funds at a cost equal to the risk free asset's rate of return.

II. 6. 3. The Modified Tobin Model

The Black model removed the nonnegativity constraints for the weights of the stocks in a portfolio created by the Markowitz Mean Variance Model, but still requires all securities to have zero variance. In case a risk free security is added to the Black model, then the efficient frontier of the portfolio becomes a line, and tangent to a risky portfolio on the upper side of the efficient frontier hyperbola. The modified Tobin model differs from the Markowitz and Black model in that a riskfree borrowing and lending rate is added to the set of n risky securities.

III. METHODOLOGY

Diversification represents a fundamental principle of successful portfolio management. The principle is to reduce the risk in investment by diversifying over several assets. The objective of diversification is not necessarily to avoid risk; but to find, and reduce it to a considerable, and acceptable level of risk (Markowitz, 1981).

Diversification limits risk, but there is a price to pay for safety as diversification limits also return. Optimal diversification means obtaining the best possible trade off between safety (i.e., risk) and return. More precisely, optimal diversification means minimizing risk (or maximizing safety) for a given expected return. In other words, optimal diversification means maximizing expected return for a given acceptable level of risk.

There are many different approaches to portfolio diversification. Among all, this study is based on the application of the Markowitz Mean-Variance Portfolio Selection Model to the ISE because of its logical assumptions that are closer to the behaviour of rational investors. The rationale that for any expected rate of return, most investors will prefer a portfolio containing minimum expected deviation of return around the mean is entirely reflected in the Markowitz Mean Variance Portfolio Selection Model (Valentine 1975).

Four classes of calculation approaches can be utilized for the construction of the efficient portfolio and the efficient frontier. These are:

1. Short selling allowed with riskless lending and borrowing;
2. Short selling allowed with no riskless lending and borrowing;

3. No short selling allowed with riskless lending and borrowing;

4. No short selling allowed with no riskless lending and borrowing.

Short selling strategy is used by the investors when it is believed that trading a nonexisting stock in the investor's portfolio can provide positive returns. Actually the act of shortselling in a security is the selling the rights of holding a security to another investor, and then buying that security in a later time for the physical delivery. The return from that transaction is the difference between the selling and buying prices. Selling of a non-owned security short is undertaken when the stock is believed to decrease in price. Since the delivery of the stock can be handled sometime later, and if it is believed by the investor that the price of the stock will decrease during that period, then the investor should certainly enter a short position for arbitrage opportunity.

In this study, no short selling approach with riskless lending and borrowing is applied in the ISE. In this respect, the main objective is to determine the efficient portfolio and construct the efficient frontier for the whole set of securities that are traded in the ISE during the 1992-June 1995 period. Then the performance of the method and the selected portfolios is measured utilizing the June1995-December1995 year monthly data.

III. 1. Method

III. 1.1. General relationships and definitions

III. 1. 1. 1. Return

$$r_{i,t} = \frac{P_{i,t} - P_{i,(t-1)} + d_{i,t}}{P_{i,(t-1)}} \qquad (3.1)$$

$r_{i,t}$: The rate of return on the i^{th} stock in the t^{th} period

$P_{i,t}$: Price of the i^{th} stock in the t^{th} period

$d_{i,t}$: Dividend and other payments for the i^{th} stock in the t^{th} period

III. 1. 1. 2. Average Return

$$\overline{R}_i = \frac{\sum_{j=1}^{n} r_{i,j}}{n} \qquad (3.2)$$

$\overline{R}_i$: Average rate of return on the i^{th} stock

n : Number of periods

III. 1. 1. 3. Variance of Return

$$\sigma_i^2 = \frac{\sum_{j=1}^{n} (r_{i,j} - \overline{R}_i)^2}{n-1} \qquad (3.3)$$

σ_i : variance of return for the i^{th} stock

III. 1. 1. 4. Covariance

$$\sigma_{i,k} = \frac{\sum_{i=1}^{n} (r_{i,j} - \overline{R}_i)(r_{k,j} - \overline{R}_k)}{n} \qquad (3.4)$$

$\sigma_{i,k}$: covariance between i^{th} and k^{th} stock returns

III. 1. 1. 5. Correlation

$$\rho_{i,j} = \frac{\sigma_{i,j}}{\sigma_i \sigma_j} \qquad (3.5)$$

$\rho_{i,j}$: Correlation coefficient for the i^{th} and j^{th} securities

σ_i : Standard deviation of the i^{th} security

σ_j : Standard deviation of the j^{th} security

III. 1. 1. 6. Minimum Variance Portfolio (MVP)

The minimum variance portfolio is a portfolio combination which has the lowest possible variance for a given set of objectives. In other words, minimum variance portfolio is the least risky portfolio for a given set of objectives.

III. 2. The Markowitz Mean Variance Model

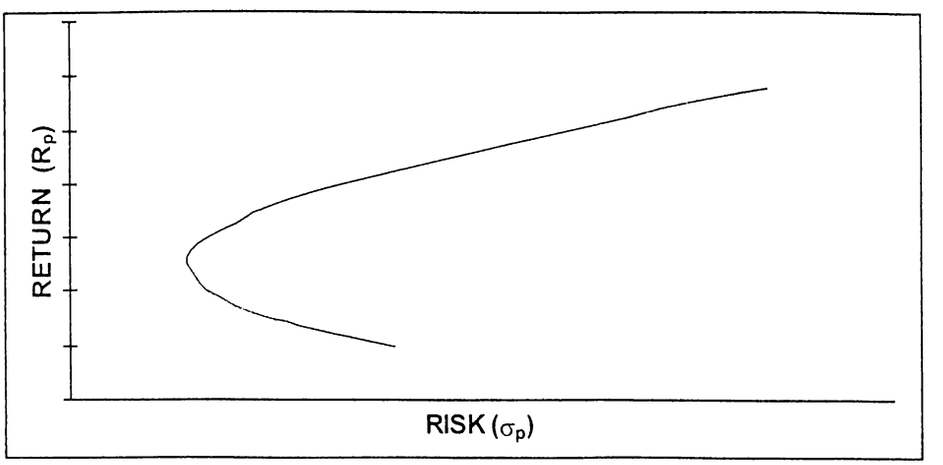
Given the necessary information outlined above, Markowitz offered a mathematical technique, solvable by a suitable computer program, which permits the

determination of the most probable rates of return on numerous possible portfolio combinations of the individual securities and the associated possible range of deviation from these most likely returns. Therefore, given the rates of return and the level of standard deviation together with the covariances among the set of securities, the Markowitz model traces the opportunity set for different risk preference levels for constructing the efficient mean-variance combinations.

Having calculated the rate of return for each security using equation (3.1) and having determined the average rate of return and variance for each security included in the analysis by equations (3.2) and (3.3) respectively, the Markowitz Mean Variance Model determines the efficient set of stocks. According to the model, an optimum, or efficient portfolio can be defined as one providing the highest possible expected return given a predetermined risk level willing to be assumed by the investor.

The group of all efficient portfolios determined by the model constitute the points on the *efficient frontier*. The efficient frontier is the locus of points in risk-return space having the maximum return at each risk class (Francis, 1991). The efficient frontier simply dominates all other investment opportunities. An illustrative efficient frontier is shown in figure 2 below.

Figure-2 Efficient Frontier



The shape of the efficient frontier is concave for the points above the MVP, and convex for the points that lie below the MVP. Because the combination of securities can not have more risk than than the risk found on a straight line connecting the set of securities, the efficient frontier can not be totally convex.

In order to apply the Markowitz Mean Variance portfolio selection model, the return and variance of the portfolio should be calculated using the average return and variance of return values that are calculated using equations (3.2) and (3.3) respectively.

III. 2. 1. Portfolio Return

$$R_p = \sum_{i=1}^{n} x_i R_i \qquad (3.6)$$

R_i : Rate of return of the i^{th} security

x_i : Proportion to invest of the i^{th} security

III. 2. 2. Portfolio Variance

$$\sigma_p^2 = \sum_{(i=1)}^{n} \sum_{(i=1)}^{n} x_i x_j \sigma_{i,j} \qquad (3.7)$$

σ_p^2 : Portfolio variance

x_i : Proportion to invest on the i^{th} security

$\sigma_{i,j}$: Covariance between the i^{th} and j^{th} security returns

The Markowitz Mean Variance Model, in its original form in 1952, to obtain the efficient frontier can be formulated as follows:

$$\min - \lambda R_p + \sigma_p \qquad , \lambda \geq 0 \tag{3.8}$$

λ : Risk preference coefficient

R_p : Rate of return of portfolio

σ_p : Variance of portfolio

The above objective function can then be written as follows:

$$\min - \lambda\left(\sum_{i=1}^{n} x_i R_i\right) + \left(\sum_{(i=1)}^{n}\sum_{(i=1)}^{n} x_i x_j \sigma_{i,j}\right) \qquad , \lambda \geq 0 \tag{3.9}$$

The set of constraints for the no short selling model that associated with the model are as follows:

1. Unity constraint : This constraint guarantees that the sum of the weights of the securities included in the efficient portfolio equals to one.

$$\sum_{i=1}^{n} x_i = 1 \tag{3.10}$$

2. Expected return constraint : This constraint ensures that a required and predetermined rate of return, R_d , is earned by the constructed portfolio.

$$\sum_{i=1}^{n} x_i R_i = R_d \tag{3.6}$$

3. Non-negativity constraint : This constrain ensures that no short selling is allowed in the analysis, and that the weigths associated with the stocks are non-negative.

$$x_i \geq 0 \qquad (i = 1,2,3.....n) \qquad (3.11)$$

Because of the difficulties encountered for the solution of the quadratic objective function of the standard Markowitz Mean Variance Model, several simplified versions have been formulated. The software package utilized in this study for the solution of the quadratic objective function, is constructed on the following quadratic optimization program based on the Markowitz Mean Variance Model.

$$\text{MIN } \sigma^2_p = \left(\sum_{(i=1)}^{n} \sum_{(i=1)}^{n} x_i x_j \sigma_{i,j} \right)$$

subject to:

1. $\sum_{i=1}^{n} x_i R_i = R_d$

2. $\sum_{i=1}^{n} x_i = 1$

3. $x_i \geq 0 \qquad (i = 1,2,3.....n)$

where;

σ^2_p : Variance of portfolio

x_i : Proportion to invest on the i^{th} security

$\sigma_{i,j}$: Covariance between the i^{th} and j^{th} security returns

R_d : Predetermined rate of return of portfolio. In the study, the locus of 20 different efficient portfolios on the efficient frontier has been determined for 20 different portfolio returns from 0.06 to 0.15 incremented by 0.015 for each iteration.

During this study, Microsoft EXCEL 5.0 is utilized for calculating the average return and standard deviation figures of the stocks. Same program is also used for determining the covariances among the whole set of stocks.

For the solution of the Markowitz Mean Variance portfolio selection model, a program code has been written on the GAMS which is a software package constructed for the solution of optimization problems (see Appendix 3 for the code written for solving the quadratic optimization problem). The results obtained by this specific program are then imported to EXCEL 5.0 for determining the efficient frontier, and for executing a performance analysis.

III. 3. Data

This study includes the whole set of stocks that have traded during the 1992-June 1995 period in th ISE. Therefore 129 stocks that were active in the ISE during the specified period have all been analyzed for obtaining the efficient portfolio and the efficient frontier (Appendix 2).

A relatively long period of 3.5 years is chosen for the analysis to get a reliable information about the trend of the stock prices and returns. The available data for the period July 1995-December 1995 has been saved for the performance measurement and analysis of the efficient portfolios determined during the study.

The average monthly return data for each stock for the mentioned period has been collected from the "Capital, Dividend and Monthly Price Data Bulletin" (ISE 1996). The monthly data presented in the bulletin are all adjusted data so that no procedure has been needed for re-adjusting the data for modifying the prices and the returns against the stock splits, etc.

For certain stocks that were out of trade for a specific time period, the average return for the stock is calculated by neglecting the period with missing monthly data. The stocks with missing monthly data are Abana Elektromekanik, Global Menkul Değerler, Hürriyet Gazetecilik, Medya Holding, Transtürk and Turcas Petrolcülük. There exists 2 missing data for Transtürk, Global Menkul Değerler and Hürriyet Gazetecilik. For the other stocks mentioned above only one monthly return data is missing among the 36 monthly data for the 1992-June 1995 period.

The 129 stocks that were traded at the ISE in the 1992-June 1995 period represents 28 different industries. The ISE stock codes, full company names and respective industry names are given in Appendix 5.

IV. FINDINGS

In this study, 20 different efficient portfolios have been determined by the Markowitz Mean Variance portfolio selection model for constructing the efficient frontier. Among the 129 stocks that are considered for the determinartion of the efficient portfolios, only 30 stocks representing 18 different sectors have entered the efficient portfoilos. (Table-1a, Table-1b).

Table-1a Efficient Portfolio Compositions

	Port. 1	Port. 2	Port. 3	Port. 4	Port. 5	Port. 6	Port. 7	Port. 8	Port. 9	Port. 10
Port. Return	0,06	0,065	0,07	0,075	0,08	0,085	0,09	0,095	0,1	0,105
Port. Variance	0,012	0,010	0,008	0,006	0,006	0,005	0,005	0,005	0,006	0,007
σ_p	0,110	0,097	0,087	0,080	0,075	0,073	0,071	0,072	0,075	0,081

Efficient Portfolio Compositions

	Port. 1	Port. 2	Port. 3	Port. 4	Port. 5	Port. 6	Port. 7	Port. 8	Port. 9	Port. 10
AFY03					1,30%	0,90%				
AKBNK				1,70%	5,00%	5,30%	4,40%	3,40%	2,60%	
AKSA				0,80%	1,90%					
ARCLK	20,20%	16,40%	12,00%	8,40%	2,90%					
CNKKL			2,50%	4,40%	5,30%	6,50%	6,20%	4,80%	2,60%	
CIMSA				1,50%	3,60%	2,00%	0,10%			
CUKEL				2,30%	3,70%	2,40%	1,50%			
DENCM										
DITAS							0,70%	2,70%	4,00%	5,80%
DUROF									0,70%	2,00%
EGBRA						0,20%	1,60%	3,00%	4,00%	3,90%
ENKA										2,10%
FENIS	31,90%	26,20%	20,00%	13,60%	7,90%	4,10%	0,20%			
GIM34										
GUBRF										0,50%
HURGZ						0,50%	1,50%	1,90%	1,80%	1,70%
IZOCM	15,30%	12,90%	8,80%	2,70%						
KLBMO										
KEN34	19,50%	33,30%	42,40%	49,30%	51,40%	54,10%	56,00%	54,90%	54,40%	50,30%
KCYAT	8,70%	7,10%	6,10%	4,00%						
MEDYA	1,20%	1,10%	0,40%		0,56%					
MIGRS					0,60%	5,60%	8,80%	13,60%	16,00%	18,90%
NTTUR	3,20%	2,10%	1,30%	0,70%	0,30%	0,20%				
NIGDE						1,80%	3,40%	5,40%	6,20%	6,80%
PETKM										
PNUN									2,50%	5,70%
PIMAS										
SARKY				0,30%	3,50%	3,10%	2,60%	1,60%	0,40%	
TBORG		1,00%	3,40%	4,40%	4,90%	5,20%	4,60%	1,90%		
TURCS			3,10%	6,10%	7,90%	8,10%	8,30%	6,00%	4,80%	2,30%

Number of Stocks and in Efficient Portfolio

	Port. 1	Port. 2	Port. 3	Port. 4	Port. 5	Port. 6	Port. 7	Port. 8	Port. 9	Port. 10
# of Stocks	7	8	10	14	15	15	14	11	12	11

Table-1b Efficient Portfolio Compositions

	Port. 11	Port. 12	Port. 13	Port. 14	Port. 15	Port. 16	Port. 17	Port. 18	Port. 19	Port. 20
Port. Return	0,11	0,115	0,12	0,125	0,13	0,135	0,14	0,145	0,15	0,155
Port. Variance	0,007	0,008	0,010	0,012	0,014	0,017	0,020	0,023	0,027	0,031
σ_p	0,085	0,092	0,100	0,110	0,120	0,130	0,141	0,152	0,164	0,177

Efficient Portfolio Compositions

	Port. 11	Port. 12	Port. 13	Port. 14	Port. 15	Port. 16	Port. 17	Port. 18	Port. 19	Port. 20
AFY03										
AKBNK										
AKSA										
ARCLK										
CNKKL										
CIMSA										
CUKEL										
DENCM						0,30%	1,40%	2,90%	8,80%	15,00%
DITAS	7,00%	8,40%	9,50%	10,30%	11,20%	12,00%	13,00%	14,00%	15,60%	17,20%
DUROF	2,90%	3,80%	4,50%	5,10%	5,80%	6,40%	6,80%	7,10%	6,80%	6,10%
EGBRA	3,40%	2,10%	0,70%	0,40%						
ENKA	2,70%	2,00%	0,60%							
FENIS										
GIM34		0,80%	1,80%	3,10%	4,20%	5,20%	6,10%	6,90%	7,00%	7,40%
GUBRF	0,60%	0,60%	0,30%							
HURGZ	1,50%	1,30%	1,20%	1,20%	1,20%	1,20%	1,20%	1,30%	1,90%	2,50%
IZOCM										
KLBMO		1,40%	3,20%	4,40%	5,30%	5,80%	6,10%	6,00%	2,20%	
KEN34	45,90%	39,80%	33,70%	26,90%	19,60%	12,50%	5,90%			
KCYAT										
MEDYA										
MIGRS	20,70%	23,10%	25,20%	26,30%	27,30%	28,00%	28,50%	28,70%	25,40%	21,50%
NTTUR										
NIGDE	7,30%	7,30%	7,10%	7,00%	6,80%	6,70%	6,30%	5,70%	3,00%	
PETKM			0,60%	2,40%	4,00%	5,70%	7,10%	8,50%	9,00%	9,50%
PNUN	7,30%	9,50%	11,50%	13,00%	14,70%	16,00%	17,10%	18,20%	18,70%	19,40%
PIMAS						0,20%	0,20%	0,60%	1,50%	1,60%
SARKY										
TBORG										
TURCS	0,70%									

Number of Stocks and in Efficient Portfolio

	Port. 11	Port. 12	Port. 13	Port. 14	Port. 15	Port. 16	Port. 17	Port. 18	Port. 19	Port. 20
# of Stocks	11	12	13	11	10	12	12	11	11	9

As evident from Table 2, Niğde Çimento, Pınar Un, Kent Gıda, Duran Ofset, Hürriyet Gazetecilik, Ditaş Doğan and Migos have entered more than 10 of the 20 portfolios constructed. Despite, Afyon Çimento and Aksa have joined 2 efficient portfolios.

The 30 different stocks engaged in the efficient portfolios represent 18 different sectors. More than 3 stocks representing each of the cement and chemistry sectors and conglemarates have entered the efficient portfolios. It is

not unexpected to observe that the efficient portfolios contain stocks representing different sectors. This is because of the fact that effective diversification is achieved if the portfolio is composed of securities that fluctuate in a different fashion. As Markowitz has mentioned (1952), it is generally more likely for firms within the same industry to do at the same time than for firms in dissimilar industries. Thus, stocks from different sectors that are expected to move in different directions provide greater opportunity for diversification.

Table-2 The Set of Stocks in Efficient Portfolios

Sector	Stock	Stock's Presence in # of Portfolios
Cement	NIGDE	14/20
Cement	CNKKL	7/20
Cement	CIMSA	4/20
Cement	AFY03	2/20
Building Materials	PIMAS	5/20
Building Materials	IZOCM	4/20
Banking	AKBNK	6/20
Brewery	TBORG	7/20
Brewery	EGBRA	9/20
Glass	DENCM	5/20
House Apparel	ARCLK	5/20
Energy	CUKEL	4/20
Food	PNUN	12/20
Food	KEN34	17/20
Conglomarate	MEDYA	4/20
Conglomarate	KCYAT	4/20
Conglomarate	ENKA	4/20
Paper	KLBMO	8/20
Paper	DUROF	12/20
Chemicals	TURCS	9/20
Chemicals	PETKM	8/20
Chemicals	GUBRF	4/20
Media	HURGZ	15/20
Metal Industry	FENIS	7/20
Automotive	DITAS	14/20
Retail	MIGRS	16/20
Retail	GIM34	9/20
Textile	AKSA	2/20
Telcommunication	SARKY	6/20
Tourism	NTTUR	6/20

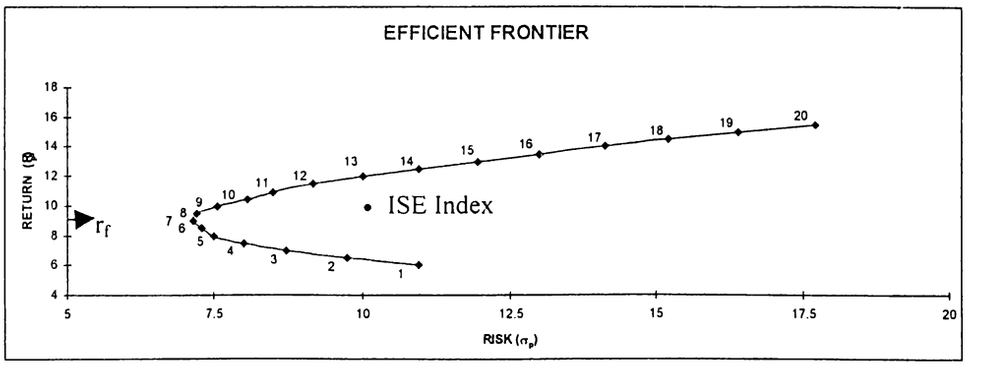
It is evident from Table-1a and Table-1b that 7 to 15 different stocks have joined the 20 different portfolios. However, it is interesting to note that, for the efficient

portfolios that lie below the MVP (Portfolio 7), the stocks that are represented in the portfolios are; Afyon Çimento, Akbank, Arçelik, Feniş Alüminyum, Çimsa, İzocam, Kent Gıda, Koç Yatırım, Net Turizm, Sarkuysan, Tuborg, Turcas Petrolcülük, and Çanakkale Çimento. On the other hand, the set of stocks that are represented with a an increasing percentage in the efficient portfolios that are above the MVP are, Ditaş Doğan, Duran Ofset, Hürriyet, Kelebek Mobilya, Kent Gıda, Migros, Oysa-Niğde Çimento, Pınar Un, Sarkuysan, Turcas Petrolcülük, and Tuborg (see Appendix 3 for portfolio weights of individual stocks).

Therefore, it is evident to conclude that two different sets of stocks are effective in the efficient portfolios that lie above and below the MVP. With a careful analysis, it is possible to find out that Kent Gıda, Migros, Tuborg, and Turcas Petrolcülük are the four different stocks that have considerable weight and effect in all of the efficient portfolios constructed. While the weight of the Kent Gıda increased from 0.333, when the average return was 0.065, to 0.549 when the return figure was 0.095, the weight of the same stock declined to 0.06 when the average return was 0.145. On the other hand, while the weigth of the Migros was zero for the efficient portfolios with an average return less than 0.08, it increased its effect over the portfolios with higher return values so gradually that its weight in the efficient portfolio rose up to 0.215 when the average return figure was 0.155.

When the whole set of efficient portfolis are examined, Kent Gıda,and Migros can be examined to have the higher weights in all of the portfolios as they have relatively less risk and higher return figures. It is undeniable that covariances among securities also effect the representativeness of stocks in the efficient portfolios. However, the covariances of the securities are so similar in quantity that the main factors determining a stock's presence in the efficient portfolios become the return and risk figures.

Figure-3 The Efficient Frontier



The first 6 portfolios that lie below the MVP, as shown in figure 3 above, are inferior to the efficient portfolios that lie above the MVP. This is because the portfolios above the MVP offer higher return for a certain amount of risk. Therefore the portfolis below the MVP are not actual efficient portfolios. A more detailed figure of efficient frontier can be examined in Appendix 2.

V. MEASUREMENT OF PERFORMANCE

In an effort to measure the performance of investment portfolis, various devices have been proposed. The more sophisticated of these techniques soughts to take both risk and return of a portfolio into consideration. Sharpe has developed a model for portflio performance measurement that considers both risk and return and allows the portfolio to be ranked (Sharpe, 1965). The model develops an ordinal number to measure the performance of each portfolio. This number is a function of the portfolio's risk and return.

Sharpe (1965) has analyzed 34 mutual fund's performance over the decade from 1954 to 1963. He subtracted from the gross average return, R_i, his estimate of the riskless return over the decade, that is assumed to be 5%.

The difference is a risk premium for investing in assets with more than zero risk. He then divided each fund's risk premium by its standard deviation of annual returns, σ, a measure of the portfolio's total risk. The resulting number is the ratio of risk prtemium per unit of risk borne. Let this ratio of risk premium per unit of risk borne be denoted S_i for the i^{th} mutual fund.

$$S_i = \frac{R_i - R_f}{\sigma_i} \qquad (5.1)$$

S is the Sharpe's Index of desirability. S is developed for comparing assets in different risk classes.

With the aim of measuring the performance of the efficient portfolios and the method, the 20 portfolios determined by the Markowitz Mean Variance portfolio

selection model to maintain the efficient frontier have been selected for analysis. Additionally, the ISE Index and naive portfolio are also analyzed in order to sustain the justification of the Mean Variance Model and its applicability to the ISE. (see Appendix 6)

The tangency portfolio is a portfolio on the efficient frontier that is tangent to a line drawn from the risk free rate on the risk-return diagram. The risk free rate is taken as 8.4 %, the average of the market returns of the treasury bills that are traded in the 1992-June 1995 period. In the analysis, the tangency portfolio is determined by a hypothetical line drawn from the risk free rate on the vertical axis tangent to the efficient frontier. Therefore, the portfolio number 13, with a variance of 0.012 and a return of 12.5% is the tangency portfolio. (see Appendix 1).

The MVP portfolio, on the other hand, is the portfolio on the left end of the efficient frontier that posesses the lowest standard deviation. In the analysis of performance measurement, the corner portfolio is selected to be the portfolio number 7, with a variance of 0.0052, and a return of 9% (see Appendix 1).

The naive portfolio is the portfolio constructed by simply equally weighing all the stocks that are traded. Therefore, the naive portfolio in this analysis is constructed by weighing each stock by 1/129. The portfolio return, standard deviation and Sharpe's performance measurement ratio for the naive prtfolio is presented in Appendix 6.

The ISE Index is the index portfolio representing the whole set of stocks being traded in the ISE during the July 1995-December 1995 period. The monthly return and standard deviation figures as well as the Sharpe's performance measurement ratio for the ISE Index is presented in Appendix 6.

In order to measure the performance of the portfolios with Sharpe's ranking device, the data on June 1995-December 1995 period is used. Firstly, the monthly data for each of the stocks for the mentioned period (Appendix 4) is utilized to obtain the monthly returns of the portfolios constructed. The portfolio returns for each month are calculated by using the appropriate weights of the stocks in the related portfolios. Next, the average returns, and standard deviations for the portfolios are calculated as shown in Appendix 6.

In order to calculate the Sharpe's Index for each of the portfolios and compare them, the equation 5.1 is used. The risk free is taken as 8.4 % as mentioned before. The Sharpe indices for each of the portfolios is given in table 3 below:

Table-3 Sharpe Index

	Port. Return	Std. Deviation	r_f rate	Sharpe's Index
Portfolio 1	0,017	0,136	8,4%	-0,492
Portfolio 2	0,013	0,112	8,4%	-0,635
Portfolio 3	0,012	0,100	8,4%	-0,724
Portfolio 4	0,015	0,088	8,4%	-0,787
Portfolio 5	0,015	0,082	8,4%	-0,840
Portfolio 6	0,001	0,072	8,4%	-1,143
(MVP) Port7	0,003	0,067	8,4%	-1,197
Portfolio 8	0,002	0,063	8,4%	-1,318
Portfolio 9	-0,001	0,059	8,4%	-1,428
Portfolio 10	-0,001	0,064	8,4%	-1,315
Portfolio 11	0,001	0,073	8,4%	-1,133
Portfolio 12	-0,001	0,086	8,4%	-0,987
(Tang.) Port 13	-0,007	0,111	8,4%	-0,821
Portfolio 14	-0,007	0,111	8,4%	-0,821
Portfolio 15	-0,008	0,124	8,4%	-0,748
Portfolio 16	-0,010	0,135	8,4%	-0,696
Portfolio 17	-0,011	0,145	8,4%	-0,659
Portfolio 18	-0,013	0,154	8,4%	-0,631
Portfolio 19	-0,016	0,151	8,4%	-0,662
Portfolio 20	-0,021	0,149	8,4%	-0,701
ISE Index	1,73E-18	0,116	8,4%	-0,721
Naive Port.	-0,017	0,118	8,4%	-0,855

As a result of the analysis, the portfolios are listed in Table-4 below according to their degree of performance as measured by the Sharpe's criterion.

The Sharpe's performance measurement ratio is negative for all portfolios as the average return for each portfolio is lower than the risk free rate for the June 1995-December 1995 period. During the test period the average of the portfolio returns was between -0.007 and 0.017 and the average return for the ISE Index was around 0. On the other hand, the riskless rate, which is expected to be lower than the return of the efficient portfolios is as high as 8.4%.

Table-4 Performance Listing of Efficient Portfolios

	Portfolio	Sharpe's Index
1	Portfolio 1	-0,492
2	Portfolio 18	-0,631
3	Portfolio 2	-0,635
4	Portfolio 17	-0,659
5	Portfolio 19	-0,662
6	Portfolio 16	-0,696
7	Portfolio 20	-0,701
8	ISE Index	-0,721
9	Portfolio 3	-0,724
10	Portfolio 15	-0,748
11	Portfolio 4	-0,787
12	(Tang.) Port 13	-0,821
13	Portfolio 14	-0,821
14	Portfolio 5	-0,840
15	Naive Port.	-0,855
16	Portfolio 12	-0,987
17	Portfolio 11	-1,133
18	Portfolio 6	-1,143
19	(MVP) Port7	-1,197
20	Portfolio 10	-1,315
21	Portfolio 8	-1,318
22	Portfolio 9	-1,428

Among the 22 portfolios, Portfolio 1 is the most effective portfolio while Portfolio 9 is the worst performing portfolio. The ISE Index is the 8th best performing portfolio according to the Sharpe's performance measurement device.

The tangency portfolio proves to be the 12th most effective portfolio in the set of 22 portfolios, with -0.821 Sharpe's Index figure. It is interesting to observe that the

naive portfolio seems to perform better than the corner portfolio in the period of June 1995-December 1995.

The naive portfolio constructed from all stocks in equivalent amounts hedges perfectly against the radical adverse changes in the stock prices. This may prove to be a reason for the better performance of the naive portfolio with respect to the minimum variance portfolio.

Another reason for the poor performance of the MVP with respect to the naive portfolio is that the performance measures of the portfolios have been made over a period of 6 months, while the portfolios were constructed using a data of 3.5 years. There is a significant difference between the length of the time periods. A better result could have been obtained for the performance of the portfolios should a longer period be available for performance measurement.

Finally, due to the shortness of the time period for performance measurement, any extraordinary economic event could directly affect the portfolio analysis.

VI. CONCLUSION

Despite the invention of the portfolio management theory, in Turkey, still most of the financial intermediaries make use of accounting methods and procedures for obtaining efficient portfolios. However these methods are actually far from reaching the efficient portfolios as the data and results obtained by these procedures is inaccurate, and presents information about only the unsystematic risks specific to the firms, and independent of political, economic and other factors that affect the financial markets systematically.

Therefore, this study attempts to develop a better approach to portfolio management by applying the Markowitz Mean Variance Model to the whole set of stocks that has been traded at the ISE during the 1992-1995 period. Although several different models for portfolio management have been proposed since 1952, the Markowitz Mean Variance Model has been accepted as the most influential and effective one.

Starting with the conception of risk and the assumed aversion to risk by the rational investors, Markowitz observed that investors should try to minimize deviations from the expected portfolio rate of return by diversifying their security selections, holding either different types of securities or securities of different companies. He pointed out to the fact that by means of effective diversification, an investor should have a lower risk from a portfolio than the risk of any of the stocks included in the portfolio for a specified return.

The Markowitz Mean Variance Model, like any other portfolio management methods, relies on the past data. However, the reliability of past data for predicting outcomes of the future may be very limited. In an environment with unforeseen

interest rates, and uncertain financial intermediaries, the confidence of the method becomes disputable.

The performance tests of the model has shown that a naive portfolio can be more efficient than a minimum variance portfolio on the efficient frontier. Such a result seems mathematically impossible when the external factors are totally ignored. However, when the structure of the financial intermediaries in Turkey are considered, it can be concluded that, in an economy where extraordinary economic events like the April 5 crisis are possible at any time, such unexpected outcomes could easily result.

Therefore, we have to admit that it is very hard to predict the actual performance of the stocks, and construct full proof portfolios with the Markowitz Mean Variance Model only. In order to perform more effective portfolio management, we need to follow the world trend of economic changes, and the financial structure of the industries. Additionally, we need to evaluate accounting information obtained from financial ratios, balance sheets, etc., to provide better predictions about portfolio selections and their respective performance.

The research work based on the Markowitz Mean Variance Model that has been performed in emerging markets including Greece, Poland and Israel has provided similar results. As in the case of this study, the application of the Markowitz Mean Variance model has been successfully implemented in finding the efficient portfolio and drawing the efficient frontier. In all cases observed, the shape of the efficient frontier complies with the theoretical frontier. However, as in this research work, in the application of the performance measurement tool in other emerging markets (Sharpe's Index), the naive portfolio has outperformed several optimum portfolio. This proves our past conclusion that the application of the Markowitz Mean Variance Model is very limited in unstable economies where the performance of the portfolios can not be effectively determined from past data.

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APPENDIX

APPENDIX 1

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.06

PORTFOLIO VARIANCE=0.012

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	-	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	0.153	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	0.195	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	0.202	KCHOL	-	TOASO	-
ASELS	-	KCYAT	0.087	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	-
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	0.012	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	-		
DITAS	-	NTHOL	-		
DOGUB	-	NTTUR	0.032		
DOKTS	-	OKANT	-		
DUROF	-	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	-		
EGBRA	-	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	-		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	0.319	PNUN	-		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	-	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.065

PORTFOLIO VARIANCE=0.0095

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	-	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	0.129	SISE	-
ALRSA	-	KARTN	-	TBORG	0.01
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	0.333	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	0.164	KCHOL	-	TOASO	-
ASELS	-	KCYAT	0.071	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	-
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	0.011	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	-		
DITAS	-	NTHOL	-		
DOGUB	-	NTTUR	0.021		
DOKTS	-	OKANT	-		
DUROF	-	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	-		
EGBRA	-	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	-		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	0.262	PNUN	-		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	-	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.07

PORTFOLIO VARIANCE=0.0076

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	-	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	0.088	SISE	-
ALRSA	-	KARTN	-	TBORG	0.034
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	0.424	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	0.12	KCHOL	-	TOASO	-
ASELS	-	KCYAT	0.061	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	0.031
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	0.025	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	0.004	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	-		
DITAS	-	NTHOL	-		
DOGUB	-	NTTUR	0.013		
DOKTS	-	OKANT	-		
DUROF	-	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	-		
EGBRA	-	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	-		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	0.2	PNUN	-		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	-	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.075

PORTFOLIO VARIANCE=0.0064

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	-	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	0.017	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	0.008	IZMDC	-	TSKB	-
ALARK	-	IZOCM	0.027	SISE	-
ALRSA	-	KARTN	-	TBORG	0.044
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	0.493	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	0.084	KCHOL	-	TOASO	-
ASELS	-	KCYAT	0.04	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	0.061
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	0.044	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	0.015	MAALT	-	VESTL	-
CUKEL	0.023	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	-		
DITAS	-	NTHOL	-		
DOGUB	-	NTTUR	0.007		
DOKTS	-	OKANT	-		
DUROF	-	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	-		
EGBRA	-	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	-		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	0.136	PNUN	-		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	-	SABAH	-		
GLOBL	-	SARKY	0.003		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.08

PORTFOLIO VARIANCE=0.0056

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	0.013	HURGZ	-	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	0.05	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	0.019	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	0.049
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	0.514	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	0.029	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	0.079
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	0.053	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	0.036	MAALT	-	VESTL	-
CUKEL	0.037	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	0.0056	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.006		
DITAS	-	NTHOL	-		
DOGUB	-	NTTUR	0.003		
DOKTS	-	OKANT	-		
DUROF	-	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	-		
EGBRA	-	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	-		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	0.079	PNUN	-		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	-	SABAH	-		
GLOBL	-	SARKY	0.035		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.085

PORTFOLIO VARIANCE=0.0053

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	0.009	HURGZ	0.005	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	0.053	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	0.052
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	0.541	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	0.081
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	0.065	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	0.02	MAALT	-	VESTL	-
CUKEL	0.024	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.056		
DITAS	-	NTHOL	-		
DOGUB	-	NTTUR	0.002		
DOKTS	-	OKANT	-		
DUROF	-	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.018		
EGBRA	0.002	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM			
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	0.041	PNUN	-		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	-	SABAH	-		
GLOBL	-	SARKY	0.031		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.09

PORTFOLIO VARIANCE=0.0051

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.015	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	0.044	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	0.046
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	0.56	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	0.083
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	0.062	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	0.001	MAALT	-	VESTL	-
CUKEL	0.015	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.088		
DITAS	0.007	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	-	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.034		
EGBRA	0.016	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	-		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	0.002	PNUN	-		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	-	SABAH	-		
GLOBL	-	SARKY	0.026		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.095

PORTFOLIO VARIANCE=0.0052

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.019	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	0.034	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	0.019
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	0.549	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	0.06
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	0.048	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.136		
DITAS	0.027	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	-	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.054		
EGBRA	0.03	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	-		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	-		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	-	SABAH	-		
GLOBL	-	SARKY	0.016		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.1

PORTFOLIO VARIANCE=0.0057

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.018	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	0.026	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	0.544	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	0.048
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	0.026	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.16		
DITAS	0.04	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.007	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.062		
EGBRA	0.04	PARSN	-		
EGEEN	-	PEGPR			
EGGUB	-	PETKM	-		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.025		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	-	SABAH	-		
GLOBL	-	SARKY	0.004		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.1065

PORTFOLIO VARIANCE=0.0065

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.017	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	0.503	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	0.023
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.189		
DITAS	0.058	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.02	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.068		
EGBRA	0.039	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	-		
EMEK	-	PKENT	-		
ENKA	0.021	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.057		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	-	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	0.005	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.11

PORTFOLIO VARIANCE=0.0072

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.015	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	0.459	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	0.007
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.207		
DITAS	0.07	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.029	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.073		
EGBRA	0.034	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	-		
EMEK	-	PKENT	-		
ENKA	0.027	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.073		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	-	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	0.006	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.115

PORTFOLIO VARIANCE=0.0084

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.013	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	0.014	TEKST	-
AYC35	-	KEN34	0.398	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	-
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.231		
DITAS	0.084	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.038	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.073		
EGBRA	0.021	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	-		
EMEK	-	PKENT	-		
ENKA	0.02	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.095		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	0.008	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	0.006	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.12

PORTFOLIO VARIANCE=0.010

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.012	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	0.032	TEKST	-
AYC35	-	KEN34	0.337	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	-
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.252		
DITAS	0.095	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.045	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.071		
EGBRA	0.007	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	0.006		
EMEK	-	PKENT	-		
ENKA	0.006	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.115		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	0.018	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	0.003	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.125

PORTFOLIO VARIANCE=0.012

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.012	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	0.044	TEKST	-
AYC35	-	KEN34	0.269	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	-
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.263		
DITAS	0.103	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.051	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.07		
EGBRA	0.004	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	0.024		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.13		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	0.031	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.13

PORTFOLIO VARIANCE=0.0143

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.012	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	0.053	TEKST	-
AYC35	-	KEN34	0.196	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	-
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	-	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.273		
DITAS	0.112	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.058	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.068		
EGBRA	-	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	0.04		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.147		
FINBN	-	PIMAS	-		
GENTS	-	POLYL	-		
GIM34	0.042	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.135

PORTFOLIO VARIANCE=0.0169

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.012	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	0.058	TEKST	-
AYC35	-	KEN34	0.125	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	-
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	0.003	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.28		
DITAS	0.12	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.064	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.067		
EGBRA	-	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	0.057		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.16		
FINBN	-	PIMAS	0.002		
GENTS	-	POLYL	-		
GIM34	0.052	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.14

PORTFOLIO VARIANCE=0.0199

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.012	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	0.061	TEKST	-
AYC35	-	KEN34	0.059	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	-
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	0.014	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.285		
DITAS	0.13	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.068	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.063		
EGBRA	-	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	0.071		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.171		
FINBN	-	PIMAS	0.002		
GENTS	-	POLYL	-		
GIM34	0.061	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.145

PORTFOLIO VARIANCE=0.0231

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.013	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	0.06	TEKST	-
AYC35	-	KEN34	-	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	-
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	0.029	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.287		
DITAS	0.14	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.071	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.057		
EGBRA	-	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	0.085		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.182		
FINBN	-	PIMAS	0.006		
GENTS	-	POLYL	-		
GIM34	0.069	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.15

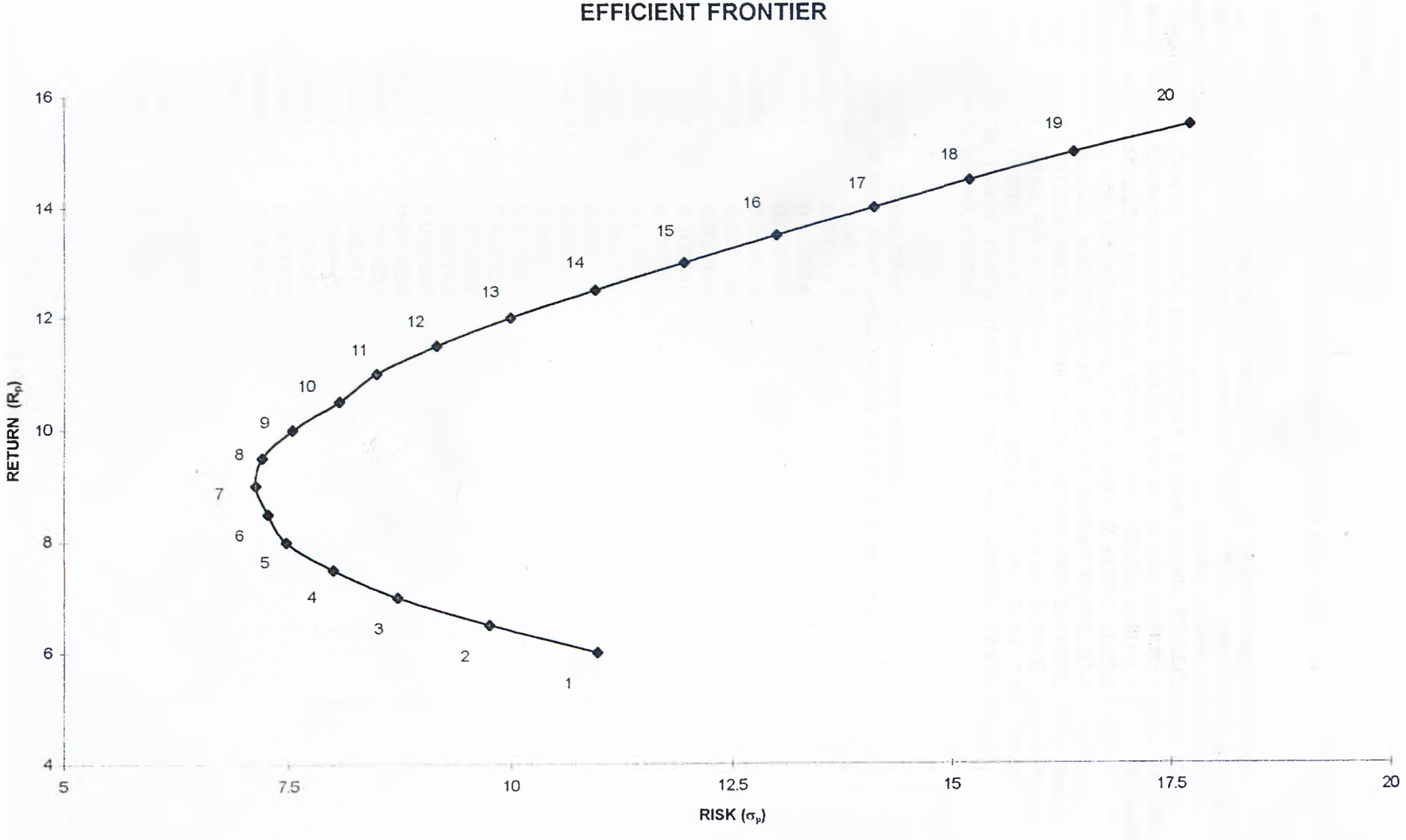
PORTFOLIO VARIANCE=0.0269

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.019	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	0.022	TEKST	-
AYC35	-	KEN34	-	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	-
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	0.088	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.254		
DITAS	0.156	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.068	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	0.03		
EGBRA	-	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	0.09		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.187		
FINBN	-	PIMAS	0.015		
GENTS	-	POLYL	-		
GIM34	0.07	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		

WEIGHTS OF STOCKS IN THE EFFICIENT PORTFOLIO FOR R=0.155

PORTFOLIO VARIANCE=0.0314

ABANA	-	GUNEY	-	TUDDF	-
ADANA	-	HEKTS	-	DISBA	-
AFY03	-	HURGZ	0.025	GARAN	-
AKALT	-	IKTFN	-	ISCTR	-
AKBNK	-	INTEM	-	TKBNK	-
AKCIM	-	ISTMP	-	SMSNS	-
AKSA	-	IZMDC	-	TSKB	-
ALARK	-	IZOCM	-	SISE	-
ALRSA	-	KARTN	-	TBORG	-
TELTS	-	KAVOR	-	TUTUN	-
ALTIN	-	KLBMO	-	TEKST	-
AYC35	-	KEN34	-	TIRE	-
ANACM	-	KEPEZ	-	TOFAS	-
ARCLK	-	KCHOL	-	TOASO	-
ASELS	-	KCYAT	-	TRKCM	-
ASL41	-	KONYA	-	TRNSK	-
AYGAZ	-	KORDS	-	TURCS	-
BAGFS	-	KOYTS	-	TUPRS	-
BIR35	-	KUTPO	-	THYAO	-
BOLUC	-	LUKSK	-	USAK	-
BRISA	-	MAKTK	-	UNYEC	-
CNKKL	-	MRDIN	-	VAKFN	-
CELHA	-	MARET	-	VKFYT	-
CIMSA	-	MAALT	-	VESTL	-
CUKEL	-	MMART	-	YKBNK	-
DEMIR	-	MRSHL	-	YASAS	-
DENCM	0.15	MEDYA	-	YUNSA	-
DERIM	-	METAS	-		
DEVA	-	MIGRS	0.215		
DITAS	0.172	NTHOL	-		
DOGUB	-	NTTUR	-		
DOKTS	-	OKANT	-		
DUROF	0.061	OLMKS	-		
ECILC	-	OTOSN	-		
ECZYT	-	NIGDE	-		
EGBRA	-	PARSN	-		
EGEEN	-	PEGPR	-		
EGGUB	-	PETKM	0.095		
EMEK	-	PKENT	-		
ENKA	-	PTOFS	-		
ERCYS	-	PNET	-		
EREGL	-	PINSU	-		
ESBNK	-	PNSUT	-		
FENIS	-	PNUN	0.194		
FINBN	-	PIMAS	0.016		
GENTS	-	POLYL	-		
GIM34	0.074	SABAH	-		
GLOBL	-	SARKY	-		
GOODY	-	SIFAS	-		
GOR41	-	SOKSA	-		
GUBRF	-	SONME	-		


EFFICIENT FRONTIER
RETURN (R_p)
RISK (σ_p)
16
14
12
10
8
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4
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7.5
10
12.5
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17.5
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Appendix 2

APPENDIX 3

A QUADRATIC PROGRAMMING MODEL FOR PORTFOLIO ANALYSIS

SETS

I Securities / ABANA, ADANA, AFY03, AKALT, AKBNK, AKCIM, AKSA, ALARK, ALRSA, TELTS, ALTIN, AYC35, ANACM, ARCLK, ASELS, ASL41, AYGAZ, BAGFS, BIR35, BOLUC, BRISA, CNKKL, CELHA, CIMSA, CUKEL, DEMIR, DENCM, DERIM, DEVA, DITAS, DOGUB, DOKTS, DUROF, ECILC, ECZYT, EGBRA, EGEEN, EGGUB, EMEK, ENKA, ERCYS, EREGL, ESBNK, FENIS, FINBN, GENTS, GIM34, GLOBL, GOODY, GOR41, GUBRF, GUNEY, HEKTS, HURGZ, IKTFN, INTEM, ISTMP, IZMDC, IZOCM, KARTN, KAVOR, KLBMO, KEN34, KEPEZ, KCHOL, KCYAT, KONYA, KORDS, KOYTS, KUTPO, LUKSK, MAKTK, MRDIN, MARET, MAALT, MMART, MRSHL, MEDYA, METAS, MIGRS, NTHOL, NTTUR, OKANT, OLMKS, OTOSN, NIGDE, PARSN, PEGPR, PETKM, PKENT, PTOFS, PNET, PINSU, PNSUT, PNUN, PIMAS, POLYL, SABAH, SARKY, SIFAS, SOKSA, SONME, TUDDF, DISBA, GARAN, ISCTR, TKBNK, SMSNS, TSKB, SISE, TBORG, TUTUN, TEKST, TIRE, TOFAS, TOASO, TRKCM, TRNSK, TURCS, TUPRS, THYAO, USAK, UNYEC, VAKFN, VKFYT, VESTL, YKBNK, YASAS, YUNSA /

ALIAS (I,J)

SCALAR TARGET Target return on efficient portfolio / .1 /

PARAMETERS MEAN(I) Mean annual returns on individual securities

/ ABANA	0.065128
ADANA	0.07119
AFY03	0.084524
AKALT	0.109048
AKBNK	0.082619
AKCIM	0.080238
AKSA	0.081905
ALARK	0.109048
ALRSA	0.123902
TELTS	0.07619
ALTIN	0.092857
AYC35	0.105714
ANACM	0.122619
ARCLK	0.065
ASELS	0.097381
ASL41	0.063333
AYGAZ	0.077619
BAGFS	0.087143
BIR35	0.089048
BOLUC	0.080238
BRISA	0.123333
CNKKL	0.083571
CELHA	0.095
CIMSA	0.08619
CUKEL	0.060238
DEMIR	0.132619
DENCM	0.19
DERIM	0.097619
DEVA	0.091429
DITAS	0.15381
DOGUB	0.121667

DOKTS	0.058333
DUROF	0.151667
ECILC	0.060476
ECZYT	0.075619
EGBRA	0.104524
EGEEN	0.126429
EGGUB	0.161905
EMEK	0.085238
ENKA	0.093333
ERCYS	0.109286
EREGL	0.092857
ESBNK	0.054524
FENIS	0.059762
FINBN	0.113095
GENTS	0.13381
GIM34	0.149048
GLOBL	0.121579
GOODY	0.103333
GOR41	0.152857
GUBRF	0.141905
GUNEY	0.096429
HEKTS	0.12119
HURGZ	0.16475
IKTFN	0.125238
INTEM	0.110714
ISTMP	0.138333
IZMDC	0.094762
IZOCM	0.059762
KARTN	0.113571
KAVOR	0.110238
KLBMO	0.130714
KEN34	0.083095
KEPEZ	0.109286
KCHOL	0.086667
KCYAT	0.057381
KONYA	0.099524
KORDS	0.095952
KOYTS	0.112381
KUTPO	0.119524
LUKSK	0.12619
MAKTK	0.104762
MRDIN	0.085476
MARET	0.073571
MAALT	0.104762
MMART	0.089762
MRSHL	0.105476
MEDYA	0.058056
METAS	0.096429
MIGRS	0.122619
NTHOL	0.11619
NTTUR	-0.10238
OKANT	0.100476
OLMKS	0.125238
OTOSN	0.103571

NIGDE	0.124524
PARSN	0.135476
PEGPR	0.088095
PETKM	0.154286
PKENT	0.065476
PTOFS	0.095714
PNET	0.088095
PINSU	0.13
PNSUT	0.152381
PNUN	0.167143
PIMAS	0.158095
POLYL	0.122143
SABAH	0.093333
SARKY	0.091667
SIFAS	0.10881
SOKSA	0.115714
SONME	0.104762
TUDDF	0.062857
DISBA	0.100476
GARAN	0.110952
ISCTR	0.134286
TKBNK	0.109048
SMSNS	0.090714
TSKB	0.082143
SISE	0.10881
TBORG	0.07619
TUTUN	0.064286
TEKST	0.10119
TIRE	0.150238
TOFAS	0.094048
TOASO	0.100476
TRKCM	0.101667
TRNSK	0.106364
TURCS	0.088333
TUPRS	0.120714
THYAO	0.142143
USAK	0.135714
UNYEC	0.087143
VAKFN	0.097857
VKFYT	0.07881
VESTL	0.072619
YKBNK	0.109762
YASAS	0.132857
YUNSA	0.091429 /

TABLE V(I,J) Variance-covariance array

	ABANA	ADANA	AFY03	AKALT	AKBNK
ABANA	0.064231	0.025363	0.02236	0.019627	0.013033
ADANA	0.025363	0.037289	0.017387	0.027704	0.012977
AFY03	0.02236	0.017387	0.05183	0.013534	0.005173
AKALT	0.019627	0.027704	0.013534	0.062219	0.020876
AKBNK	0.013033	0.012977	0.005173	0.020876	0.042527
AKCIM	0.014688	0.019458	0.006231	0.02071	0.013112
AKSA	0.013747	0.018581	0.01704	0.017936	0.015624
ALARK	0.030388	0.026984	0.013819	0.036397	0.019142
ALRSA	0.042019	0.036291	0.005554	0.040865	0.018024
TELTS	0.030165	0.025802	0.001057	0.018904	0.010161
ALTIN	0.011893	0.023304	-0.00193	0.040864	0.03549
AYC35	0.05393	0.035044	0.036942	0.029952	0.031643
ANACM	0.03098	0.038699	0.022915	0.038681	0.013052
ARCLK	0.011079	0.012528	0.005984	0.01718	0.014772
ASELS	0.035131	0.032081	0.017137	0.02819	0.019097
ASL41	0.028663	0.023906	0.007472	0.019815	0.011367
AYGAZ	0.021718	0.030032	0.004535	0.04261	0.017102
BAGFS	0.02246	0.024225	0.004589	0.031022	0.027591
BIR35	0.058046	0.03095	0.018168	0.023131	0.016015
BOLUC	0.039734	0.04049	0.016343	0.034942	0.022758
BRISA	0.034166	0.037181	0.02048	0.040691	0.013547
CNKKL	0.019401	0.01672	0.002201	0.016484	0.004686
CELHA	0.028326	0.030355	0.019845	0.026354	0.020745
CIMSA	0.01653	0.014566	-0.00169	0.008874	0.003759
CUKEL	0.020879	0.024624	0.013743	0.024227	0.008731
DEMIR	0.032479	0.025041	0.005229	0.034046	0.040261
DENCM	0.041099	0.038422	0.01	0.034512	0.032776
DERIM	0.056769	0.040542	0.017631	0.021759	0.003758
DEVA	0.03373	0.035113	0.016574	0.040999	0.019306
DITAS	0.011272	0.010144	-0.0044	0.02557	-0.00797
DOGUB	0.026581	0.027976	0.003161	0.045767	0.011344
DOKTS	0.021287	0.027007	0.013122	0.035557	0.023909
DUROF	0.032248	0.016393	0.004192	1.38E-05	0.012025
ECILC	0.017846	0.028665	0.002769	0.030549	0.016469
ECZYT	0.035377	0.039914	0.013707	0.035539	0.022776
EGBRA	-0.00076	0.017273	0.003011	0.015602	0.015234
EGEEN	0.039712	0.031929	0.016631	0.033999	0.012224
EGGUB	0.043464	0.029585	0.007906	0.030592	0.034195
EMEK	0.040927	0.038359	0.020037	0.031593	0.018118
ENKA	0.010727	0.008757	0.011302	0.017723	0.012084
ERCYS	0.009622	0.015991	0.003211	0.019475	0.012956
EREGL	0.033384	0.037984	0.012484	0.040595	0.027514
ESBNK	0.035248	0.030646	0.01065	0.034678	0.020937
FENIS	0.015762	0.02181	0.015704	0.022207	0.008981
FINBN	0.026809	0.036296	0.0063	0.048001	0.026633
GENTS	0.032511	0.036149	0.019777	0.027113	0.018378
GIM34	0.015152	0.00463	0.004712	0.016858	0.0388
GLOBL	0.04819	0.040534	0.021474	0.042107	0.029195
GOODY	0.028535	0.024396	0.015187	0.034698	0.011947

GOR41	0.061598	0.03534	0.011382	0.052722	0.028587
GUBRF	0.015109	0.025368	-0.00712	0.022792	0.016866
GUNEY	0.013836	0.024668	0.006314	0.028818	0.023151
HEKTS	0.035071	0.029845	0.007246	0.04286	0.024377
HURGZ	0.061757	0.042407	0.046579	0.02988	0.036364
IKTFN	0.064603	0.038362	0.017673	0.035049	0.036781
INTEM	0.040591	0.045372	0.025397	0.041289	0.014037
ISTMP	0.046073	0.038961	0.014944	0.025906	0.030575
IZMDC	0.031739	0.035689	0.012834	0.030831	0.02037
IZOCM	0.011386	0.019066	0.008982	0.023692	0.008952
KARTN	0.019822	0.030244	0.009674	0.022823	0.023922
KAVOR	0.036389	0.030717	0.017765	0.033934	0.02368
KLBMO	0.027042	0.021024	0.012475	0.020393	0.011149
KEN34	0.004886	0.006316	0.004708	0.004893	-0.00028
KEPEZ	0.032504	0.026325	0.016694	0.03609	0.009692
KCHOL	0.014746	0.019836	0.005013	0.032563	0.032463
KCYAT	0.013057	0.022764	0.007068	0.026883	0.021761
KONYA	0.029129	0.027893	0.018741	0.017248	0.004855
KORDS	0.035405	0.035168	0.017116	0.036633	0.018343
KOYTS	0.036066	0.031953	0.017316	0.027415	0.011125
KUTPO	0.025802	0.034359	0.017561	0.033812	0.017043
LUKSK	0.040486	0.029495	0.00514	0.034111	0.035164
MAKTK	0.060795	0.048504	0.020607	0.034675	0.022758
MRDIN	0.02567	0.033727	0.012311	0.0259	0.014993
MARET	0.032489	0.02642	0.010771	0.036511	0.011571
MAALT	0.014626	0.024287	0.012629	0.027095	0.019777
MMART	0.026999	0.030644	0.01365	0.034183	0.014323
MRSHL	0.014838	0.022284	0.006711	0.016761	0.00538
MEDYA	0.008404	0.012884	0.006371	0.024332	0.011046
METAS	0.02886	0.035397	0.006417	0.028275	0.025249
MIGRS	0.009948	0.01218	0.013768	0.021564	0.01141
NTHOL	0.033879	0.033061	0.012152	0.032952	0.01551
NTTUR	0.048304	0.009742	-0.00711	0.009149	0.003123
OKANT	0.044577	0.033885	0.008593	0.022725	0.016621
OLMKS	0.039452	0.044008	0.025978	0.046634	0.011405
OTOSN	0.029778	0.031701	0.022561	0.029143	0.020932
NIGDE	0.017406	0.017473	0.010406	0.003109	0.003871
PARSN	0.039388	0.035842	0.018572	0.0371	0.031415
PEGPR	0.041696	0.023971	0.005094	0.016296	0.022927
PETKM	0.031482	0.036207	0.00498	0.018021	-0.00084
PKENT	0.01846	0.019945	0.006814	0.023544	0.012229
PTOFS	0.021812	0.037693	0.008552	0.031013	0.018097
PNET	0.027304	0.034017	0.016177	0.02554	0.015617
PINSU	0.037653	0.026151	0.017778	0.030139	0.0262
PNSUT	0.045195	0.042539	0.027084	0.057793	0.036577
PNUN	0.028647	0.018321	-0.00013	0.019036	0.028069
PIMAS	0.011855	0.025278	-0.01236	0.044952	0.031851
POLYL	0.040285	0.038441	0.026561	0.032939	0.015809
SABAH	0.005217	0.016823	0.00888	0.020986	0.001113
SARKY	0.003202	0.004688	-0.00663	0.012658	0.0089
SIFAS	0.053602	0.049601	0.028503	0.033299	0.010413
SOKSA	0.043047	0.036517	0.025174	0.032193	0.016743
SONME	0.018566	0.026987	0.016219	0.03257	0.022614
TUDDF	0.015129	0.020992	0.009282	0.025193	0.005151

DISBA	0.02191	0.026868	0.006264	0.0378	0.02004
GARAN	0.002638	0.018104	0.006157	0.024567	0.024875
ISCTR	0.049849	0.0381	0.015217	0.031399	0.035701
TKBNK	0.03509	0.027777	0.007634	0.018489	0.017722
SMSNS	0.011629	0.028465	0.016545	0.038398	0.01591
TSKB	0.028798	0.020997	0.010563	0.024466	0.010872
SISE	0.039751	0.037416	0.021252	0.035872	0.028884
TBORG	-0.00421	0.006836	-0.00499	0.00704	0.023761
TUTUN	0.019457	0.024285	0.006631	0.021726	0.009498
TEKST	0.022072	0.011162	-0.00364	0.025623	0.017687
TIRE	0.038176	0.041427	0.01437	0.041578	0.014387
TOFAS	0.02939	0.039124	0.018515	0.061648	0.036033
TOASO	0.015199	0.025926	0.026566	0.033547	0.023343
TRKCM	0.023124	0.028515	0.016856	0.036555	0.02551
TRNSK	0.053705	0.041963	0.012341	0.044586	0.011438
TURCS	-0.00215	0.015844	0.00236	0.012762	-0.00255
TUPRS	0.022327	0.043706	0.013787	0.044542	0.019342
THYAO	0.028305	0.029758	0.013595	0.028429	0.015541
USAK	0.027566	0.039644	0.018903	0.029137	0.019499
UNYEC	0.017137	0.030564	0.009238	0.020068	0.012066
VAKFN	0.032629	0.033983	-0.00588	0.034695	0.01874
VKFYT	0.027322	0.026228	0.014842	0.032282	0.023489
VESTL	0.045624	0.028997	0.013515	0.0229	0.022498
YKBNK	0.037851	0.027352	0.01405	0.029031	0.031562
YASAS	0.026366	0.035048	0.013304	0.031654	0.029739
YUNSA	0.026294	0.02112	0.00893	0.038067	0.026199
YUNSA	0.014995	0.012285	0.031972	0.044082	0.020932

. +	VESTL	YKBNK	YASAS	YUNSA
ABANA	0.045624	0.037851	0.026366	0.026294
ADANA	0.028997	0.027352	0.035048	0.02112
AFY03	0.013515	0.01405	0.013304	0.00893
AKALT	0.0229	0.029031	0.031654	0.038067
AKBNK	0.022498	0.031562	0.029739	0.026199
AKCIM	0.024029	0.028481	0.022516	0.014995
AKSA	0.005173	0.02383	0.018829	0.012285
ALARK	0.047144	0.036675	0.035466	0.031972
ALRSA	0.059318	0.041299	0.049747	0.044082
TELTS	0.048364	0.023814	0.059145	0.020932
ALTIN	0.016292	0.053789	0.056633	0.048303
AYC35	0.077648	0.086797	0.040361	0.057526
ANACM	0.040017	0.036959	0.047436	0.03686
ARCLK	0.015277	0.028472	0.029583	0.013239
ASELS	0.036856	0.042521	0.052934	0.035157
ASL41	0.026459	0.031223	0.035568	0.027678
AYGAZ	0.023594	0.029577	0.036236	0.035523
BAGFS	0.026942	0.046148	0.052501	0.04198
BIR35	0.04862	0.01931	0.027691	0.024323
BOLUC	0.041712	0.043356	0.042648	0.03198
BRISA	0.036923	0.039593	0.045078	0.035066

CNKKL	0.027115	0.034701	0.021009	0.019619
CELHA	0.026701	0.045387	0.048771	0.031934
CIMSA	0.014369	0.00665	0.022406	0.007345
CUKEL	0.035104	0.019134	0.025782	0.02258
DEMIR	0.03572	0.060362	0.083519	0.049325
DENCM	0.035885	0.030963	0.066993	0.046541
DERIM	0.042604	0.027782	0.041926	0.011572
DEVA	0.049252	0.048056	0.048718	0.056078
DITAS	0.014395	0.028806	0.006955	0.027697
DOGUB	0.070659	0.035147	0.072332	0.058615
DOKTS	0.022212	0.029619	0.036449	0.023798
DUROF	0.013617	0.044637	0.05669	0.01729
ECILC	0.044613	0.029646	0.038589	0.043051
ECZYT	0.052186	0.04095	0.062336	0.043416
EGBRA	0.002734	0.006094	0.028004	0.013469
EGEEN	0.040297	0.043128	0.047196	0.060698
EGGUB	0.050395	0.066179	0.082709	0.048683
EMEK	0.040342	0.051601	0.038407	0.040266
ENKA	0.017762	0.016876	0.010202	0.012468
ERCYS	0.004136	0.015375	0.026258	0.014233
EREGL	0.049397	0.054345	0.049953	0.041118
ESBNK	0.044749	0.053225	0.04007	0.050337
FENIS	0.022579	0.012161	0.025128	0.020632
FINBN	0.03408	0.049167	0.058764	0.049503
GENTS	0.036492	0.039884	0.05226	0.041426
GIM34	0.017805	0.023822	0.009239	0.020806
GLOBL	0.050608	0.060946	0.05946	0.055848
GOODY	0.025181	0.026498	0.029627	0.028937
GOR41	0.087051	0.028432	0.07355	0.05781
GUBRF	0.060288	0.031035	0.064177	0.058761
GUNEY	0.026005	0.006245	0.034167	0.018725
HEKTS	0.053541	0.050447	0.057655	0.056447
HURGZ	0.065432	0.114654	0.050349	0.05549
IKTFN	0.081523	0.071628	0.058731	0.061829
INTEM	0.037444	0.052564	0.057259	0.044536
ISTMP	0.075343	0.037626	0.052088	0.038866
IZMDC	0.043797	0.049157	0.055301	0.042703
IZOCM	0.018801	0.015754	0.022679	0.015139
KARTN	0.0165	0.028484	0.04379	0.017636
KAVOR	0.027624	0.031173	0.034958	0.028822
KLBMO	0.029986	0.029493	0.052854	0.036106
KEN34	0.005326	0.003952	0.004786	0.00622
KEPEZ	0.025551	0.044314	0.034036	0.024333
KCHOL	0.020989	0.034475	0.0482	0.026922
KCYAT	0.019339	0.019465	0.028974	0.019214
KONYA	0.023616	0.026719	0.043438	0.015384
KORDS	0.025811	0.035214	0.031005	0.034096
KOYTS	0.056333	0.014808	0.038654	0.036021
KUTPO	0.035374	0.025922	0.051323	0.036201
LUKSK	0.049779	0.032323	0.054448	0.055391
MAKTK	0.076214	0.066428	0.078735	0.060632
MRDIN	0.025719	0.025372	0.045538	0.016448
MARET	0.0235	0.026918	0.027263	0.025378
MAALT	0.008153	0.040467	0.058869	0.040522

MMART	0.056635	0.027249	0.038918	0.043259
MRSHL	0.018056	0.025494	0.051896	0.019777
MEDYA	0.004271	0.01382	0.017417	0.021636
METAS	0.043817	0.045677	0.066093	0.040598
MIGRS	-0.00277	0.00552	0.012953	0.000645
NTHOL	0.044076	0.041553	0.04927	0.04923
NTTUR	0.050687	0.04298	0.088805	0.05715
OKANT	0.068155	0.049225	0.054116	0.048687
OLMKS	0.045991	0.049289	0.044555	0.045675
OTOSN	0.027127	0.034406	0.054802	0.022126
NIGDE	0.013537	0.007528	0.024745	0.009571
PARSN	0.082017	0.047787	0.060886	0.066277
PEGPR	0.06419	0.044395	0.036547	0.025215
PETKM	0.050145	0.033572	0.055924	0.025982
PKENT	0.043056	0.021023	0.034274	0.033441
PTOFS	0.042558	0.037697	0.044747	0.029016
PNET	0.031756	0.037536	0.061196	0.03671
PINSU	0.025971	0.01998	0.038154	0.034588
PNSUT	0.046052	0.071698	0.061974	0.074982
PNUN	0.026761	0.035682	0.060884	0.031492
PIMAS	0.037751	0.042531	0.079142	0.068793
POLYL	0.028399	0.058961	0.066147	0.048394
SABAH	0.015996	0.030364	0.021498	0.026059
SARKY	-0.00291	0.003798	0.018332	0.001485
SIFAS	0.058898	0.066385	0.069101	0.050387
SOKSA	0.048733	0.033731	0.079286	0.041326
SONME	0.028934	0.017474	0.046537	0.036083
TUDDF	0.02568	0.016889	0.024157	0.016515
DISBA	0.031367	0.038015	0.056255	0.038814
GARAN	0.009895	0.02789	0.032295	0.024908
ISCTR	0.040154	0.100333	0.055012	0.053374
TKBNK	0.046393	0.038402	0.033456	0.033355
SMSNS	0.01794	0.017022	0.029164	0.029321
TSKB	0.023867	0.038174	0.022916	0.030431
SISE	0.052164	0.065007	0.046682	0.046914
TBORG	0.003405	0.013658	0.040638	0.020032
TUTUN	0.046979	0.028847	0.028907	0.03496
TEKST	0.045309	0.038515	0.047194	0.048925
TIRE	0.039877	0.038446	0.041436	0.035634
TOFAS	0.048509	0.029801	0.053995	0.056923
TOASO	0.025977	0.026054	0.038889	0.009548
TRKCM	0.018139	0.028435	0.034729	0.027461
TRNSK	0.066019	0.057132	0.051757	0.071203
TURCS	-0.00153	0.001179	0.01202	0.008858
TUPRS	0.06254	0.05021	0.047415	0.050236
THYAO	0.043792	0.046001	0.045277	0.03148
USAK	0.024429	0.029865	0.030783	0.023457
UNYEC	0.026191	0.026387	0.045011	0.020724
VAKFN	0.054396	0.037704	0.051389	0.045071
VKFYT	0.030098	0.052124	0.041025	0.040046
VESTL	0.098966	0.039618	0.042005	0.038247
YKBNK	0.039618	0.103056	0.054832	0.056669
YASAS	0.042005	0.054832	0.102782	0.046725
YUNSA	0.038247	0.056669	0.046725	0.071656 ;

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SCALARS  LOWYIELD  Yield of lowest yielding security
         HIGHRISK   Variance of the highest risk security;

LOWYIELD = SMIN(I, MEAN(I));

HIGHRISK = SMAX(I, V(I,J));

DISPLAY LOWYIELD, HIGHRISK;

* In GAMS the default VARIABLE type is FREE

VARIABLES  X(I)          Fraction of portfolio invested in asset I
           VARIANCE      Variance of portfolio

POSITIVE VARIABLE X;

EQUATIONS  FSUM    Fractions must add to 1.0
           DMEAN   Definition of mean return on portfolio
           DVAR    Definition of variance;

FSUM..     SUM(I, X(I))                          =E=   1.0 ;
DMEAN..    SUM(I, MEAN(I)*X(I))                  =G=   TARGET;
DVAR..     SUM(I, X(I)*SUM(J,V(I,J)*X(J)))         =E=    VARIANCE;

MODEL PORTFOLIO  / ALL / ;

SOLVE PORTFOLIO USING NLP MINIMIZING VARIANCE;
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APPENDIX 4

	ABANA	ADANA	AFY03	AKALT	AKBNK	AKCIM	AKSA	ALARK	ALRSA	TELTS	ALTIN	AYC35
Jul-95	0.5	0.33	0.2	0.05	0.16	0.01	0.08	0.04	0.1	0.05	0.19	0.01
Aug-95	0.02	-0.14	-0.2	-0.21	-0.06	-0.12	-0.18	0.09	-0.01	-0.17	-0.21	0.02
Sep-95	0.08	0.07	-0.12	0	0.04	0	0.03	-0.02	0.02	0.04	-0.15	-0.08
Oct-95	1	-0.09	0.16	0.16	0.06	0.1	0.21	0	0.25	0.68	0.21	0.18
Nov-95	-0.35	-0.28	-0.16	-0.09	-0.02	0.51	-0.06	0.03	-0.19	-0.23	-0.03	-0.14
Dec-95	-0.07	0	0.1	-0.02	-0.13	-0.18	0.25	0.2	-0.07	-0.07	-0.05	-0.08

	ANACM	ARCLK	ASELS	ASL41	AYGAZ	BAGFS	BIR35	BOLUC	BRISA	CNKKL	CELHA	CIMSA
Jul-95	-0.03	0.06	0.03	0.15	0.04	0.1	0.2	0.1	0.12	0.34	0.06	0.14
Aug-95	-0.31	-0.06	-0.13	-0.23	-0.07	-0.01	0.03	-0.19	-0.06	-0.18	-0.19	-0.21
Sep-95	-0.01	0.04	-0.09	0.04	-0.09	-0.02	0.15	-0.03	-0.11	-0.16	-0.13	-0.09
Oct-95	0.54	0.1	0.02	0.12	0.6	0.22	0.26	0.03	0.11	0.88	0.4	0.29
Nov-95	-0.19	-0.36	-0.19	-0.29	-0.29	-0.14	-0.03	-0.09	-0.1	-0.11	0.05	-0.18
Dec-95	-0.07	-0.09	0.1	0.14	0	-0.13	0.02	-0.12	0.05	-0.15	-0.06	-0.04

	CUKEL	DEMIR	DENCM	DERIM	DEVA	DITAS	DOGUB	DOKTS	DUROF	ECILC	ECZYT	EGBRA
Jul-95	0.13	0	0.05	-0.02	0.07	0.49	0.15	0.26	0.01	0.27	0	-0.08
Aug-95	-0.17	-0.11	-0.24	0.12	-0.34	-0.17	-0.22	-0.2	-0.15	-0.28	-0.25	-0.06
Sep-95	-0.29	-0.07	-0.06	-0.13	-0.22	-0.15	0.1	-0.05	-0.23	-0.21	-0.17	-0.06
Oct-95	0.42	-0.05	-0.1	0.22	0.02	0.15	0.07	-0.03	0.3	0.11	0.1	0
Nov-95	0.79	-0.23	-0.42	-0.27	-0.24	0.05	-0.1	-0.13	-0.35	-0.21	-0.03	-0.16
Dec-95	0.11	0.21	-0.04	-0.05	-0.06	0.03	-0.12	-0.03	-0.13	-0.07	-0.03	0.38

	EGEEN	EGGUB	EMEK	ENKA	ERCYS	EREGL	ESBNK	FENIS	FINBN	GENTS	GIM34	GLOBL
Jul-95	0.37	0.01	-0.02	0.85	-0.03	0.26	-0.05	0.23	-0.05	-0.09	0.25	0.03
Aug-95	-0.07	-0.2	-0.18	0.57	-0.15	-0.07	-0.17	0.38	-0.2	-0.05	-0.09	-0.29
Sep-95	-0.14	-0.2	0.17	-0.22	-0.03	-0.1	-0.15	-0.14	-0.15	0.02	-0.04	-0.09
Oct-95	0.14	0.11	-0.1	-0.08	0.07	0.02	0.02	0.54	0	0.14	0.06	0.06
Nov-95	-0.21	-0.02	-0.29	-0.32	-0.11	-0.19	0.07	-0.16	-0.23	-0.17	-0.08	-0.13
Dec-95	-0.09	-0.15	0.02	-0.04	-0.02	0.01	0.07	-0.08	0.13	-0.15	0	-0.02

	GOODY	GOR41	GUBRF	GUNEY	HEKTS	HURGZ	IKTFN	INTEM	ISTMP	IZMDC	IZOCM	KARTN
Jul-95	0.1	0.53	0.05	-0.01	0.3	0.03	0.06	0	0.13	-0.01	0.06	0.19
Aug-95	-0.22	0.26	-0.15	-0.15	-0.12	-0.24	-0.32	-0.3	-0.13	-0.24	-0.27	0
Sep-95	-0.1	0.52	-0.16	-0.18	-0.12	-0.06	-0.25	-0.14	-0.14	-0.06	-0.14	-0.17
Oct-95	0.29	-0.1	0	0.34	0.57	0.08	0.07	0.08	0.12	-0.04	0.01	0.16
Nov-95	-0.2	-0.28	-0.17	-0.16	-0.27	-0.29	-0.38	-0.21	-0.17	-0.04	-0.17	-0.16
Dec-95	-0.04	-0.07	0	-0.01	-0.03	0	0.15	-0.09	-0.11	0.05	-0.03	-0.03

	KAVOR	KLBMO	KEN34	KEPEZ	KCHOL	KCYAT	KONYA	KORDS	KOYTS	KUTPO	LUKSK	MAKTK
Jul-95	0.58	0.21	-0.03	-0.15	-0.03	0.09	0.12	0.09	-0.14	0.04	0.41	0.03
Aug-95	-0.04	-0.36	0	-0.04	-0.2	-0.1	-0.33	-0.22	-0.04	-0.17	-0.2	-0.37
Sep-95	-0.18	-0.2	0	-0.27	-0.21	0.04	-0.25	-0.2	0.08	-0.08	-0.25	0.17
Oct-95	0.27	-0.01	0	0.15	0.16	0.04	-0.06	0.1	0.06	-0.03	0.03	0.08
Nov-95	-0.26	-0.23	0	0.15	-0.15	-0.14	-0.23	-0.09	0.03	-0.13	0.12	-0.17
Dec-95	-0.05	-0.12	0	-0.08	0	0.04	-0.05	-0.07	-0.14	0.18	-0.14	-0.09

	MRDIN	MARET	MAALT	MMART	MRSHL	MEDYA	METAS	MIGRS	NTHOL	NTTUR	OKANT	OLMKS
Jul-95	0.24	-0.09	-0.06	0.12	-0.03	-0.13	0.08	0.29	-0.2	0.32	-0.14	0.03
Aug-95	-0.15	0	0.01	0.16	-0.17	-0.18	-0.31	-0.17	-0.13	-0.06	-0.18	-0.15
Sep-95	0.03	-0.11	0.03	0.04	0.06	0.47	-0.04	0	0.33	0.1	-0.11	-0.07
Oct-95	0.12	0.38	0.07	-0.1	0.02	0.27	-0.04	0.11	-0.14	0.33	0.06	0.27
Nov-95	-0.31	-0.2	-0.37	-0.3	-0.34	-0.36	0	-0.05	-0.18	-0.31	0.21	-0.18
Dec-95	-0.07	0.02	-0.14	0.07	0.59	0	-0.04	0	-0.02	-0.05	-0.04	0.04

	OTOSN	NIGDE	PARSN	PEGPR	PETKM	PKENT	PTOFS	PNET	PINSU	PNSUT	PNUN	PIMAS
Jul-95	0.2	0.17	0.41	0.15	0.13	0	0.21	0.11	-0.01	0.05	0.07	0.27
Aug-95	0.06	-0.14	-0.16	0.02	-0.16	-0.08	-0.19	-0.13	-0.21	-0.21	-0.23	0.3
Sep-95	-0.07	-0.08	-0.16	0.13	-0.16	0.04	-0.06	-0.03	-0.12	-0.06	-0.19	-0.24
Oct-95	0.08	0.06	0.06	-0.12	0.22	-0.02	0.09	0.27	0.12	0.45	0.16	0
Nov-95	-0.25	-0.07	-0.27	-0.2	-0.21	-0.13	-0.24	-0.12	-0.26	-0.23	0	-0.21
Dec-95	-0.03	-0.17	0.15	0.11	0.02	0.08	0.04	-0.02	-0.04	0	-0.12	0.14

	POLYL	SABAH	SARKY	SIFAS	SOKSA	SONME	TUDDF	DISBA	GARAN	ISCTR	TKBNK	SMSNS
Jul-95	0.02	-0.06	0.02	0.18	0.07	0.04	0.31	0.24	0.05	-0.03	-0.14	0.15
Aug-95	-0.16	0.03	-0.17	-0.18	-0.32	-0.07	-0.07	-0.14	-0.32	-0.14	-0.23	-0.15
Sep-95	0.02	0.25	-0.1	-0.18	0.12	-0.06	-0.19	-0.23	-0.17	-0.07	0.29	0
Oct-95	0.25	0.08	0.08	0.1	0.04	0.13	0.01	-0.02	0.37	0.15	0.38	0.09
Nov-95	-0.08	-0.25	-0.12	-0.08	-0.39	-0.12	-0.15	-0.21	-0.18	-0.26	-0.29	-0.21
Dec-95	-0.08	0.19	0.06	-0.17	0.13	-0.15	-0.05	-0.01	0.28	0.18	0.07	0.11

	TSKB	SISE	TBORG	TUTUN	TEKST	TIRE	TOFAS	TOASO	TRKCM	TRNSK	TURCS	TUPRS
Jul-95	-0.09	0.09	-0.03	-0.04	-0.06	0.23	-0.05	0.08	0	-0.04	0.02	0.07
Aug-95	-0.1	-0.02	-0.11	-0.37	-0.06	-0.09	-0.24	-0.29	-0.11	-0.12	-0.22	-0.17
Sep-95	0.11	-0.21	-0.02	0.08	0.07	-0.18	-0.01	-0.01	-0.08	-0.16	-0.1	0.02
Oct-95	0.1	0.12	0.44	0.06	0.06	0.16	-0.06	-0.08	0.37	-0.19	0.15	0.11
Nov-95	-0.17	-0.05	-0.26	-0.1	-0.07	-0.19	-0.06	-0.06	-0.27	-0.14	-0.22	-0.17
Dec-95	0.09	-0.17	0.19	0.04	0.2	-0.09	-0.09	-0.05	0.15	-0.04	0.03	0.16

APPENDIX 5

ISE CODE	COMPANY NAME	SECTOR
GOR41	GORBON IŞIL	CERAMICS
GUBRF	GUBRE FABRİKALARI	AGROCHEMICALS
GUNEY	GUNEY BİRACILIK	BREWERY
HEKTS	HEKTAŞ	AGROCHEMICALS
HURGZ	HÜRRİYET GAZETECİLİK	MEDIA
IKTFN	İKTİSAT FİNANSAL KİRALAMA	LEASING
INTEM	İNTEMA	BUILDING MATERIALS
ISTMP	İSTANBUL MOTOR PİSTON	METAL INDUSTRY
IZMDC	İZMİR DEMİR ÇELİK	METAL INDUSTRY
IZOCM	İZOCAM	BUILDING MATERIALS
KARTN	KARTONSAN	PAPER
KAVOR	KAV	PAPER
KLBMO	KELEBEK MOBİLYA	FURNITURE
KEN34	KENT GIDA	FOOD
KEPEZ	KEPEZ ELEKTRİK	ENERGY
KCHOL	KOÇ HOLDİNG	CONGLOMARATE
KCYAT	KOÇ YATIRIM	CONGLOMARATE
KONYA	KONYA ÇİMEMTO	CEMENT
KORDS	KORDSA	AUTO TIRES
KOYTS	KÖYTAŞ	TEXTILE
KUTPO	KÜTAHYA PORSELEN	CERAMICS
LUKSK	LÜKS KADİYE	TEXTILE
MAKTK	MAKİNA TAKIM ENDÜSTRİSİ	AUTO SUPPLIERS
MRDIN	MATDİN ÇİMENTO	CEMENT
MARET	MARET	FOOD
MAALT	MARMARİS ALTINYUNUS	TOURISM
MMART	MARMARİS MARTI	TOURISM
MRSHL	MARSHALL BOYA	PAINT
MEDYA	MEDYA HOLDİNG	CONGLOMARATE
METAS	METAŞ İZMİR METALURJİ	METAL INDUSTRY
MIGRS	MİGROS	RETAIL
NTHOL	NET HOLDİNG	CONGLOMARATE
NTTUR	NET TURİZM	TOURISM
OKANT	OKAN TEKSTİL	TEXTILE
OLMKS	OLMUKSA	PAPER
OTOSN	OTOSAN	AUTOMOTIVE
NIGDE	NİĞDE ÇİMENTO	CEMENT
PARSN	PARSAN MAKİNA	AUTO SUPPLIERS
PEGPR	PEG PROFİLO	HOUSE APPAREL
PETKM	PETKİM	CHEMICALS
PKENT	PETROKENT	TOURISM
PTOFS	PETROL OFİSİ	PETROLEUM
PNET	PINAR ET	FOOD
PINSU	PINAT SU	FOOD
PNSUT	PINAR SÜT	FOOD
PNUN	PINAR UN	FOOD
PIMAS	PIMAŞ	BUILDING MATERIALS
POLYL	POLYLEN	TEXTILE
SABAH	SABAH GAZETECİLİK	MEDIA
SARKY	SARKUYSAN	TELECOMMUNICATION

APPENDIX 5

ISE CODE	COMPANY NAME	SECTOR
ABANA	ABANA ELEKTROMEKANİK	ENERGY
ADANA	ADANA ÇİMENTO	CEMENT
AFY03	AFYON ÇİMENTO	CEMENT
AKALT	AKAL TEKSTİL	TEXTILE
AKBNK	AKBANK	BANKING
AKCIM	AKÇANSA ÇİMENTO	CEMENT
AKSA	AKSA	TEXTILE
ALARK	ALARKO HOLDİNG	CONGLOMARATE
ALRSA	ALARKO SANAYİ	BUILDING MATERIALS
TELTS	TELETAŞ	TELECOMMUNICATION
ALTIN	ALTINYILDIZ	TEXTILE
AYC35	ALTINYUNUS ÇEŞME	TOURISM
ANACM	ANADOLU CAM	GLASS
ARCLK	ARÇELİK	HOUSE APPARELS
ASELS	ASELSAN	TELECOMMUNICATION
ASL41	ASLAN ÇİMENTO	CEMENT
AYGAZ	AYGAZ	PETROLEUM
BAGFS	BAĞFAŞ	AGROCHEMICALS
BIR35	BİRLİK MENSUCAT	TEXTILE
BOLUC	BOLU ÇİMENTO	CEMENT
BRISA	BRISA LASTİKLERİ	AUTO TIRES
CNKKL	ÇANAKKALE ÇİMENTO	CEMENT
CELHA	ÇELİK HALAT	METAL INDUSTRY
CIMSA	ÇİMSA	CEMENT
CUKEL	ÇUKUROVA ELEKTRİK	ENERGY
DEMIR	DEMİRBANK	BANKING
DENCM	DENİZLİ CAM	GLASS
DERIM	DERİMOD	TEXTILE
DEVA	DEVA HOLDİNG	CONGLOMARATE
DITAS	DİTAŞ DOĞAN	AUTO SUPPLIERS
DOGUB	DOĞUSAN BORU	METAL INDUSTRY
DOKTS	DÖKTAŞ	AUTO SUPPLIERS
DUROF	DURAN OFSET	PAPER
ECILC	ECZACIBAŞI İLAÇ	PHARMACEUTICALS
ECZYT	EZCACIBAŞI YATIRIM	CONGLOMARATE
EGBRA	EGE BİRACILIK	BREWERY
EGEEN	EGE ENDÜSTRİ SANAYİ	METAL INDUSTRY
EGGUB	EGE GÜBRE	AGROCHEMICALS
EMEK	EMEK SİGORTA	INSURANCE
ENKA	ENKA HOLDİNG	CONGLOMARATE
ERCYS	ERCİYAS BİRACILIK	BREWERY
EREGL	EREĞLİ DEMİR ÇELİK	METAL INDUSTRY
ESBNK	ESBANK	BANKING
FENIS	FENİŞ ALUMİNYUM	METAL INDUSTRY
FINBN	FİNANSBANK	BANKING
GENTS	GENTAŞ	FURNITURE
GIM34	GİMA	RETAIL
GLOBL	GLOBAL MENKUL DEĞERLER	NON-BANK FIN INST.
GOODY	GOOD-YEAR LASTİKLERİ	AUTO TIRES

APPENDIX 5

ISE CODE	COMPANY NAME	SECTOR
SIFAS	ŞİFAŞ	TEXTILE
SOKSA	ŞÖKSA	TEXTILE
SONME	SÖNMEZ FİLAMENT	TEXTILE
TUDDF	TÜRK DEMİR DÖKÜM	BUILDING MATERIALS
DISBA	DIŞBANK	BANKING
GARAN	GARANTİ BANKASI	BANKING
ISCTR	İŞ BANKASI C	BANKING
TKBNK	KALKINMA BANKASI	BANKING
SMSNS	SİEMENS	TELECOMMUNICATION
TSKB	TÜRKİYE SINAİ KALKINMA BANKASI	BANKING
SISE	ŞİŞECAM	GLASS
TBORG	TUBORG	BREWERY
TUTUN	TUTUNCÜLER BANKASI	BANKING
TEKST	TEKSTİL BANK	BANKING
TIRE	TİRE KUTSAN	PAPER
TOFAS	TOFAŞ OTO TİCARET	AUTOMOTIVE
TOASO	TOFAŞ FABRİKA	METAL INDUSTRY
TRKCM	TRAKYA CAM	GLASS
TRNSK	TRANSTÜRK	CONGLOMARATE
TURCS	TURCAS PETROLCÜLÜK	PETROLEUM
TUPRS	TÜPRAŞ	PETROLEUM
THYAO	TÜRK HAVA YOLLARI	AIRLINE INDUSTRY
USAK	UŞAK SERAMİK	CERAMICS
UNYEC	ÜNYE ÇİMENTO	CEMENT
VAKFN	VAKIF FİNANSAL KİRALAMA	LEASING
VKFYT	VAKIF MENKUL KIYMETLER	NON. BANK FIN. INST.
VESTL	VESTEL	HOUSE APPAREL
YKBNK	YAPI KREDİ BANKASI	BANKING
YASAS	YAŞAR BOYA	PAINT
YUNSA	YÜNSA YÜN SANAYİ	TEXTILE