İ.Ü. İşletme Fakültesi Dergisi C:30 S:2 Kasım 2001 S: 29 - 51

THE USE OF DATA ENVELOPMENT ANALYSIS FOR STOCKS SELECTION ON ISTANBUL STOCK EXCHANGE

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Abstract :
A potantial investor who wants to pick amongst major securities traded on the İSE is faced with many options in both performance and cost . This paper propuses a decision model to help the investor to select his/her stocks in Torkish securities market. In this article, Data Envelopment Analysis, DEA is used to identify efficient companies that provide the best combinalions of financial spesificiations on the performance parameters of the companies. This model takes into considcration the fact that the performance of a company is spesified by its financial ratios.

Özet :

İSTANBUL MENKUL KIYMETLER BORSASINDA HİSSE SENEDİ SEÇİMİ İÇİN VERİ ZARFLAMA ANALİZİ

İstanbul Menkul Kıymetler Borsasında (İMKB de) hisse senetleri arasından seçim yapmak isteyen bir potansiyel yatırımcı hisse senedi verimliliği, piyasa değeri/ defter değeri oranı, maliyet vs. gibi bir çok kriter ile karşı karşıyadır. Bu makalede, İMKB de hisse senet(ler)ini seçmek isteyen yatırımcıya yardımcı olacak bir karar modeli sunulmaktadır. Model, bir şirketin performans parametrelerinin o şirketin finansal oranları yoluyla belirlenebileceğini dikkate almaktadır. Modelde, şirketlerin performans parametreleri üzerinde finansal spesifikasyonların en iyi kombinasyonunu veren etkin şirketleri dolayısıyla da etkin kağıtları teşhis etmek amacıyla Veri Zarflama Analizi (VZA) kullanılmıştır.

Key Words : Data Envelopment Analysis, Performance Measurement, Stocks Selection

1. INTRODUCTION

It is not easy to earn money with speculative movement as though. It must be become an expert on this field with knowledge and experimentations. The number of successful investor or buyer is less with respect to the number of unsuccessful person. It is temporary to get success coincidentally because of not to be recursive. For the permanent success, it must be defined the psychological factors and made the analysis truly and must be taken into consideration the financial management. In exchange, the most note-worthy point is which securities are chosen and then the securities chosen are pursued and finally the timing of the purchase and sale of them is being correct. In this paper, for selecting the securities in the context of Data Envelopment Analysis (DEA), it must be evaluated the financial performances of companies whose securities traded on ISE in terms of outputs and inputs such as variety of its financial ratios, and then the performance measurement is assigned to each of companies. The efficient companies are identified. Besides, the inefficient companies are explored of which sources and what amount of any inefficiencies that may be present. The portfolio is constituted from these stocks of which companies identified as efficient (i.e. whose financial nuture is strong and powerful) by using DEA. These securities may be pursued with other approaches known such as performing security analysis. One purpose for conducting such examinations is to identify those securities that currently appear to be mispriced.

In the literature, there are several approaches to construct a portfolio. Historically the Mean-Varyans Model is the first example of a portfolio optimization problem and credited to Hanry Markowitz, who presented his ideas at 1952 [24]. It is important because mean-varyans analysis provides a basis for the derivation of the equilibrium model known variously as The Capital Asset Pricing Model(CAPM), Sharpe-Lintner Model, Black Model and Two-Factor Model. The Market Model was developed by William F. Sharpe at 1963 , an extensive discussion of the market model can be made by Eugene F. Fama at 1976. Credit for the initial development of the CAPM is usually given to Sharpe at 1964, John Lintnner at 1965, and John Mossin at 1966. A critique of the CAPM was made by Richard Roll at 1977. Despite Roll's critique, several tests of CAPM have been conducted. Some extended versions of the CAPM and Arbitrage Pricing Theory (APT) are described in [31]. The methods and theory of the

financial decision making is found in such as [3,4,10,31]. Besides, portfolio system that has more complex nuture by using Analytic Hierarchy Process is analyzed by Saaty, Rogers, Pell at 1980 in [27], and by Durer, Ahlatcıoglu, Tiryaki at 1997 in [9]. And also, some papers contributed to the efficiency of ISE about Turkish Capital Market are in [18].

2. TECHNICAL ANALYSIS, FINANCIAL (or FUNDAMENTAL) ANALYSIS and RATIO ANALYSIS

The technical and fundamental analysis are commonly used on the stock market. Although technical analysis is used many investors, fundamental analysis is far more prevalent. Furthermore, unlike technical analysis, it is essential activitiy if capital markets are to be efficient. Some speculators are used both of them.

In the broad sense, financial analysis involves determining the levels of risk and expected return of individual financial assets as well as groups of financial assets. For example, financial analysis involves both individual common stocks such as IBM and groups of common stocks such as the computer industry or, on an even larger basis, the stock market itself. In this case, financial analysis would result in a decision of how to split the investor's money between the stock, bond, and money market as well as a decision of whether to buy or seli computer stocks in general and IBM in particular.

Financial analysts as synonymous with security analysts or investment analysts are investment professionals who evaluate securities and then make investment recommendations. Those recommendations may be used by professional money managers (portfolio managers) or by certain clients of the analysts. According to this definition, financial analysis can be wieved as the activity of providing inputs to the portfolio management process[31,pp.740]

There are two primary reasons for engaging in financial analysis : to determine certain characteristics of securities and to attempt to identify misprised securities.

To understand and estimate the risks and returns of individual securities as well as groups of securities, one must understand both financial markets and the principals of security valuation.

Technical analysis involves short-term predictions of security price movements based on past patterns of prices and trading volumes. Fundamental analysis concerns estimates of the basic determinants of

security values, such as future sales, expences, and earnings for firms.(For the technical analysis, see [2, 28, 29, 30, 31]).

Many financial analysts focus their research efforts on analyzing company financial statements. Such research permits an analyst to better understand a company's business operations, its plans for future growth, what factors affect its profitability, and how those factors affect its profitability. When analysts publish favorible reports on a stock, its price tents to immediately rise by an abnormal amount. Conversely, when they publish unfavorable reports on a stock, its price tents to immediately fall. Neither of these price movements is subsequently reversed. Stocks that are neglected by analysts tend to have abnormally high returns. [31,pp.777; 15, pp.5-14]

Ratio analysis is a technique commonly employed by analysts examining a company's financial statements. Standing alone, the values of various financial statement items are difficult to interpret. They display more meaning when they are considered relative to one another. [31,pp.762]. One way of avoiding the problems involved in comparing companies of different sizes is to calculate and compare *financial ratios*. Such ratios are ways of comparing and investigating the relationships between different pieces of financial information [26,pp.53]. But which ratios occured are meaningful or essential financial characteristics among the several ratios for considering? For example, there is a paper in [19] about this subject for the banking sector.

We cover some of the more common ratios next, but there are many others that we don't touch on in this paper.

The types of ratios considered depends on the purpose of the analysis. In general, analysts concerned with a company's equity securities will look at ratios relating to the firms return on equity. Analysts viewing the company from a creditor's perspective will focus on measures of dept capacity and liquidity [4, pp.29-30; 31,pp.762].

Financial ratios are traditionally grouped into the following categories [26, pp.53; 4, pp.28-29; 34, pp.41]:

- Short-term solvency, or liquidity, ratios
- Long-term solvency, or financial leverage, ratios
- Asset management, or turnover, ratios
- Prifitabilitiy ratios
- Market value ratios

Key financial ratios used in this study and their brief definitions:

In this paper, the following ratios are chosen as key ratios by us , based on Balance Sheets of Sectors prepared by Republic of Turkey, Central Bank. [34, pp.41] and based on the results given by Talu [33]. In her study, Talu explored which indicators are important to examine the companies by the analysts and evaluated theirs sights about the efficient of this indicators. Let us consider each of these in turn. For more knowledge, see [4,13,15,26, 31].

A) Short-Term Solvency, or Liquiditiy, Measures: As the name suggests, short-term solvency ratios as a group are intended to provide information about a firm's liquidity. The primary concern is the firm's ability to pay its bills over the short run without undue stress. Consequently, these ratios focus on current assets and current liabilities.

For obvious reasons, liquidity ratios are particularly interesting to short-term creditors. Since financial managers are constantly working with banks and other short-term lenders, an understanding of these ratios is essential and the higher liquidity ratios, the prefered.

Current Ratio: One of the best-known and most widely used ratios is the current ratio is defined as :

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

To a creditor, particularly a short term creditor, such as a supplier, the higher the current ratio, the better. To the firm, a high current ratio indicate liquidity, but it also may indicate an inefficient use of cash and other short-term assets. Absent some extraordinary circumstanses, it is expected to see a current ratio of at least 1, it means that net working capital (current assets less current liabilities) is negative. In order to interpret the significiance of this ratio it will be necessary to evaluate the trend of liquidity over a longer period and to compare firm's coverage with industry competitors. Also, to supplement the current ratio, it is necessary to use other measures of liquiditiy, including cash flow from operations and other financial ratios which rate the liquidity of specific assets.

Quick (or Asit-Test) Ratio : Inventory is often considered the least liquid current asset and the most likely source of losses. More to the point, relatively large inventories are often a sign of short-term trouble. In this case, the firm may have a substantial portion of its liquidity tied up in slow-moving inventory. To further evaluate liquidity, the quick or asit-test ratio is computed. This ratio is more rigorius test of short-run solvency than the current ratio because the numerator eliminates inventory.

$$\text{Quick ratio} = \frac{\text{Current assets} - \text{Inventory}}{\text{Current liabilities}}$$

This ratio must also be examined in relation to the firm's own trends an to other firms operating in the same industry.

B) Long-Term Solvency, or Financial Leverage, Measures : Long-term solvency ratios are intended to address the firm's long-run ability to meet its obligations, or, more generally, its financial leverage. These ratios are sometimes called "financial leverage ratios" or just "leverage ratios".

Total Dept Ratio : The total dept ratio takes into account ali depts of all maturities to ali creditors. It can be defined in several vays, the easiest of which is:

$$\text{Total dept ratio} = \frac{\text{Total assets} - \text{Total equity}}{\text{Total assets}}$$

Two useful variations on the total dept ratio are the "dept-equity ratio" and the "equity multiplier":

$$\text{Dept - equity ratio} = \text{Total dept}/\text{Total equity}$$

$$\text{Equity multiplier} = \text{Total assets}/\text{Total equity}$$

The fact that the equity multiplier is 1 plus the dept-equity ratio is not a coincidence:

$$\begin{aligned}\text{Equity multiplier} &= \text{Total assets}/\text{Total equity} \\ &= (\text{Total equity} + \text{Total dept})/\text{Total equity} \\ &= 1 + \text{Dept - equity ratio}\end{aligned}$$

The thing to notice here is that given any one of these three ratios, immediately calculated the other two. So they ali say exactly the same thing. The lower the dept-equity ratio or eqivalently the higher the total equity/total assets ratio, the better.

Current Liabilities/Total Assets Ratio : The high current liabilities/total assets ratio shows that the assets of the firm are compensated by the current liabilities. This is negativeness for liquidity.

C) Asset Management, or Turnover, Measures : The specific ratios we discuss can ali be interpreted as measures of turnover. What they are intended to describe is how efficiently, or intensively, a firm uses its assets to generate sales.

Inventory Turnover : Inventory turnover measures the efficiency of the firm in managing and selling inventory. It is a gauge of the liquiditiy of a firm's inventory and can be calculated as

$$\text{Inventory turnover} = \frac{\text{Cost of goods sold}}{\text{Inventory}}$$

Generally, a high turnover is a sign of efficient inventory management and profit for the firm; the faster inventory sells, the fewer funds are tied up in inventory. But a high turnover can also mean understocking and lost orders, a decrease in prices, a shortage of materials, or more sales than planned. A relatively low turnover could be the result of a company's carrying too much inventory ot stocking inventory that is obsolate, slow moving, or inferier. The type of industry is important in assesing inventory turnover.

Receivables Turnover : The accounts receivable turnover indicates how many times, on average, accounts receivable are collected during the year. It measures the quality of receivables and the efficiency of the firm's collection and credit policies. The turnover expresses this information in number of times. The *receivables turnover* is defined in the same way as inventory turnover:

$$\text{Receivables turnover} = \frac{\text{Sales}}{\text{Accounts receivable}}$$

Generally, a high turnover is good because it is evidence of efficiency in converting receivables into cash; but a turnover that is too high may be indicative of credit and collection policies that are overly restrictive.

D) Prifitabilitiy Ratios: This measures we discuss in this section are probably the best known and most widely used of ali financial ratios.

Operating profit margin : The operating profit margin, a measure of overall operating efficiency, incorporates ali of the expanses associated with ordinary business activities and represents the firm's ability to translate sales dollars into profits as a different stage of measurement.

$$\text{Opereting profit margin} = \frac{\text{Operating profit}}{\text{Net sales}}$$

Return on equity (ROE): Return on equity measures the return to common shareholders; this ratio is also calculated as return on common equity if a firm has preferred stock outstanding. ROE is usually measured as:

$$\text{Return on equity} = \frac{\text{Net income}}{\text{Stockholders' equity}}$$

The simplest expression for ROE is to view it as the product of profit margin (net income divided by sales) and equity turnover (sales divided by stockholders' equity). That is:

$$\text{ROE} = \frac{\text{Net income}}{\text{Stockholders' equity}} = \frac{\text{Net income}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Stockholders' equity}}$$

Interest coverage ratio: Measures how many times interest expense is covered by operating profit (also called earnings before interest and taxes). It can be calculated as

$$\text{Interest coverage ratio} = \frac{\text{Earnings before interest and taxes}}{\text{Interest paid}}$$

E) Market value ratios: Market ratios of particular interest to the investor are earnings per common share, the price-to-earnings ratio, market value-to-book value ratio, earning-to-price ratio, the dividend payout ratio, and dividend yield, ete. In this paper, the first of our market value measures, the earnings-price ratio is defined as the reciprocal of the price-earnings ratio. We used this ratio as a productivity of the stock.

Earnings-Price Ratio: The earnings-to-price ratio is typically calculated as follows. First, the accounting value of the firm's earnings per share is determined by using the most recent income statement and dividing the firm's earnings after taxes by the number of shares outstanding. Second, the market price of the firm's common stock is determined by taking the most recent price at which the firm's common stock was traded. Last, the earnings per share figure is divided by the market price of the stock to arrive at the E/P ratio. That is :

$$\text{E/P} = \frac{\text{Earnings per share}}{\text{Price per share}}$$

Common stocks are often divided into two categories—growth stocks (sometimes called glamour stocks) and value stocks.Relatively low values of this ratio characterize growth stocks, and relatively high values characterize value stocks. An interesting question is whether there is a relationship between stock returns and their E/P ratios. Fama and French examined this issue and discovered such a relationship [12]. Specifically, they found that on average the larger the size of the E/P ratio, the larger the rate of return. Because growth stocks tend to have low E/P ratios and value stocks tend to have high E/P ratios, this resuts suggests that value stocks tended to outperform growth stocks over the periyod analyzed. So, in this paper, this ratio is ineluded to the criteria set to be maximized.

Market value-to-book value ratio: A second market value measure we used is the market value-to-book value ratio (MV/BV)

$$\text{MV/BV} = \frac{\text{Market value per share}}{\text{Book value per share}}$$

Notice that book value per share is total equity (not just common stock) divided by the number of shares outstanding. The MV/BV ratio has meaningful interpretations. Since book value per share is an accounting number, it reflects historical costs. In a loose sense, the MV/BV ratio therefore compares the market value of the firm's investments to their cost, and it must be high [36, pp.112]. And related to have confidence in company, the value of ratio on and under the average means respectively, expensiveness and cheapness of the stocks's prices [4, pp.43]. On the other hand, an interesting question is whether there is a relationship between stock returns and the stocks's MV/BV ratios. Fama and French also examined this issue and found that there was such a relationship [12]. Specifically, they found that on average the smaller the size of the MV/BV ratio, the larger the rate of return. Because growth stocks tend to have high MV/BV ratios and value stocks tend to have low MV/BV ratios, this results suggests that over the period analyzed, value stocks tended to outperform growth stocks [31,pp.480-481]. And also in [20], it is shown that if the portfolio based on low MV/BV ratios is occured, stocks will tend to have above normally high returns at long-term. So, in this paper, this ratio is included to the criteria set to be minimized.

3. DATA ENVELOPMENT ANALYSIS (DEA)

Data Envelopment Analysis is itself a basic concept and an effective tool for measuring efficiency. DEA, first demonstrated by Charnes, Cooper and Rhodes at 1978 [5], can be applied to ampirical data via different types of models to optain estimates of the relative technical efficiency of a group of Decision Making Units (DMUs) . DEA uses observed or raported values of multiple outputs and inputs for each DMU and mathematically selects subsets of efficient DMUs—those which are most like the DMU being evaluated (in terms of input and output mixes)—to effect its performance evaluations. Each DMU is individually evaluated and the amounts and sources of its inefficiencies are estimated and identified.

The organizational units which are to serve as DMUs are evidently an important issue and must be addressed in any use of DEA.In past studies, DMUs have consisted of cities, hospitals, banks, schools, products, firms, teams, ete [5,6,7,8,16,17,21,22,23,25,27,32,37]. Guiding principles to use in choosing DMUs are (1) each DMU should be identified as an entity which is responsible for the resources it uses and the outputs it produces and (2) the number of DMUs utilized should be large enough to provide an adequate number of degrees of freedom—as determined by the number of DMUs

relative to the number of outputs and inputs used in the study—to help ensure that the resulting efficiency measures are meaningful.

In addition to choosing the entities which will serve as DMUs, the choices of inputs utilized and outputs produced are important. DEA is designed to consider multiple outputs and inputs simultaneously without requiring *a priori* specified weights and/or without requiring explicit specification of functional forms for the relationships between inputs and outputs. These characteristics are particularly useful in evaluating not-for-profit entities since many of the outputs characteristically produced by such organizations cannot be adequately measured by traditional measures such as profit or return on investment. As previously noted, the choice of outputs to be used in measuring benefits and the choise of inputs to measure the resources used is a difficult and important task. These decisions may be based on the effect of adding or dropping some of the factors and/or altering the time period and DMUs to be considered [1].

Continuing research has resulted in more than one mathematical programming model being available for use implementing DEA. These essential models such as the CCR ratio form, "additive" and "multiplicative" forms of DEA, the BCC model are generally given in [7]. And also primal and dual characterizations for each model are presented, and comparisons between models are developed via geometric portrayals of the corresponding envelopment surface, and invariance of mesurement units. Essentially, the various models for DEA each seek to estabish which subset of n DMUs determine parts of an *envelopment surface*. The geometry of this envelopment surface is prescribed by the specific DEA model employed. To be efficient, the point P_j corresponding DMU_j must lie on this surface. Units that do not lie on the surface are termed inefficient, and the DEA analysis identifies the sources and amounts of inefficiency and/or provides a summary measure of relative efficiency. The envelopment surface, called the efficient frontier serves to (1) characterize efficiency and (2) identify inefficiencies.

Let's assume that there are n DMUs to be evaluated. Each DMUs consumes varying amounts of m different inputs to produce s difference outputs. Specifically, DMU_j consumes amounts $X_j = \{x_{ij}\}$ of inputs $i = 1,...,m$ and produces amounts $Y_j = \{y_{rj}\}$ of outputs $r = 1,...,s$. For these constants, which generally take the form of observations, we

assume $x_{ij} > 0$ ve $y_{rj} > 0$. The $s \times n$ matrix of output measures is denoted by Y, and the $m \times n$ matriz of input measures is denoted by X.

By simultaneously evaluating multiple inputs and outputs common to each unit; each DMU is thus assigned an effiency score. The original formulation of DEA model is called the "CCR ratio form" and is a family of fractional linear programs; each linear program measures the relative efficiency of a particular DMU. Even though the modelling is nonlinear, under appropriate transformations the efficiency rating can be derived from an equivalent linear program. The DEA model we used is the input-oriented CCR model given below.

Input-Oriented CCR Primal

$$\text{Amaç: } \min_{\theta,\lambda,s^+,s^-} z_0 = \theta - \varepsilon \cdot \overset{p}{1} s^+ - \varepsilon \cdot \overset{p}{1} s^-$$

$$\text{Kısıtlar: } Y\lambda - s^+ = Y_0$$

$$\theta X_0 - X\lambda - s^- = 0$$

$$\lambda, s^+, s^- \geq 0$$

Input-Oriented CCR Dual

$$\text{Amaç: } \max_{\mu,\nu} w_0 = \mu^T Y_0$$

$$\text{Kısıtlar: } \nu^T X_0 = 1$$

$$\mu^T Y - \nu^T X \leq 0$$

$$-\mu^T \leq -\varepsilon \cdot \overset{p}{1}$$

$$-\nu^T \leq -\varepsilon \cdot \overset{p}{1}$$

The variable θ appears in the primal problem, and the constant ε, a non-Archimedean (infinitesimal) constant, appears both in the primal objective function and as a lower bound for the multipliers in the dual problem. The (scaler) variable θ is the (proportional) reduction applied to all inputs of DMU_0 (the DMU being evaluated) to improve efficiency. This reduction is applied simultaneously to all inputs and results in a radial movement toward the envelopment surface. The presence of the non-Archimedean ε in the primal objective function effectively allows the minimization over θ to preempt the optimization involving the slacks. Thus, the optimization can be computed in a two-stage process with maximal reduction of inputs being achieved first, via the optimal θ^*; than, in the second stage, movement onto the efficient frontier is achieved via the slack variables (s^+ and s^-). Evidently the following two statements are equivalent:

1. A DMU is efficient if and only if the following two conditions are satisfied: (a) $\theta^* = 1$, (b) ali slacks are zero.
2. A DMU is efficient if and only if $w_0^* = z_0^* = 1$.

The nonzero slacks and the value of $\theta^* \leq 1$ identify the sources and amount of any inefficiencies that may be present [7,pp.32].

This paper demonstrates how data envelopment analysis can assist the choosing the securities traded on ISE. Moreover, with this formulation, the basis variables of the "equivalent" linear program can be used for suggesting actions an inefficient company manager should consider to direct his/her operations toward efficiency. In other words, DEA is a dynamic analytical decision-making tool that not only provides a "snapshot" of the current efficieny of the DMU compared with the group, but also indicates possibilities for improving relative efficiency.

The term Data Envelopment Analysis, as coined in Charnes, Cooper and Rhodes [5], was suggested by the formulation CCR Primal in which, as may be observed, an optimal solution envelops the inputs from below and the outputs from above. So the primal problem on the left is referred to as the *envelopment form* while dual problem on the right is the *multiplier form*. The CCR dual formulation may be interpreted so that the objective is to maximize the virtual output for DMU_0 with (a) virtual input constrained to unity, and (b) no virtual output can exceed the virtual input value used in its production with, also, (c) ali variables restricted to be positive with values at least as great as $\varepsilon > 0$ [1].

If the convexity constraint $e^T\lambda \geq 1$ is added to formulation CCR primal and the objective function of the CCR dual is replaced by $\max_{v} \; w_0 = \mu^T Y_0 + u_0$, than it is obtained input-oriented BCC primal problem. The absence of the convexity constraint enlarges the feasible region for CCR primal from the convex hull considered in the BCC primal model to the *conical* hull of (or the convex cone generated by) the DMUs. The result is a reduction in the number of efficient DMUs.

In an input orientation, the objective is to produce the observed outputs with a minimum resource level. For the CCR input orientation, the efficient projection is given by $(X_0, Y_0) \rightarrow (\hat{X}_0, \hat{Y}_0) = = (\theta^* X_0 - s^{-*}, Y_0 + s^{+*})$ or, equivalently, $(\hat{X}_0, \hat{Y}_0) = (X\lambda^*, Y\lambda^*)$. It is shown that "If a DMU is characterized as efficient in the CCR model, it will also be characterized as efficient with the BCC model; the converse does not necessarily hold" (see Ahn, Charnes and Cooper [1] for theoretical differences in efficiency characterizations of different DEA models).

Differences in the actual efficiency scores/projections simply reflect the metrics used in the models.

For the BCC and CCR ratio formulations, a change in orientation simply amounts to inverting the ratio. The effect is less obvious for the linear programming formulations of them, since the Charnes-Cooper transformation in fractional programming selects the denominator of the ratio as the objective function of the equivalent linear program. Thus, the effect of passing from an input to an output orientation for the BCC and CCR models is the observed rearrangement of normalizing constraint and objective function for the (multiplier side) linear program.

The choice of a particular DEA model determines the implicit return-to-scale properties; the geometry of the envelopment surface (with recpect to which efficiency measurements will be made); and the efficient projection, i.e., the inefficient DMU's path to the efficient frontier [7,s.23-46].

In this paper, to make the number of efficient DMUs reduce we will use the input-oriented CCR primal model.

4. SELECTING STOCKS BY USING DATA ENVELOPMENT ANALYSIS

A potantial investor who wants to pick amongst major securities traded on the ISE is faced with many options in both performance and cost.. This paper proposes a decision model to help the investor to select his/her stocks in Turkish securities market. In this article, Data Envelopment Analysis, DEA is used to identify efficient companies that provide the best combinations of financial spesificiations on the performance parameters of the companies. This model takes into consideration the fact that the performance of a company is spesified by its financial ratios.

In this paper, we aim to show that DEA can be used to consider companies wholly and to analyse them with respect to their financial ratios and then to classify them two category as the efficient companies and inefficient companies, and for inefficient companies to identify which sources and what amount of inefficiencies that may be present, and also how to serve as a guide by suggesting actions to inefficient companies managers for improving their relative efficiency.

For this purpose, we can summarize the steps to be performed as follows.

Step 1 : Choosing the feasible sector(s). It must be selected the sector before choosing the certain stock. This choise can be made by using the available decision making methods such as technical analysis, analythic hierarchy process, etc, or with respect to the initiative of the decision maker (analyst, speculator or investor) by utilizing such as the indexes of sectors, the economical data, and the performance of the trade market or different sources [i.e.11,14,34,35,39].

Step 2 : Choosing the stocks in the certain (feasible) sector. This step is the original part of our study and is made by using the DEA as the alternative methods we assert.

Step 3 : Pursueing and evaluating the efficient stocks chosen. To consentrate on the same stocks, it brings about the accomplishment of their timing rise and fail. The stocks (about 8-10 stocks) chosen at the step 2 can be included of the portfolio. Over stocks in the portfolio casuses to distract attention. It may be dangerous to inelude only one or two stocks in portfolio because of making the risk ratio increase. It must be explored the stocks for several aspects by using such as technical analysis: short-term indices for example charts, moving averages, and long-term indices like relative strength measures etc., and it must be made true timing to buy and sell. Besides, since financial statements and ratios that are persueing the price have variable nutures continuously, it must be periodically (weekly, mountly, three mounthly) investigated for efficiency and than for inefficient stocks must be sold and hopeful stocks must be included.

5. APPLICATION

Choosing the sector : According to the knowledge in [34], for year 1998 produetions of textile industry have the most ratio as %44 in the export of manufactured goods. Metal industry and productions of metal goods have the second order as %12 proportion, and foodstuffs have the third order as %9 percentage [34, s.6]. The biggest 500 private companies of Turkey with respect to the sales from produetion as the distribution order of the sectors according to the exploring made by Capital Mountly Economical Review, half of companies is formed by four main sectors—textile, foods, medicine-ehemistry and otomotive [38, pp.28]. According to the searehing knowledge thoroughly, observations and getting information from the sources concerned with subject; textile, otomotive, tourism and telecommunication sectors are to make hopeful sectors on the ISE in future. These sectors have intensive investments and therefore have intensive competition. So in this paper textile and textile products sector are chosen to make investigation on.

The textile sector is classified four subsectors—Cotton, Synthetic, Home Textile, Ready-made clothing and Leather. We particularly focus on *Textile-Cotton and Synthetic Subsectors* by excluding Tekstile-Home, and Ready-made Clothing and Leather because of not to become large dimension.

DEA as the alternative methods on choosing the stocks :

Choosing the observation set: To determine efficient companies included in tekstile-cotton and synthetic sectors, namely to be invested, to have strong financial nuhire whose stocks traded on the ISE , we consider 21 companies as the DMUs in the context of Data Envelopment Analysis —the Akal Textile, the Akın Textile, the Aksu Iplik, the Altınyıldız, the Arat Textile, the Arsan Textile, the Berdan Textile, the Bossa, the Gediz Iplik, the Karsu Textile, the Kordsa Sabancı Dupont, the Luks Kadife, the Menderes Textile, the Mensa Mensucat, the Metemtex, the Okan Textile, the Polylen, the Sifas, the Söktas, the Sonmez Filament, and the Yunsa—whose data consists of market performance and volume information and evaluation ratios given in weekly bulletin [39, pp.19-20], dated, September,8th,2000, printed by the ISE. The DMU index numbers and the data set corresponding to them are shown in Table 2.

Choosing the elements of the input and output sets : It must be made decision about which of the ratios that will be considered to evaluate the companies are belonged to the input set (X) and also which of them are belonged to output set (Y). In this paper, the objective is to choose companies which have the biggest ratios, that are being desired high, and which have the smallest ratios, that are being desired low, as large as possible. For this reason, in the context of VZA "the ratios that will be desired high" are considered as the outputs and the same manner "the ratios that will be desired low" are considered as the inputs.

So the ratios chosen as inputs are:

Current Liabilities/Total Assets Ratio,

Dept - equity ratio = Total dept/Total equity ,

Market value-to-book value ratio $(\text{MV/BV}) = \dfrac{\text{Market value per share}}{\text{Book value per share}}$;

and the ratios chosen as outputs are:

$$\text{Opereting profit margin} = \frac{\text{Operating profit}}{\text{Net sales}},$$

$$\text{Return on equity} = \frac{\text{Net income}}{\text{Stockholders' equity}},$$

$$\text{E/P} = \frac{\text{Earnings per share}}{\text{Price per share}},$$

$$\text{Interest coverage ratio} = \frac{\text{Earnings before interest and taxes}}{\text{Interest paid}},$$

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}},$$

$$\text{Quick (or Asit - Test) ratio} = \frac{\text{Current assets} - \text{Inventory}}{\text{Current liabilities}},$$

$$\text{Receivables turnover} = \frac{\text{Sales}}{\text{Accounts receivable}},$$

$$\text{Inventory turnover} = \frac{\text{Cost of goods sold}}{\text{Inventory}}$$

The elements of input and output sets are summarized in Table 1.

TABLE 1. The elements of Input (X) and Output (Y) Sets

Ratios to be desired low		**Ratios to be desired high**	
X	**Input Set**	Y	**Output Set**
X_1	Current Liabilities/Total Assets Ratio	Y_1	Operating profit margin
X_2	Dept-equity ratio	Y_2	Return on equity
X_3	Market value/Book value ratio (MV/BV)	Y_3	Earnings-Price Ratio
		Y_4	Interest coverage ratio
		Y_5	Current ratio
		Y_6	Quick (or Asit-test) ratio
		Y_7	Receivables turnover
		Y_8	Inventory turnover

With these ratios we aimed to identify the efficient firms that have low dept ratios and low MV/BV ratio that we thought as the product price for persueing the stock exchange;on the other hand that have high profit margin, return on equity, and productivity(E/P) ratio, high interest coverage ratio about the financial nuture, high liquidity measured by current ratio and quick ratio, and high asset management ratios such as receivables turnover and inventory turnover.

Gathering the data : These ratios for each of the DMUs are gathered from the official web site of the Istanbul Stock Exchange. We optained these ratios individually by using in question items of the Detailed Balance Sheets at 6/30/2000 (TLs in Millions) and Income Statements for the six mounth ended July 30, 2000 (TLs in Millions) reported by the DMUs and controlled by independent inspector and announced by the ISE— that the Turkish and English website addresses of the ISE are www.imkb.gov.tr and www.ise.org [41]. The E/P and MV/BV ratios are evaluation ratios given in weekly bulletin[39, pp.19-20], dated, September,8th,2000, published by the ISE. These data are given in Table 2.

Solution of the problem: For each DMU, the input-oriented CCR model given equations (6) are being run with the computer program QSB [40]. The 21 reached efficiency (as %) and the reference sets pertaining to each DMU are given in Table 3. A reference set stakes out the efficiency frontier that any particular company is aiming for. From the manufacturer's point of view, the reference set is a sketch of who the best of the competition is in terms of their product spec. Now it is clear that some companies achieve efficiency by occupying a "tecnical niche" in the stock market. That is, they have the most cost efficient feature A of any, though they might be quite pedestrian when it comes to features B and C. We see from Table 3 that 13 companies out of the 21 reached maximum efficiency. The lowest efficiency was 26.75%, achieved by the Arat Textile.The maximum effiency was 100%, achieved by the Aksu Iplik, the Arsan Textile, the Berdan Textile, the Bossa, the Gediz Iplik, the Karsu Textile, the Kordsa Sabancı Dupont, the Mensa Mensucat, the Okan Textile, the Polylen, the Söktas, the Sönmez Filament, and the Yünsa. These companies as whose financial nutures are strong or powerful will be proposed to investor who wants to choose with respect to 11 evaluation criteria.

How does the investor distinguish among the 100% efficient set between the niche and broad company? The reference sets in Table 3 contains this information. Niche companies will seldom appear in the

TABLE 2. Ratio Data Pertaining to Decision Making Units

		Inputs			Outputs							
		Cur Liabilit. / Total assets	Dept-Equity ratio	MV/BV	Operating Profit Margin	Return on Equity	Earning-Price ratio	Interest Coverage ratio	Current ratio	Qulck(or Asit-test) ratio	Receivables turnover	Inventory turnover
DMU Numbers	Decis.Mak. Units	X_1	X_2	X_3	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8
DMU_1	Akal Textile	0.458759	1.221096	1.70	0.00012	0.00144	2.0088	1.095935	1.63008	1.105215	1.637566	2.39391
DMU_2	Akın Textile	0.415395	1.197618	2.08	0.03718	-0.04126	-2.495	0.714078	1.677509	0.862541	1.919472	1.4997
DMU_3	Aksu Iplik	0.249945	0.78437	1.74	0.049055	0.005501	1.6812	1.599278	2.661359	2.49944	1.832138	2.23299
DMU_4	Altınyıldız	0.62375	2.472498	2.83	0.094386	0.011285	0.4132	1.041231	1.114689	0.765535	1.144736	1.58249
DMU_5	Arat Textile	0.812507	19.57547	5.38	0.093642	-0.9916	-39.3	0.373767	0.743021	0.350315	1.354829	0.94247
DMU_6	Arsan Tex.	0.375061	0.770312	1.17	0.057992	0.002791	0.1125	1.230183	1.508372	1.147634	1.348679	3.30268
DMU_7	Berdan Tex.	0.518489	2.382052	0.44	-0.04302	-0.17191	-42.242	-0.102807	0.937812	0.335385	1.781202	0.81577
DMU_8	Bossa	0.485909	1.410376	1.54	-0.02689	0.030541	7.752	1.561534	1.604924	1.171445	1.618507	1.49968
DMU_9	Gediz Iplik	0.182441	0.717544	2.44	0.017404	0.011034	0.7277	1.849123	1.613047	1.058961	2.738241	2.02089
DMU_{10}	Karsu Tex.	0.341275	0.720472	2.13	0.144824	0.138767	9.425	6.210924	1.671578	1.049926	2.422836	2.825577
DMU_{11}	Kordsa Dup.	0.226174	0.930694	4.65	0.150479	0.135822	3.269	5.085385	2.256648	1.393487	1.8629	1.63761
DMU_{12}	Luks Kadife	0.662183	3.086192	4.50	-0.30817	-0.83973	-30.7169	-0.812611	1.064778	0.342671	1.61772	0.59736
DMU_{13}	MenderesTex	0.381782	1.900438	3.98	0.108751	0.078849	2.6853	2.61799	1.315484	0.561	2.784528	1.6881
DMU_{14}	Mensa Men.	0.375842	3.123609	1.74	0.13965	0.052284	-13.718	1.216811	1.675074	0.884595	1.578366	1.31717
DMU_{15}	Metemteks	0.627188	2.632257	3.92	0.095855	0.048833	-2.1455	1.162533	1.021575	0.723086	2.057649	2.99064
DMU_{16}	Okan Textile	0.467828	0.980511	0.63	0.054467	0.00886	-12.285	1.18721	0.726046	0.273231	2.111974	0.95443
DMU_{17}	Polylen	0.478679	7.749584	0.25	-0.07806	-0.24522	-273.056	0.691617	0.909475	0.76331	0.541703	4.3089
DMU_{18}	Sifas	0.563835	87.37228	3.09	0.09364	-0.68449	-64.294	0.91237	1.141907	0.947217	0.690484	3.29487
DMU_{19}	Soktas	0.342327	2.316197	1.09	0.018454	-0.15092	-36.488	0.183385	1.304644	0.695047	2.040366	1.78846
DMU_{20}	SonmezFlam	0.409521	0.918122	4.76	0.094584	0.03621	-1.548	1.286111	1.106546	0.580034	4.371003	3.09023
DMU_{21}	Yunsa	0.645604	2.272895	2.43	0.200091	0.071545	4.742	1.479192	1.209737	0.984699	1.1426	1.615953

TABLE 3. DMU Numbers, Names, Efficiencies and Reference Sets of 21 Companies

DMU Numbers	Decision Making Units	Efficiency (%)	Reference set
DMU_1	Akal Textile	80.89	3,6,8,10,16
DMU_2	Akın Textile	67.32	3,9,10,16,
DMU_3	Aksu Iplik	100	3
DMU_4	Altınyıldız	47.16	3,6,10,14,21
DMU_5	Arat Textile	26.75	10,11
DMU_6	Arsan Textile	100	6
DMU_7	Berdan Textile	100	7
DMU_8	Bossa	100	8
DMU_9	Gediz Iplik	100	9
DMU_{10}	Karsu Textile	100	10
DMU_{11}	Kordsa Dup.	100	11
DMU_{12}	Luks Kadife	27.19	3,9,16,19
DMU_{13}	Menderes Textile	76.99	9,10,11
DMU_{14}	Mensa Men.	100	14
DMU_{15}	Metemteks	53.74	6,9,10
DMU_{16}	Okan Textile	100	16
DMU_{17}	Polylen	100	17
DMU_{18}	Sifas	65.95	6,9,10
DMU_{19}	Soktas	100	19
DMU_{20}	Sonmez Flam.	100	20
DMU_{21}	Yunsa	100	21

reference sets of other companies because, almost by definition, there can be few competitors in any one niche. Companies with broad scope will appear in many others' reference sets. Consequently, if we add the number of times each 100% efficient company appears in others' reference sets we should get an ordering of companies from broad to niche. This has been done in Table 4. That is, in Table 4, the number of times each 100% efficient company oecurs in the reference set of another company, and if the investor thinks about these 13 companies are too many to select in, in this case it is more feasible to movement of him/her as the ordering results shown in Table 4.

Further investigation of Table 4 reveals this interesting point. The Karsu Textile achieves 24% reference ratio, the Gediz Iplik achieves 17% both the Aksu Iplik and the Arsan Textiles achieve 14% reference ratio pointed by the inefficient companies. So it is more sensible seen to inelin towards these companies whose stocks traded on ISE.

In addition, which sources are shortage or excess and what are the amount of these inefficiencies? For the inefficient companies , say DMU_{15}, the Metemteks Company, if we investigate the nonzero slacks and the value of θ^* that identify the sources and amount of any inefficiencies we see the following values :

$\theta = 0.5374 \quad \lambda_6 = 0.3031 \quad \lambda_9 = 0.2750 \quad \lambda_{10} = 0.5075 \quad s_2^- = 0.6181$

$s_2^+ = 0.0255 \quad s_3^+ = 7.1625 \quad s_4^+ = 2.8706 \quad s_5^+ = 0.7275 \quad s_6^+ = 0.4488 \quad s_7^+ = 0.3336$

So we can say that it must be apply the (proportional) reduction to its all inputs with the 0.5374 radial ratio, and also it must be input reduction to the second input, Dept-equity ratio, with 0.6181; besides it must augment its outputs, respectively, at the Return on Equity with the 0.0255, at the productivitiy of the stock with the 7.1625 , at the interest coverage ratio with the 2.8706 , at the current ratio with the 0.7275 , at the liquidity ratio with the 0.4488 and at the receivables turnover with the 0.3366.

TABLE 4. The number of times each 100% efficient company occurs in the reference set of another company.

DMU Numbers	Decision Making Units	Number of times in other
DMU_3	Aksu Iplik	4
DMU_6	Arsan Textile.	4
DMU_7	Berdan Textile	0
DMU_8	Bossa	1
DMU_9	Gediz Iplik	5
DMU_{10}	Karsu Textile	7
DMU_{11}	Kordsa Dup.	2
DMU_{14}	Mensa	1
DMU_{16}	Okan Textile	3
DMU_{17}	Polylen	0
DMU_{19}	Soktas	1
DMU_{20}	Sonmez Flament	0
DMU_{21}	Yunsa	1

Therefore, the efficient projection (comparison point) , that is the input-output vector calculated for the inefficient Metemteks Company by using the CCR-Input Model

$$(X_0, Y_0) \rightarrow (\hat{X}_0, \hat{Y}_0) = (\theta^* X_0 - s^{-*}, Y_0 + s^{+*})$$

determines a convex combination of the vectors $(X_i, Y_i), i = 6,9,10$ which are the Arsan Textile, the Gediz Iplik and the Karsu Textile and is found by using the relations $\hat{X}_0 = \theta^* X_0 - s^{-*} = 0{,}5374(0.627188;\ 2.632257;\ 3.92)$ - $(0\ ;\ 0.6181\ ;\ 0) = (0.337\ ;\ 0.797\ ;\ 2.107)$ and

$\hat{Y}_0 = Y_0 + s^{+*} =$ (0.095855; 0.048833; -2.1455; 1.162533; 1.021575; 0.723086; 2.057649; 2.99064) + (0; 0.0255; 7.1625; 2.8706; 0.7275; 0.4488; 0.3336; 0) = (0.095855; 0.074333; 5.017; 4.033133; 1.749055; 1.171886; 2.391249; 2.99064). The Metemteks will be become an efficient DMU only if it achieves these values.

6. RESULTS AND COMPARISONS

As known, to take meaningful results from financial analysis made by using data from the Balance Sheets and the Income Statements of the companies, it is the prior condition to use true and reliable data. The another important point is these data changes continuously. So , after the financial statements are announced, it must be made DEA analysis periodically (i.e. weekly or mountly) by considering these ratios or ratios pursueing the price could be changed. Therefore, we will have an opinion about whether the efficient DMUs are stili efficient in the course of time. This is called "Windows Analysis" in the context of DEA. Being formed database in the course of time it will be more easier to give direction to the investments by persueing the market conditions. Because this work using DEA analysis contains entirely financial ratios positive results must be expected in long term istead of short term. According to conclusions occured companies must be pursued and more detail investigations are made. Besides the purchise-selling points or trade points must be determined with the technical analysis.

The DEA properties such as to have flexible nuture and to use various or different inputs-outputs can be made this paper direct to more different dimensions. The difficulty of using ratios is reason for being noncomparativeness of companies. While the company is more efficient at the certain ratio, the another one may be efficient at the another one. The applied methods to this subject is chosen according to preferance of the analysts. In the ali complexity and indecision, by considering more than one ratio simultaneously, DEA not using any parameter, suitible for the entire market conditions and need not to be attention the sector averages is considering more than one ratio and enables its to apply to one group of companies.

With DEA, it is seen that inefficient DMUs will also become efficient only if they arrange certain improvements on their operations. On the other hand, therefore, inefficient companies are also pursued during the investment process by the investor and if they reach achivements then investor can be able to give decision to invest in their stocks. In the market that has quite variable structure such as stocks market, with the studies made periyodically and with the input-output values chosen carefully, large scale studies that have more dimensionality, made the investor's initiative to minimize and get him to point at efficient stocks that are possible undiscovered can be made.

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