A COMPARATIVE PERFORMANCE ANALYSIS OF MANUFACTURING COMPANIES IN BRAZIL, CHINA AND TURKEY

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To The Turkish National Football Team

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1. The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.

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June, 2008

ABSTRACT

Gökhan DÜZÜ **June 2008**

A COMPARATIVE PERFORMANCE ANALYSIS OF MANUFACTURING COMPANIES IN BRAZIL, CHINA AND TURKEY

This thesis is aiming at measuring and comparing financial performance of manufacturing firms in Brazil, China and Turkey. It consists of three parts after the introduction that is included to explain today's general business environment and also mention about the structure of the thesis. The first part is a general explanation about the business performance measurement which is aimed to answer such questions why performance is measured and what the performance measures are. Second part gives theoretical information about the Data Envelopment Analysis which will be used as analysis tool. The history of Data Envelopment Analysis, models, weight restrictions, strong and weak sides of Data Envelopment Analysis are included in this part. Third part of thesis is the empirical study. The data, the method and results of analysis are given in details. This part also consists of general information about manufacturing sector of aforementioned countries. According to results, manufacturing companies of Brazil and China are more efficient than Turkey's manufacturing. Lastly, the conclusion part reveals that the result of the analysis is a motivation factor for inefficient countries and companies to be more efficient.

Key words:

Business Performance Measurement, Financial Performance, Manufacturing, Brazil, China, Turkey, Data Envelopment Analysis

KISA ÖZET

Gökhan DÜZÜ **Haziran 2008**

BREZİLYA, ÇİN ve TÜRKİYE'DEKİ İMALAT FİRMALARININ KARŞILAŞTIRMALI PERFORMANS ANALİZİ

Bu tez, Brezilya, Çin ve Türkiye'deki imalat firmalarının finansal performanslarını ölçme ve karşılaştırmayı amaçlamıştır. Tezin genel yapısını ve bugünün iş çevresi hakkında genel bilgi veren giriş bölümünden sonra üç kısmı kapsamaktadır. İlk kısım, performans ölçümü niçin yapılır ve performans ölçütleri nelerdir gibi soruları yanıtlayan işletme performans ölçümü ile ilgili genel bir açıklamadır. İkinci kısım analiz aracı olarak kullanılacak Veri Zarflama Analizi hakkında teorik bilgiler vermektedir. Veri Zarflama Analizi'nin tarihi, modeller, ağırlık kısıtlamaları, Veri Zarflama Analizi'nin güçlü ve zayıf yanları da bu kısım içinde yer alır. Tezin üçüncü kısımı ampirik çalışmadır. Veriler, metod ve analiz sonuçları detaylı bir şekilde verilir. Bu kısımda ayrıca bahsedilen ülkelerin imalat sanayiileri ile ilgili genel bilgiler de yer alır. Sonuçlara göre, Brezilya ve Çin imalat firmaları Türk imalat firmalarından daha etkindir. Son olarak, sonuç kısmı analiz sonucunun etkin olmayan firma ve ülkeler açısından etkin hale gelebilmek için bir motivasyon faktörü olduğunu ortaya koyar.

Anahtar Kelimeler

İşletme Performans Ölçümü, Finansal Performans, İmalat, Brezilya, Çin, Türkiye, Veri Zarflama Analizi

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LIST OF ABBREVIATIONS

BCG	Boston Consulting Group
BRIC	Brazil, Russia, India, China
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
EBIT	Earnings before Interest and Taxes
EU	European Union
GDP	Gross Domestic Product
ISO	International Organization for Standardization
SWOT	Strengths, Weaknesses, Opportunities, Threats

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INTRODUCTION

GENERAL OUTLOOK

Today, with the help of globalization, business moved to a new dimension. The expectations, the plans, the forecasts, the strategies shifted. In fact, globalization is the result of great changes in internet and communication technologies. The distances between people and organizations decreased. People can buy anything from other side of Pacific or Atlantic. This change also affected business environment. As interaction increased, businesses faced competition closer due to fact that borders removed. Firms formerly competed with local competitors, today they have to challenge their international rivals.

Performance measurement is the process of evaluation of any business activities (branches, persons, groups, etc.) by comparing and measuring with previously determined standards or plans. It is one of mechanism of controlling function of the management. There are a lot of aims of performance measurement. It is basically for getting information about business. The information will be used when making decisions about organization. Wage increase, trainings, discipline, promotion and some of other business activities are decided on performance measurement. A second reason is to provide feedback about standards of job descriptions and job analysis.

There are a lot of dimensions of performance to be measured. In this thesis study, financial performance will be analyzed. It is known that firms try to maximize profit in economics literature. Firms have to have a healthy financial position in order to survive in business. Without having such a strong finance, firms will face difficulties in implementing plans and strategies. One of most popular performance measurement tool is Balanced Scorecard in today's business world. Balance Scorecard evaluates performance through four dimensions. One of these dimensions is financial perspective. Others are customer perspective, internal process perspective and learning and growth perspective. The firms that will be analyzed in terms of financial performance belong to Brazil, China and Turkey. The reason behind selecting these countries in this analysis is that these countries come into importance in the world economy. Brazil and China are included in four countries (Brazil, China, India and Russia) that will dominate world economy by 2050s. Turkey is also one of developing countries. These countries are all emerging markets and attract foreign direct investment intensely. China is especially threatening other developing countries with its cheap labor costs. It plays an important role in the world trade balance. It has a huge trade surplus with United States and has an important share in world's total export import share. Therefore, it affects the world economy directly. Brazil, one of major automobile producer, is another huge economy with its GDP surpassing a trillion dollar and tenth largest economy in the world and showing sustainable growth. Turkey, in the edge of being a member of

European Union, is a competitive economy in various areas. Being a European Customs Union, being in largest 20 economies and having an advantageous geographic location makes Turkey an important player in world market.

The manufacturing sector which is reflection of real economy will be analyzed. The main factor of these countries' competitiveness power comes from producing goods cheaper. It can be thought that the manufacturing sector is the most reflective sector of this competitiveness.

Data Envelopment Analysis will be used to determine financial efficiency of these countries. It is a widely applied technique since its appearance in the literature. It is a useful tool to determine and compare efficiencies of similar decision making units. As a result, the financial performance of Brazilian, Chinese and Turkish manufacturing firms will be analyzed in this context.

CHAPTER 1

BUSINESS PERFORMANCE MEASUREMENT

1.1 THE CONCEPT OF PERFORMANCE MEASUREMENT

Performance, which means "the fulfillment of a claim, promise or request" (Marriam Webster online, 2007), performance measurement and performance management have been subject to a lot of studies. Performance measurement can be defined in various ways such as:

Performance measurement is the process of quantifying action, where measurement is the process of quantification and performance is the result of action (Neely,2007) or performance measurement is primarily managing outcome, and one of its main purposes is to reduce or eliminate overall variation in the work product or process. The goal is to arrive at sound decisions about actions affecting the product or process and its output (Artley and Stroh, 2001). Business performance management is a set of processes that help organizations optimize their business performance. It is a framework for organizing, automating and analyzing business methodologies, metrics, processes and systems that drive business performance (Blansfield, 2003). It can also be defined as the process of gathering data systematically and properly by analyzing and reporting in order to monitor outcomes, produced product or service and used resources (Yörüker et al, 2002).

Center for Strategy and Performance of Cambridge University states Business Performance Measurement is concerned with (Schmitz, 2007):

- measuring the efficiency and effectiveness of actions;
- aggregating and standardizing information;
- setting appropriate targets.

Performance measurement and its management is an activity for controlling function of business management. It does not only effect controlling but also other functions of management: planning, organizing, leading. Organizations make strategic plans for future terms. Then standards for these plans are determined. After key performance indicators are assigned, performance measurement is used to compare whether planned targets are achieved or not. Performance measurement is also used for assessing how much of a business activity was accomplished. Namely performance measurement, with the help of key performance indicators, measures the gap between plans and targets. The narrower the gap, the nearer the organization is to its targets.

Performance measurement is not only related with internal factors of organizations. It is also related with investors, creditors and customers who can affect overall performance of organization.

Performance measurement can be applied to different groups. Overall performance of a firm, a division or department of a company, research and

project teams, individuals, etc. Performance measurement is not limited to companies. Governments, non profit and non governmental organizations also use it.

There are multi dimensional issues about business performance measurement. Here arises the diversity problem. The concept of performance measurement has tremendous usage diversity in the academic fields. For example, researchers and academicians from accounting, economics, human resource management, operations management, and psychology all use this concept independently from each other (Kellen, 2007). Another example about diversity is that Neely (2002) reports that there are 12 million websites related with performance measurement.

There are various systems to measure performance. It can be grouped according to which ways are used. These systems can be finance oriented (e.g. using financial ratio analysis, economic value added), production oriented (using productivity, efficiency and effectiveness analysis), quality oriented (international standards such as Malcolm Baldrige, ISO 9000, etc.), marketing oriented (analyzing sales and sales mix, market share), strategic planned (SWOT Analysis, BCG Matrix), internet based performance (website rankings, number of clicks per day, etc) and performance systems that are used in management accounting (Activity Based Costing, Budgeting and today's most popular tool Balanced Scorecard).

1.2 Why Measure Business Performance?

With the rapid growth of competition in a globalizing world, organizations must adapt to new, changing environment conditions. To challenge with rising competition it is important for firms to measure performance. A contemporary business condition, which is called new economy, forces the companies to measure performance adequately. This new economy has the following characteristics (Gardrey, 2003):

- It is a high growth economy
- Production and diffusion of Information and Communication Technologies
- Expansion of service jobs
- Requiring of highly flexible labor force and labor market
- It is an open economy which is competitive and private capital market that is free from government regulations.

Performance measurement provides knowledge to determine where the firm is and how close to its targets. Every company, both big and small sized, makes some strategic plans for the future and all organizations measure their performance. This can be in many ways. From very simple measurements -as mostly small and medium enterprises do- to more balanced systems –as mostly big sized and multinational corporations do-. For example, Performance Measurement Association reports that 39% of Financial Times Stock Exchange companies use Balanced Scorecard and a

percentage between 40% and 60% of Fortune 1000 companies attempted to implement Balanced Scorecard (bpir.com, 2007). Performance measurement helps firms to understand whether they reach their planned targets or help them to understand how they must act according to their situation. Aims and needs of applying performance measurement are a lot. Different authors represent these needs from different perspectives.(Bititci et al,2002) explains these as follows:

- To monitor and control
- To drive improvement
- To maximize the effectiveness of the improvement effort
- To achieve alignment with organizational goals and objectives
- To reward and to discipline

According to Simmons (Simmons, R., Performance Measurement and Control Systems for Implementing Strategy, cited by Kellen, 2000) business performance measurement is used as a tool for:

1. Balancing profit, growth and control
2. Balancing short term results against long-term capabilities and growth opportunities
3. Balancing performance expectations of different constituencies
4. Balancing opportunities and attention
5. Balancing the motives of human behavior

Another view that firms need performance measurement is from Artley and Stroh (2001). They state that performance measurement can be used

for controlling, self assessment, continuous improvement and management assessment.

According to a survey on top 500 industry firms from Turkey, (Coşkun, 2006) the most important reason why firms apply performance measurement is "to determine areas that have problem and determine areas that can be developed". Some other reasons are those with respect to importance order:

-to understand whether plans for management processes are achieved or not

-to understand whether the firm is successful in general

-to be sure that decisions are based on real data not assumptions

-to provide feedback

Mark Graham Brown, a performance measurement expert state those:

-Measurement reduces emotionalism and encourages constructive problem solving.

-Measurement increases one's influence

-Improvement is impossible without measurement (Artley and Stroh, 2001).

It is obvious that performance measurement brings some benefits. Some are "providing information for better management, helping to solve problems during the work process and work plans, motivating employees, being a beneficial tool for policy makers and decision takers (Yörüker et al, 2002).

It can be concluded that business performance is a general framework that covers all stages. It is used for both earlier stages of organizational plans and later stages.

1.3 What Are Performance Measures?

A performance measure (also called as performance indicator or metric)[1] is the tool that is used to measure performance and to compare performance. In every area of our life, people use these metrics to define how well an action is performed. For example, two men carry boxes. If first man carries 10 boxes and second one carries 15 fifteen boxes, it can be said second man performed better than first man. Here the boxes are said to be performance measure. As a second example, if the first man carries 10 boxes in 10 minutes and second man carries 15 boxes in 20 minutes, it can be said first man has better performance in terms of box per minute. As understood from given examples, a performance metric can be a single unit or can have multi units. Performance measures can be different units. It varies according to what is measured. They can be time (nanoseconds to centuries), length (metres to miles) and can be anything –even a box as stated above- or ratio of these metrics as other different metrics such as miles per hour, windows per house, GDP per capita, number of defective products per machine etc

Organizations are using performance and performance tools to measure productivity, effectiveness, efficiency, quantity, quality, costs etc. As most of the authors take similar evaluation criteria for performance measurement,

1 In the Performance Based Management Handbook, Artley and Stroh (2001) explain it as "Performance measurement terminology is tricky. For example, some people equate performance measures and performance indicators as being one and the same. Others look at the two as being entirely different or some use goals, objectives, and targets interchangeably, while others do not. Then there's the statutory definitions, the agency definitions, and those used in the private sector."

there are little differences between them. According to National Audit Office of England, performance criteria are compatibility, finance, service quality, efficiency and productivity. According to Aktan (2003 as cited by Şentürk) these are quality, productivity, profitability, cost, innovation, and customer and employee satisfaction.

Performance measures or indicators must be S.M.A.R.T. (specific, measurable, achievable, related and time-bound) and Performance measurement must always support self evaluation (Parker, 2000). Effective performance measures can allow us to understand whether we meet our goals, whether our customers are satisfied, whether our processes are in statistical control and whether and where improvements are necessary (Artley and Stroh, 2001).

According to Akal's (1992) classification, dimensions of performance are effectiveness, productivity, quality, health of working environment, innovation and profitability.

Among these, most widely used performance indicators as terms in the literature are financial-non financial indicators. In recent studies, it is revealed out that top managers still give importance and use financial ratios as performance indicators (Gosselin, 2005). The similar results were found in other studies. According to another survey, firms mostly use financial measures and internal operating measures. One of the reasons why managers use financial indicators is that financial performance indicators are

less ambiguous compared to non-financial indicators (Chow and Stede, 2006).

1.4 Financial Measures

There are a lot of synonyms of financial measurement such as financial statement analysis, (because of that they are derived from financial statements) financial ratio analysis, financial performance indicators etc. Financial measures so as to do financial analysis are used for evaluating profitability, liquidity, efficient asset usage, stability of a business or sub-units of the business. Financial ratios can be used for any purposes. A lot of groups that are related with business can benefit from financial ratios. Table 1 shows which group can use these ratios for which motives:

TABLE 1. WHAT DO THE USERS OF ACCOUNTS NEED TO KNOW?

Investors	to help them determine whether they should buy shares in the business, hold on to the shares they already own or sell the shares they already own. They also want to assess the ability of the business to pay dividends.
Lenders	to determine whether their loans and interest will be paid when due
Managers	might need segmental and total information to see how they fit into the overall picture
Employees	information about the stability and profitability of their employers to assess the ability of the business to provide remuneration, retirement benefits and employment opportunities
Suppliers and other trade creditors	businesses supplying goods and materials to other businesses will read their accounts to see that they don't have problems: after all, any supplier wants to know if his customers are going to pay their bills!
Customers	the continuance of a business, especially when they have a long term

	involvement with, or are dependent on, the business
Governments and their agencies	the allocation of resources and, therefore, the activities of business. To regulate the activities of business, determine taxation policies and as the basis for national income and similar statistics
Local community	Financial statements may assist the public by providing information about the trends and recent developments in the prosperity of the business and the range of its activities as they affect their area
Financial analysts	they need to know, for example, the accounting concepts employed for inventories, depreciation, bad debts and so on
Environmental groups	many organisations now publish reports specifically aimed at informing us about how they are working to keep their environment clean.
Researchers	researchers' demands cover a very wide range of lines of enquiry ranging from detailed statistical analysis of the income statement and balance sheet data extending over many years to the qualitative analysis of the wording of the statements

Source: http://www.bized.co.uk/compfact/ratios/intro3.htm

But every group is interested in different financial ratios. Even though it is difficult to determine certain ratios for certain groups. Table 2 gives a list for who are interested in which ratios:

Financial ratios can be grouped in different ways. Sometimes different resources classify them a little different. It can be grouped into five categories: liquidity, leverage (debt), asset usage and activity, profitability and market value ratios. (Weston et al., 1996; Bodie et al., 2007; spireframe.com, 2007)

TABLE 2. WHO USE FINANCIAL RATIOS?

Interest Group	Ratios to watch
Investors	Return on Capital Employed Earnings per Share Dividends per Share Dividend Yield Interest Cover Liquidity P/E Ratio
Lenders	Gearing ratios Interest cover Dividend payout ratio Dividend Cover Dividend Yield
Managers	Profitability ratios Asset turnover ratios Stock, debtors and creditors turnover ratios Liquidity ratios Investor ratios
Employees	Return on Capital Employed Profitability Cash flow figures Investor ratios
Suppliers and other trade creditors	Profitability Liquidity Creditors' turnover Working capital management
Customers	Profitability Liquidity Return on Capital Employed
Governments and their agencies	Profitability Liquidity Return on Capital Employed
Financial analysts	The majority of all ratios

Environmental groups	Expenditure on anti pollution schemes Expenditure on animal based research Donations to charities and political organizations
Researchers	Depends on the purpose of their study

Source: *Which ratios will each of these groups be interested in? (http://www.bized.co.uk/compfact/ratios/intro4b.htm)*

1.4.1 Profitability Ratios:

Profitability ratios measure how efficient the firm is at converting its resources to profits. Namely these ratios determine how much of assets, investment, equities and capital the company used to get a reliable profit.

1.4.1.1 Net Profit Margin Ratio: It is also known as profit margin ratio. This ratio tells us tells how much net profit the firm got every $1 from its sales. For the companies in the same sector, higher profit margin ratio is better.

Net Profit Margin Ratio= Net Income/Net Sales

1.4.1.2 Return on Sales Ratio (Operating Profit Margin): This ratio calculates the percentage of profitability of firm from its operating activities. Operating income indicates the "earnings before income and interest expenses, in short form: EBIT.

Return on Sales Ratio: Operating Income (EBIT) / Sales

1.4.1.3 Return on equity (Return on Worth Net): This is an indicator of how well the firm generated from investments coming from its stockholders.

Return on equity= Net Sales / Shareholders' Equity

1.4.1.4 Return on assets: The Return on Assets (ROA) ratio tells us the how profitable the firm's assets are for making revenue.

ROA = Net income / Total Assets

1.4.1.5 Return on capital: Return on Capital is a measure of economic performance within a business firm. This ratio is used to measure how much capital (e.g. debt and equity) was needed to produce a firm's earnings. This ratio is also an indication of how well a company uses its capital to generate returns to shareholders.

ROIC = (Net Operating Profit - Taxes) / (Total Capital)

1.4.1.6 Return on capital employed: This is the ratio for understanding whether company gets reliable returns for the cost of the capital. Namely it measures the utility of capital usage.

Return on capital employed= Pre-tax operating profit/ Capital employed or

EBIT / (Total Assets – Total Liabilities)

1.4.2 Asset Usage and Activity Ratios:

The ratios in this group help us to understand how efficiently the firm uses its assets. That is to say, they measure how well the company utilizes its assets and collecting receivables.

1.4.2.1 Asset turnover: This ratio measures the ability of the company in converting assets to sales revenue.

Total Asset Turnover= Annual Sales / Total Assets

1.4.2.2 Fixed Asset Turnover: It has the same meaning with total asset turnover but this ratio takes in calculation only fixed assets which are Net Property, Plant, and Equipment.

Fixed Asset Turnover = Net Sales / Net Property, Plant and Equipment

1.4.2.3 Inventory Turnover: It is used to calculate how frequently the company circulates its inventory. It helps us to how many times the company sold in a period. It can be calculated in two ways:

Inventory Turnover= Sales/Inventory or

Cost of Goods Sold / Average Inventory

1.4.2.4 Average Collection Period: This ratio measures the number of days that company collects its receivables from its credit sales. It is also called as Dales Sales Outstanding.

Average Collection Period = Accounts Receivables / (Net sales / 360)

1.4.3 Liquidity Ratios

Ratios in this group help us to understand firm's ability to convert its assets into cash. The more liquid the company is, the quicker the time of converting assets into cash. We should know what current assets and current liabilities are.

Current Assets=Assets that can be converted to cash in short term. They are cash and equivalents, accounts receivables, inventory and short term investments.

Current Liabilities=The obligations that company must pay in short term (generally one year) They are accounts payables, note payables, interest payables, etc.

1.4.3.1 Current Ratio: It measures the ability of the company to meet its short term debts.

Current ratio= Current Assets / Current Liabilities

1.4.3.2 Quick Ratio: It is similar to current ratio but it indicates more liquidity. Inventories are exempted in the calculation. It is also known as Acid Test ratio.

Quick Ratio= (Current Assets-Inventories) / Current Liabilities

1.4.3.3 Cash Ratio: This is the financial ratio that measures how well cash and cash equivalents meet current liabilities.

Cash Ratio= Cash and Cash Equivalents / Current Liabilities

1.4.3.4 Working Capital: It indicates how much liquid the company has to operate its business.

Working Capital= Current Assets-Current Liabilities

1.4.4 Leverage Ratios

Debt ratios, also known as leverage ratios, are the ratios to calculate how much debt the company has and how efficient the company uses this debt. It is a measure of financial health. It has three implications (Weston et al, 1996):

- It does not reduce the strength of stockholder ownership by increasing the amount of debt.

- It is an indicator for creditors in order to understand by whom total financing of the company is bore.
- The return of owners' capital is said to be "leveraged" if return of investments from debt is greater than interest payments.

1.4.4.1 Debt ratio: This ratio measures the proportion of debt compared to its assets.

Debt ratio: Total debt / Total Assets

1.4.4.2 Times Interest Earned: Also known as Interest Coverage Ratio. This ratio, which is very useful for creditors, let them to realize whether their debt is in safety margin or not. Because it indicates that if the company has ability to pay its interest obligations.

Times Interest Earned: EBIT / Interest Expenses

1.4.4.3 Fixed Charge Coverage: This ratio explains how well the company meets its fixed financing expenses such as interest and lease payments. It is similar to Times Interest Earned Ratio but it is more inclusive.

Fixed Charge Coverage: (EBIT+Lease Payments) / (Interest + Lease Payments)

1.4.4.4 Debt to Equity Ratio: It is used to calculate how much of debt, namely total liabilities, is met by amount invested boy owners, namely total stockholders' equity.

Debt to Equity Ratio: Total Liabilities / Total Stockholder's Equity

1.4.5 Market Ratios

1.4.5.1 Payout Ratio: This ratio indicates that how much of its dividend payout is supplied by its earnings per share.

Payout Ratio: (Stock Dividends / Average Shares Outstanding) / (Net Earnings / Average Shares Outstanding)

1.4.5.2 Price to Earnings Ratio: Also named as PE ratio, is used to calculate the price of ratio relative to its earning. It can be counted as expensiveness of the price. If a stock price increases while its earnings decrease, it can be said to be expensive.

Price to Earnings Ratio = Market Price of Common Stock / Earnings per Share

1.4.5.3 Price to Cash Flow Ratio: This ratio helps to evaluate to compare the market value and cash flow of company. It can be said the higher ratio is better. Because that means the market capitalization of the company, namely its value, can be operated with even a little cash.

Price to Cash Flow= (Market Price of Common Stock x Average Share Outstanding) / Cash Flow from Operations

1.4.5.4 Price to Book Ratio: This ratio is used to compare stock price and the book value of the company. The book value is synonymous to shareholders' equity. That means total assets minus total liabilities.

Price to Book Ratio: Price of Stock / Book Value per Share (In some resources, only book value is taken.)

There are more financial ratios to be used in financial performance evaluating. Some of them are the following:

Account Receivables Turnover= Net Sales / Accounts Receivable

Cash Flow Margin = Cash Flow from Operating Activities / Net Sales

Cash Flow to Total Debt = Cash Flow from Operations / (Short-Term Debt + Long-Term Debt)

Cash Return on Assets = Cash Flow from Operating Activities /Total Assets

Debt to Equity Ratio = Total Liabilities / Total Stockholder's Equity

Dividend Yield = Dividends per Share / Market Price of Common Stock

Earnings to Total Assets = Earnings before Income Taxes / Total Assets

Interest Expense to Total Debt = Interest Expense / (Long-Term Debt +Short-Term Debt)

Stockholder's Equity Ratio = Total Stockholder's Equity / Total Assets

Working Capital Turnover = Net Sales / Working Capital

CHAPTER 2

DATA ENVELOPMENT ANALYSIS (DEA)

This chapter consists of the information regarding to Data Envelopment Analysis. Firstly, a description of DEA will be introduced. Also specific characteristics and some extent of general knowledge about it will be presented. After that, a small numerical example will be given and a graphical solution for this example will be illustrated. Thirdly, modeling of DEA will be explained. After that, steps of DEA will be ordered. Then, we will deal with the performance measurement and DEA. Namely some areas that we can use DEA for relative performance analysis. Lastly, the limitations and powerful sides of DEA will be stressed.

2.1 The Concept of DEA

The concept of performance is basically related with planning and controlling functions of management. An organization should use its resources efficiently to do so. They have to adapt to new and changing economic environment with a fierce competition. The ratio of efficiency is:

Outputs / Inputs

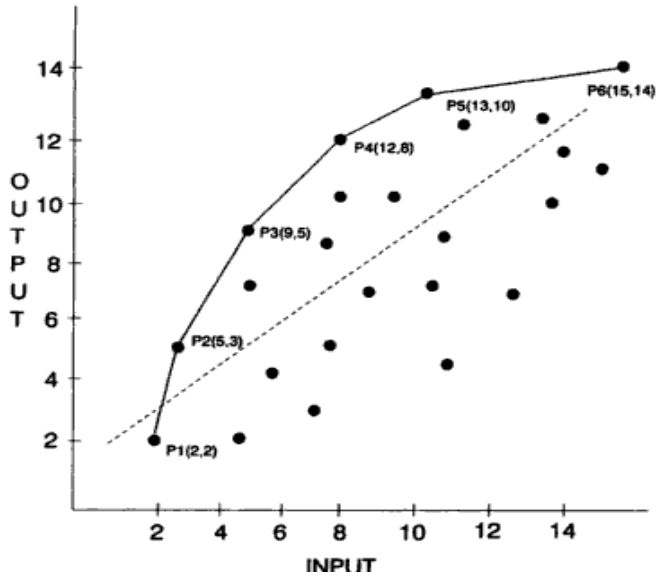
So we can understand that we can increase efficiency by using fewer resources or increasing output level or doing both.

Data Envelopment Analysis (DEA) is a non parametric linear programming tool which is used to measure relative efficiencies of Decision Making Units (DMUs). DEA is first introduced by work of Charnes, Cooper

and Rhodes (1978) called "Measuring the efficiency of decision making units". They built it on the work of Farrell named "The Measurement of Productive Efficiency". From 1978 to present, DEA was used from welfare agencies to the military; from education to policing and from welfare agencies to the military etc. for organizational design, organizational effectiveness, credit evaluation, privatization, insurance underwriting, benchmarking, productivity analysis, modernization policy analysis, scale and performance measurement, physician report cards, environmental regulation, pollution prevention, facilities/equipment planning, evaluation of macroeconomic performance, etc.

DEA allows us to use multiple inputs and multiple outputs. This is important because DEA has very few assumptions. So it is easier to use when other approaches are not available due to being complex nature of multiple input and output (Cooper et al, 2004). The DEA tries to represent the efficient frontier in contrast to regression analysis which takes the average of observations (Charnes et al, 1994). Figure 1 is the graphical representation the difference between regression and DEA:

FIGURE 1. DEA vs. REGRESSION



Source: Data Envelopment Analysis: Theory, Methodology, and Application, 1994

There is no need to construct a specific functional form in DEA analysis such as in regression models.

DEA allows us to get an efficiency score for every observation by using multiple inputs and outputs in a linear programming model. DMUs whose efficiency score equals to 1 assumed as efficient and ones that have a score less than one are assumed as inefficient. DEA compares the homogeneous DMUs between each other and determines the best efficient frontier and other observations are considered according to this frontier. The basis of this comparison is based upon the existence of efficient DMUs. Namely it can be assumed that the inefficient units can reach the same level of efficient units by applying similar techniques of efficient units (Aydagün, 2003).

2.1.1 A Small Numerical Example

Let us consider an example illustrating a simple DEA problem:

Below is the number of chairs, number of tables and hours employed of four different carpenters;

	Tables produced	Chairs produced	Hours employed
Carpenter A	39	15	3
Carpenter B	36	18	6
Carpenter C	32	40	4
Carpenter D	28	28	7

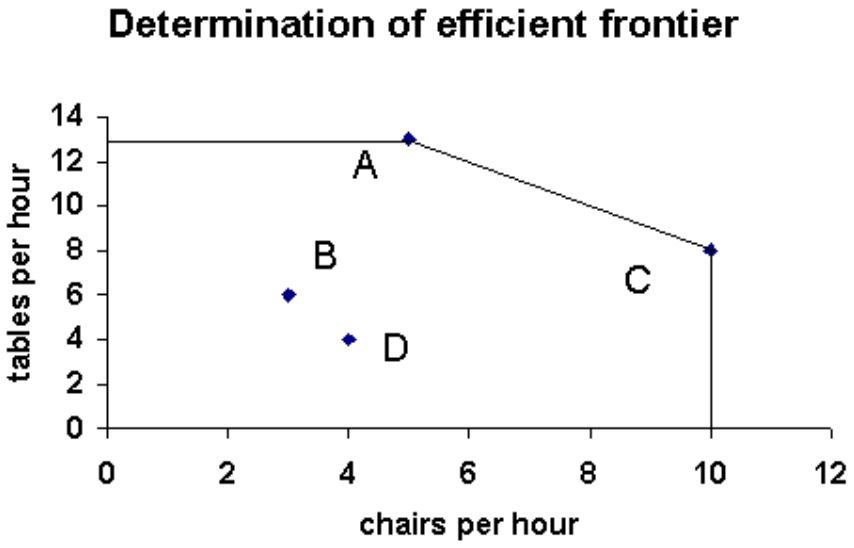
We will use a one input and two output measures. Hours employed is input and tables per hour and chairs per hour will be outputs. So we have the following:

	Tables per hour	Chairs per hour	Hours employed
Carpenter A	13	5	3
Carpenter B	6	3	6
Carpenter C	8	10	4
Carpenter D	4	4	7

We see here Carpenter A is most efficient at producing tables while Carpenter C is the most efficient at producing chairs. The problem here is that it is difficult to combine an entire set of different ratios. Especially when we want to increase number of DMUs. DMUs are carpenters in the above example. DEA is used to overcome this. We can see the combination of different ratios in a graphical illustration. X axis will be the tables per hour and y axis will be the chairs per hour.

Figure 2 shows the efficient decision making units. A and C are on the best efficient frontier so they are attached 100% efficient units. It is clearly seen that B and D are less efficient when compared to A and C. The efficient frontier is convex and it encloses all data. That is how the name of this method constructs.

FIGURE 2. GRAPHICAL ILLUSTRATION OF DEA

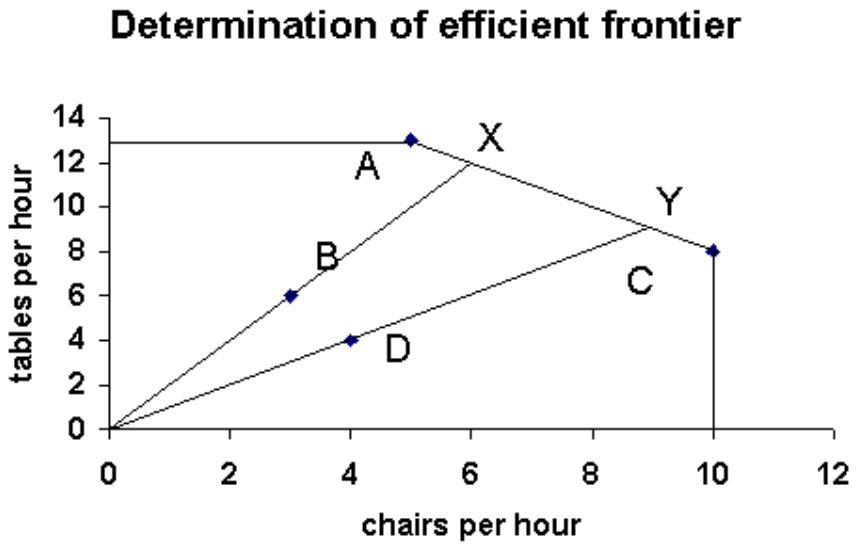


We can measure the relative efficiency scores for both B and D. When B is considered, it has a ratio of 6:3=2 table per chair. If we assume that B decrease the number of hours employed, it will stiil have a 2 tables per chairs ratio. But it will move towards a higher point on a line that goes through the origin. The length of line from origin to B divided by The length of line from origin through B to efficient frontier will give us the relative efficient score of B. This is the same for D. That means A and D are the reference set for this example:

Efficiency of B= the length of line from origin to B/ The length of line from origin through B to efficient frontier

Efficiency of D= the length of line from origin to D/ The length of line from origin through D to efficient frontier

FIGURE 3. MEASURING EFFICIENCIES WITH GRAPH



Efficiency of B= |OB| / |OX| = 6/12= 50%

Efficiency of D= |OD| / |OY| = 4/9 = 44,4% (see Figure 3)

As B or D come closer to efficient frontier, their efficiency increases. They can do this by reducing inputs (hours employed) or producing more outputs (tables or chairs or both). Another meaning for this graph is that we can construct efficient virtual branches which could be the combination of A and C. Namely we divide weighted outputs by weighted inputs. Below is the mathematical representation of this problem for one decision unit, A:

Maximize S_A

With subject to:

$S_A = (39W_{table}+15W_{chair}) / (3W_{hour})$

$S_B = (36W_{table}+18W_{chair}) / (6W_{hour})$

$S_C = (32W_{table}+40W_{chair}) / (4W_{hour})$

$S_D = (28W_{table}+28W_{chair}) / (7W_{hour})$

$0 <= S_A <= 1$

$0 <= S_B <= 1$

$0 <= S_C <= 1$

$0 <= S_D <= 1$

$W_{table} >= 0$

$W_{chair} >= 0$

$W_{hour} >= 0$

But it is known that linear programming cannot deal with fractions, we can overcome this problem by substituting denominator ($3W_{hour}$) with 1. Finally we get a reasonable problem to solve:

Maximize $(39W_{table}+15W_{chair}) / (3W_{hour})$

with subject to:

$(39W_{table}+15W_{chair}) - (3W_{hour}) <= 0$

$(36W_{table}+18W_{chair}) - (6W_{hour}) <= 0$

$(32W_{table}+40W_{chair}) - (4W_{hour}) <= 0$

$(28W_{table}+28W_{chair}) - (7W_{hour}) <= 0$

$W_{table} >= 0$

$W_{chair} >= 0$

$W_{hour} >= 0$

This indicates;

- S_A is the efficiency of carpenter A
- S_B is the efficiency of carpenter B
- S_C is the efficiency of carpenter C
- S_D is the efficiency of carpenter D
- W_{table} is the weight attached to tables
- W_{chair} is the weight attached to chairs
- W_{hour} is the weight attached to hours employed

2.2 Modeling of DEA

The first DEA model, also known as CCR model, was introduced by Charnes, Cooper and Rhodes in 1978. This original model was applicable to constant returns to scale. Banker, Charnes and Cooper extended the original model in 1984 and they developed BCC model with variable returns to scale. Most of the studies in DEA applications appeared in these forms.

DEA models can be classified in two groups: input oriented and output oriented. As we know DEA tries to maximize the ratio of:

$$\frac{\Sigma \text{ weighted outputs}}{\Sigma \text{ weighted inputs}}$$

In the input oriented model, it is tried to maximize weighted output to weighted input while in the output oriented model, it is tried to minimize the ratio of weighted inputs to weighted outputs in the objective function (Şatır, 2005). In the output oriented model, it is aimed to try to maximize output with a certain amount of input. In the input oriented model, it is aimed to minimize the inputs with a certain amount of output. Charnes et al.(1999) explains the basic models of DEA as follows:

- *CCR model* yields an objective evaluation and estimates inefficient DMUs
- *BCC model* recognizes between technical and scale efficiencies by estimating pure technical efficiency at the given scale of operation and identifying if returns to scales are present for future exploitations

- *Multiplicative models* allows a log-linear envelopment or a piecewise Cobb Douglas function of production process
- *Additive model* relates efficiency results to Pareto economic concept

There are many other models. Appropriateness of a model depends on the core of production technology and these models differ in their orientation (Input-orientation, Output-orientation ...), disposability (Strong, Week), Diversification and Returns to Scale (CRS, VRS, NIRS, NDRS ...), types of measure (Radial measure, Non-radial measure, Hyperbolic measure ...) (Emrouznejad, A 1995-2001)

TABLE 3. DEA CLASSIFICATIONS

(1) Formulation	Primal Form	Dual Form
(2) Orientation	Input Minimization	Output Maximization
(3) Returns to Scale	Fixed Returns	Variable Returns
(4) Discretionary?	Discretionary Variables	Non-discretionary Variables
(5) Models	Additive	Multiplicative

2.3 Steps of DEA

Yolalan (1993) puts in order of steps of DEA as follows:

a) Choosing observation group

b) Choosing input and output groups

c) Selecting the model

d) Relative efficiency measurement

e) Evaluation of results for observation groups

In the first step, decision units which will determine the efficiencies are appointed. DMUs are selected as below (Cooper, 1999):

- Numerical data are available for each input and output
- Choice of DMUs, inputs and outputs, must project the managers' interest in the components of the DMUs.
- Smaller amount of inputs and larger amount of outputs are preferable
- The different units of different output and input do not have to be similar

Choosing appropriate DMUs is important because it directly affects the results of DEA if wrong DMUs are selected. DMUs should be similar to each other in terms of inputs they use and outputs they produce. Secondly inputs and outputs which will be used in the analysis are determined. These inputs and outputs should be common for every DMU. A statistical analysis can be made in order to obtain the correlations between inputs and outputs. These desirable set of factors should be complete, decomposable, operational, nonredundant, and minimal (Keeney and Raiffa, 1993). Another point is the isotonicity relation. That means an increase in input level should not decrease in output level (Charnes et al, 1985). The model can be selected regarding to application areas. As stated in previous part of the thesis, the model can be input oriented or output oriented. If we have less control on inputs, the model can be output oriented. If we have less control on outputs, the model can be selected as input oriented. If both cannot be made, it is suitable to use additive models. After these stages, the related linear program is solved. There is a lot of packaging software that are useful for solving DEA models. DEA add-in for MS Excel, Frontier Analyst® DEA

software, SAITECH, Inc. DEA Solver PRO or others. As known, DEA attaches 1 (or 100%) efficient score for DMUs which are called best efficient frontier. These efficient units are also regarded as reference units for inefficient ones. Lastly, the steps for future management plans can be derived from comments based on efficiency results.

2.4 Weight Restrictions in DEA

In classical DEA model, there are no special weights attached to DMUs. There are not any rules for setting weights. Namely weights are chosen freely to maximize efficiency. This totally flexible system especially allows us to determine inefficient units as a matter of fact that if DMU is efficient when every possible weight is used. Another reason for using totally flexible weights is to attach different DMUs which are in different environment with different weights. However, using total flexible weights have some disadvantages:

First of all, this can cause us to give efficient scores for inefficient units because of that total flexible weight are given to one input or output. That is to say, one unit may be efficient just by having only one bigger input output ratio than other units. Another concern is importance rankings of inputs and outputs. The upper management determines important inputs or outputs – spending labor, time and those cost to firm- Some unimportant inputs or outputs can be given important weights or vice versa by DEA. Lastly, even though flexible weight can allow DMUs to reflect their own special circumstances as stated in above paragraph, some DMUs can have similar

environment conditions like technology. It is more observable when assessing the units in the same organization.

Beyond these, putting weights on needed due to some reasons listed as follows according to Thanassoulis et al (2004):

- Capturing prior views on the marginal rate of substitution and transformation of factors of production
- Incorporating special interdependencies between inputs and outputs
- To get some ideas about overall efficiency than technical efficiency
- To make discrimination possible between different DMUs
- Ensuring that widely differing weights are not assigned to the same factor
- To make preferences for decision makers, namely central managers, available for adjustments of inputs and outputs

The ways of incorporating value judgments in DEA can be classified in three ways:

a) Direct Restrictions on Weights
b) Adjusting the observed input-output levels
c) Restricting the virtual inputs and outputs.

We will explain the direct restrictions relevant with our work.

2.4.1 Direct Restrictions on Weights

2.4.1.1 Absolute Restrictions on Weights: This method simply puts constant lower and upper limits on weights of inputs and outputs. One

concern with this method is infeasibility of DEA models. (Cooper, 2004; Chaparro et al, 1997)

2.4.1.2 Assurance Region (Type I): In this method, weights are related with only either inputs or outputs. This method is applied for incorporating relative ordering of outputs and inputs.

2.4.1.3 Assurance Region (Type II): In contrast to AR I model, here the weights of inputs and outputs are taken, better to say related, together.

$\delta_i \leq v_i \leq \Gamma_i$ $\rho_r \leq u_r \leq \eta_r$ (direct restriction)

$\alpha_i \leq v_i/v_{i+1} \leq \beta_i$ $\theta_r \leq u_r/u_{r+1} \leq \zeta_r$ (assurance region type I)

$\gamma_i v_i \geq u_r$ (assurance region type II)

Following Thanassoulis et al.'s work (2004), the notation of mentioned weight restriction methods can be sum up as above. "v" and "u" represents the weights of inputs and outputs respectively. Greek letters are constants.

2.5 Strengths and Limitations of DEA

Some critiques that are towards DEA are as follows: (Hayes, 2007)

- DEA is very sensitive to measurement errors because of nature of DEA that it is a data based method. So reflecting both inputs data and outputs data is essential for a healthy analysis. Omitting an input or output can affect the results seriously.
- It measures relative efficiency but it is not used at estimating absolute efficiencies. For example, we can compare units in the same group but we are not able to compare them with different groups.

- As discussed DEA is a non parametric method, statistical tests are not applicable.
- All decision making units must be identical, namely homogeneous.
- The problems that contain large decision making units can be computationally insentive

The strong sides of DEA include (Aggrell and Bogetoft, 2007; Charnes et al, 2003)

- DEA is suitable to use multiple inputs and outputs
- There is no need to construct a special functional form except linear programming
- It is convenient to compare with competitors. It is core of DEA anyway. By identifying best practice, it has a great validity to measure efficiency.
- It is not dependent on measurement units. Namely different kinds of measurement units can used in the analysis
- It does not require price or priority information
- It does not require technological information
- It supports learning because of providing information for source management
- It has conservative and cautious evaluations
- It allows to accommodate when desired
- It is Pareto optimal
- It is adjustable for exogenous variables

2.6 DEA and Performance Measurement

DEA has a wide application area since it has been published in 1978. Some major application areas of DEA are education (high schools, universities), health care (doctors, hospitals), banking (branches, departments), manufacturing (operational efficiency, productivity), financial services (funds, portfolios), public organizations (tax offices, army, and police stations), sports, transportation etc. Examples can be extended to a great variety of other areas. Tavares' report (2002) about bibliography of DEA can lighten us how often DEA is used between 1978 and 2001. In his database, he reports 3203 references from 2152 different authors including research papers, journal papers and other academic publications. DEA is a useful tool for managers to compare different decision making units in the organizations. As DEA is a relative performance evaluation method, it is appropriate for benchmarking so a manager can see inefficient departments and strategic plans and operations can be shaped in this way.

CHAPTER 3

APPLICATION OF DEA

In this chapter, the empirical part of thesis will be analyzed. Data Envelopment Analysis will be applied on data collected about manufacturing companies in Brazil, China and Turkey. The aim is to compare relative financial performance of firms by using ratios derived from financial statements. After a literature review, the methodology and the data will be presented and at last, we will try to infer results in analysis towards a conclusion.

3.1 Introduction

In this part of the thesis, Brazil and China which are two countries of four BRIC* (Brazil and China) expected to dominate world economy in 2050s and Turkey which has a great investment potential will be analyzed. Even in a recent article, Turkey is being replaced instead of Brazil. (Palmer, 2007) Another finding about is in Grant Thornton International Survey (2007). Mexico, Indonesia, Pakistan and Turkey are assumed as the front runners to inherit the BRIC mantel from the original four. We will try to reveal out that which country's manufacturing companies performed better than other in terms of finance. We will measure relative performance of these firms. In the analysis, DEA will be used. Before the analysis, a general outlook of every country's business environment and competitiveness will be examined.

These countries include in top 20 economies in the world in 2006. China, Brazil and Turkey are world's fourth, tenth and seventeenth largest economies respectively. (IMF Databank, 2006) These economies also attract foreign investors. So we included these competitive countries into our analysis. These countries are also on the list of emerging market index. (Morgan Stanley Emerging Markets Index, 2006)

The table 4 compares briefly the competitiveness power of three countries by using Global Competitiveness Index:

TABLE 4. GLOBAL COMPETITIVENESS INDEX RANKINGS

Countries	**2005-2006**	**2006-2007**	**2007-2008**
Brazil	65	66	72
China	49	54	34
Turkey	66	59	53

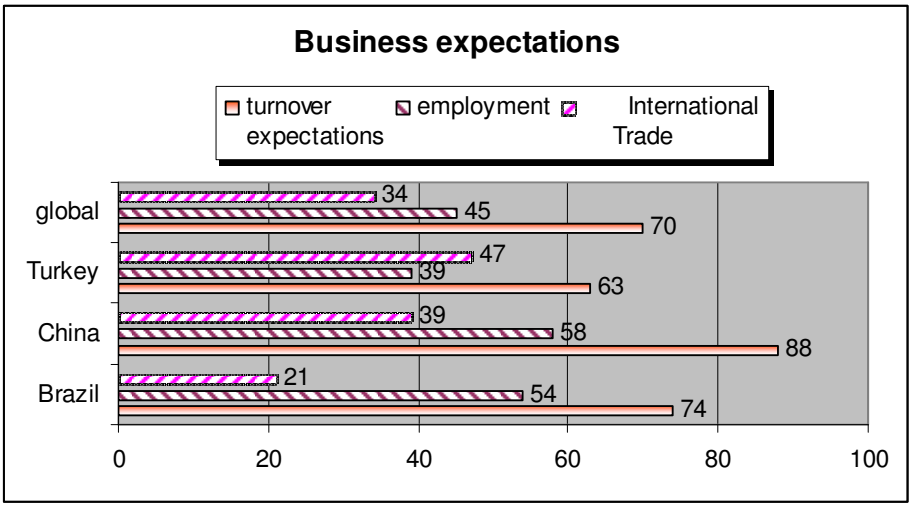
Source: Global Competitiveness Index Report, 2007

In another recent survey called International Business Report of Grant Thornton International Company*, there are some basic indicators about the business and environment that affects business. Those can be represented in Figure 4:

* **BRIC** or **BRICs** are terms used in economics to refer to the combination of **B**razil, **R**ussia, **I**ndia, and **C**hina.

* "*Grant Thornton LLP is the U.S. member firm of Grant Thornton International Ltd, one of the six global accounting, tax and business advisory organizations. Through member firms in over 100 countries, including 51 offices in the United States, the partners and employees of Grant Thornton International Ltd member firms provide personalized attention and the highest quality service to public and private clients around the globe."* is the website recognition of the company.

FIGURE 4. BUSINESS SURVEY RESULTS OF COUNTRIES



In the Figure 4, there are three categories –sales (turnover), employment growth and international trade- which reflect the expectations of businesses in three countries and a global average. Turnover expectation values in the graph shows the optimism level about sales. We see Chinese businesses are more optimistic than Brazil and Turkey. We also see that Turkish business average is lower than global average. Employment values show the expected growth in employment in aforementioned countries. The picture is the same as sales expectations. International trade shows the proportion of exports in businesses. International Business Report conducted by the survey also gives a foresight about constraints, stress levels and impacts on cost pressures of the businesses in every individual country. Countries are also compared with their region average. For example Turkey is compared with EU while China is compared with East Asia averages.

Lastly, manufacturing sectors' value added as % of Gross Domestic Product and annual growth rate is in the table 5. It can be concluded that the biggest share (manufacturing value added as % of GDP) belongs to China whereas Turkey has the largest growth rate by looking at three years' average.

TABLE 5. SHARE OF MANUFACTURING

	Value Added (% of GDP)			**Value Added (annual % growth)**		
	2004	2005	2006	2004	2005	2006
China	32	33	31	9	12	8
Turkey	14	14	14	10	6	20
Brazil	19	18	18	8	1	2

Source: World Development Indicators Database (2007)

3.2 Literature Review

The DEA in general and the manufacturing sector in particular have been the subject of a number of scholarly investigations over the years. The studies related to DEA in manufacturing are mostly regarded with operational performance metrics. Some of the relevant works are, but not limited to; Parkan (1991), Seaver and Triantis (1992), Heimerman (1993), Reitsperger et al. (1993), Wang (1993) ; Cabezas Vega (1994), Khouja (1995), Shafer and Bradford (1995), Shang and Sueyoshi (1995), BenBarka (2007).

The studies addressing DEA to manufacturing sector includes different spectrum of topics. However, most studies are related with operational performance measures. Some of the mentioned topics in these works are calculating relative performance ratings of production units, resource use and

manufacturing efficiency, manufacturing strategy, technology selection, productivity growth, machine component selection and selecting and evaluating the appropriate flexible manufacturing systems, etc. For example, in BenBarka's thesis work, DEA is applied to a manufacturing facility with a large product mix for assesing montly performance. The operational metrics she used were batches, actual units, standard, on-time releases, shifts, reworks, exceptions, units resample and material exception free. Seiford's work (1997) is a good DEA survey for a general look over the topics studied. When we mention about the financial ratios and DEA, we usually meet the studies about financial organizations as banks, portfolio selection and their efficiencies in the literature.

More specifically, the followings are methodologically similar works compared to this thesis. These studies used DEA to investigate financial efficiency of firms belonging to different manufacturing sub-industries. As done in this thesis, several financial ratios used to measure efficiency.

Feroz et al. (2003) demonstrates that DEA can complement the traditional accounting ratios. They found that there is sufficient evidence to reject the hypothesis that there is no relationship between DEA and accounting ratios. In the article, it is being stated that DEA deviations and ratio deviations are a little correlated and we can conclude that DEA can supply superior information over traditional accounting ratios. They also applied this demonstration on oil and gas industry. They used (total assets, common equity, and costs of goods sold) as inputs and sales as output.

Chien (2007) constructs a conceptual framework for defining the meaning of performance. It is based on Return on Assets. He presents two stage DEA model. Firstly, he uses employees, assets and capital stock as inputs and sales as output to define efficiency. In the second stage, he uses sales as input and profit and operating revenues as outputs to define effectiveness. His application was on 59 Taiwan electronic companies. He also realized that an efficent company cannot be effective. There seems to be no clear correlation between eficiency and effectiveness.

Despic et al. (2007) developed a new model called DEA-R related with DEA and ratio analysis. The model they develop effectively flexible and integrated with the opinions of experts. The target ratios for inefficient are more flexible and enlightening with this model.

Thore et al.'s work (1994) is on determining intertemporal efficiency of US computer manufacturers. Cost of Goods Sold, capital expenditures, expenditures on R&D, selling, general and administrative expenditures, labor force, holding of plant, property, equipment at the beginning of the year are inputs and sales & income before taxes are outputs.

Kayalıdere and Kargın (2004) studied on determining the efficient cement and textile companies which are traded on Istanbul Stock Exchange. They constructed two DEA applications. In the first one, inputs were total assets and number of employees and outputs were net sales and net profit. In the second one, tangible assets and number of employees were inputs;

net sales and net profit were outputs. They analyzed 15 cement and 27 textile companies with 2002 data.

In another study, Çetin (2006) investigates the efficiency of Turkish textile firms and how many inefficient firms should adjust input-output level. He used current ratio, quick ratio, net working capital ratio, cash ratio, return on equity, and return on assets and net profit margin. First four ratios are inputs and last three are outputs.

Esenbel et al. (2007) uses the same metrics of Çetin's work (2006) to a partial category. They examined the efficiencies of sub industries of Turkish textile sector as apparels, fabrics and leather. They found that 6 out of 15 companies are efficient. Potential recovery levels are also provided. The analyses were made using data presenting the end of 2000.

A very similar study to this thesis is Yalama and Sayım's empirical study (2008) on listed manufacturing firms in Istanbul Stock Exchange. The result indicates that avearge efficiency score for listed manufacturing firms is 83.94 % for the end of 2005. The study also includes average potential recovery rates for all companies and sub-industries. (Food and beverages, apparel, fabric and leather textiles, forestry, paper, chemicals, construction, metal producers).

3.3 The Data

Data was collected from CorporateInformation.com. The website recognition is as follows: This site holds "Best of the Web" recognition from FORBES Magazine. BARRON's Magazine featured the site as one of the best

sources of company information for investors. This site is also one of the few sources in the world for English language reports on many companies in Asia, Latin American and Eastern Europe that do not release their results in English.

In total, the data of 283 companies were collected. Of these, 164 companies were Chinese, 57 Brazilian and 62 Turkish firms. The companies were selected from different industries. The distribution of number of companies according to country and industry is summarized in the table 6. The companies are from 18 different industries every industry has several sub-industries. For example, chemical industry has six sub-industries. (Diversified Chemical Manufacturers, Household Chemicals, Industrial Chemicals, Miscellaneous Chemicals, Paint & Resin Manufacturers, Rubber & Tire Manufacturers)

TABLE 6. DISTRIBUTION of FIRMS by INDUSTRY

	Aerospace	**Apparel & Textiles**	**Automotive**	**Chemicals**
CHINA	2	11	9	32
BRAZIL	0	9	4	4
TURKEY	0	3	6	8
TOTAL	2	23	19	44
	Construction	**Diversified**	**Drugs, Cosmetics**	**Electrical**
CHINA	10	3	25	15
BRAZIL	7	2	1	2
TURKEY	10	0	1	3
TOTAL	27	5	27	20
	Electronics	**Food & Beverages**	**Machinery & Equipment**	**Metal Producers & Manufacturers**
CHINA	12	9	10	15
BRAZIL	3	4	0	7
TURKEY	2	9	1	7
TOTAL	17	22	11	29

	Miscellaneous	Oil, Gas, Coal	Paper	Printing & Publishing	Recreation	Utilities
CHINA	5	2	2	0	1	1
BRAZIL	4	3	4	1	1	1
TURKEY	4	4	2	2	0	0
TOTAL	13	9	8	3	2	2

An overlook of manufacturing sectors of Brazil, China and Turkey is as follows (Encyclopedia Britannica, 2008):

Manufacturing in Brazil accounts for about one-fifth of the GDP and more than one-tenth of the labor force. Brazil is one of major car manufacturers in the world. Other major manufacturing sectors are electrical machinery, paints, soaps, medicines, chemicals, aircraft, steel, food products, and paper. Brazil has been a major producer of textiles, clothing, and footwear since the early 19th century.

Chinese overall industrial output often has grown at an annual rate of more than 10 percent, and China's industrial workforce probably exceeds the combined total for all other developing countries. The major manufacturers are metallurgical and machine-building industries, textiles, clothing, shoes, processed foods, and toy. These sectors have also big share in exports.

Manufacturing is at the core of Turkish industrial sector. The value added growth of Turkey’s manufacturing sector has been impressive during the last decade, even outpacing the growth experience by the service sector. Between 2000 and 2004, manufacturing value added grew at 4.4 per cent per annum. However the manufacturing sector represents only one forth of the service sector’s GDP contribution to the country’s economy. The

European foreign investors are behind the boom of the service sector in Turkey – the quasi-liberalisation of the sector, the perfect location and the favourable EU membership prospects make Turkey a perfect spot for investment. (Albaladejo, 2006)

We are to find relative ratios to use in our analysis. We will not use all of the aforementioned ratios exactly due to fact that most of them are similar to each other. For example, using both pre tax income margin and net income margin is meaningless. It is clear that correlation between some ratios is very close to one. The below is an explanation of prospective ratios to be used in the analysis. When doing this, opinions of managers are especially taken into account:

Inventory turnover, that represents how frequent a company's stock is sold and turned, is especially essential for manufacturing firms. This ratio is useful when comparing similar operation within a given segment like in our analysis (Reynolds, 1999). It is also one of the most frequent ratios used by Fortune 500 companies (Hendricks, 1989).

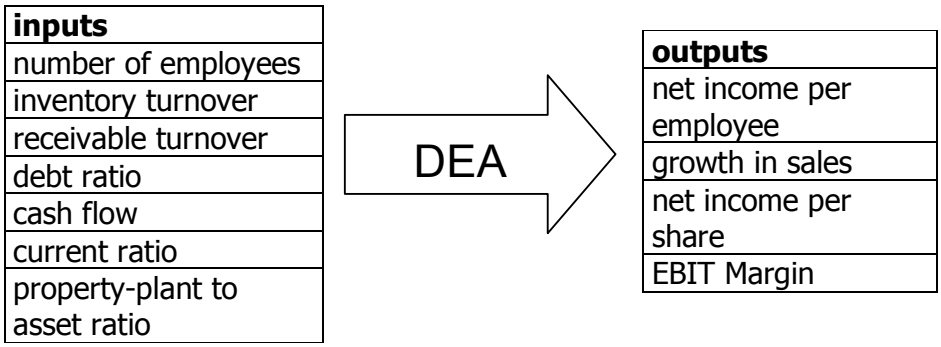
Receivable turnover ratio, showing the firm's effectiveness to collect its debt, can be counted as an indicator of performance. Gosselin's study (2005) proves this by examining a manufacturing survey. The managers evaluate this ratio 3.9 over 5 in the survey. Inventory turnover ratio is also important according to that survey (4.02/5). Debt ratio, showing the credibility of companies, is another important factor that we investigate for performance. Remmers et al. (1972) says that it is used to show decision

makers subscribe to the notion of optimal financial structures suited to their characteristic business risks. The aim of using fixed assets/ total asset is to show its importance at reflecting the tendency of the company in investing resources. In Chakravarthy's study (1986), it is stated that excellent firms invest more in fixed asserts and that regards consistency with their commitment to future growth. Current ratio and cash flows will also be used in the analysis which are two ratios mostly used by managers.

These are the ratios that we will use as inputs in DEA. Dependent variables (outputs in DEA) are growth in sales (GS), net income per share (NIPS) and EBIT margin (EM) and net income per employee (NIPE). Growth in Sales is a reflection of using resources effectively to transform into outputs. We know businesses, economically meaning, try to maximize their profit. This ratio provides a measure of economic performance that reflects how well an organization relates to their environment (Hofer and Schendel, 1978). As we used firms traded in their own stock exchange markets, we added net income per share measure showing the performance for investors. According to Coşkun's study (2006), operating income is one of the ratios that is measured frequently and is given importance by managers mostly. We used net income per employee in order to reflect efficiency through both labor performance and sales. EBIT Margin (Earning before Interest and Taxes) is used instead of net income due to fact that tax and interest rates differ from country to country.

If the analysis is illustrated, see figure 5::

FIGURE 5. ILLUSTRATION OF ANALYSIS



3.4 The Analysis

Some firms were excluded due to missing data. The outliers were also excluded from the analysis according to Mahalanobis distance at %5 significance level. So lastly, we sampled 126 Chinese, 44 Brazilian and 47 Turkish companies for the analysis with 2006 data. We used the most basic DEA model, namely CCR (output oriented) model under constant returns to scale. Data Envelopment Analysis will be applied with weights and without weights.

3.4.1 The non-weighted DEA

DEA-Solver Pro5.0 software (2007) was used to solve the analysis. 55 companies are found as efficient companies. Namely they have efficiency maximum score of 1. The average efficiency score for total 217 companies is 0,814 and the standard deviation is 0,151. The minimum efficiency score belongs to a Chinese company (=0, 36). Of 55 efficient companies, 30 were Chinese, 12 were Brazilian and 13 were from Turkish manufacturing. The average efficiency score for Brazilian firms is 0, 83, for Chinese firms 0, 81

and for Turkish firms 0, 79. If we make an ANOVA test, we see that no difference exist between the average efficiency scores.

TABLE 7. ANOVA for NON WEIGTED DEA MODEL

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	0.053931	2	0.026966	1.168111	0.312928	3.038063
Within Groups	4.940169	214	0.023085			
Total	4.994101	216				

3.4.2 The Weighted DEA

In this section, we will use a weighted DEA model. Canonical correlation analysis is the tool inorder to obtain weights of inputs and outputs.

3.4.2.1 Canonical Correlation Analysis

Canonical correlation analysis seeks to identify and quantify the associations between two sets of variables (Johnson, Wichern, 2002). It is the most general method that can be used for both metric and non-metric values of the sets Y (dependent-criterion) and X (independent-predictor) (Hair et. al. 1998). Moreover, it is the strongest and the most appropriate technique that can be applied when the number of variables in the dependent set is more than one. While canonical correlation is used for explaining the relation between dependent and independent variables, it explains not only which independent variable has an effect on which dependent variable but also which independent variable has a higher effect

on which dependent variables (Levine, 1977:6). The formula can be shown as follows:

$u = \sum \alpha_i x_i$, $v = \sum \beta_i y_i$

Canonical variates $u \text{ and } v$ are linear composites of the variables of independent and dependent sets respectively. $\alpha_i \text{ and } \beta_i$, that are called canonical coefficients of the variates are found by maximizing the correlation between $u \text{ and } v$ under some constraints given below.

$$Max\, Kor(u,v) = \frac{Kov(u,v)}{\left[\text{var}(u)\,\text{var}(v)\right]^{1/2}} = \frac{\alpha' \Sigma_{12}\, \beta}{\sqrt{\alpha' \Sigma_{11}\, \alpha}\sqrt{\beta' \Sigma_{22}\, \beta}} = \frac{Kov(u,v)}{(1 \quad 1)^{1/2}}$$
$$= Kov(u,v) = \alpha' \Sigma_{12} \beta = \rho$$

s.t.

$$\sigma^2{}_u = \alpha' \Sigma_{11} \alpha = 1$$

$$\sigma^2{}_v = \beta' \Sigma_{22} \beta = 1$$

Optimums of the function can be found by means of Lagrange Multipliers λ_1 and λ_2. $L = \alpha' \Sigma_{12} \gamma - \frac{1}{2}\lambda_1(\alpha' \Sigma_{11} \alpha - 1) - \frac{1}{2}\lambda_2(\beta' \Sigma_{22} \beta - 1)$

$$\frac{\partial L}{\partial \alpha} = \Sigma_{12} \beta - \lambda_1 \Sigma_{11} \alpha = 0$$
$$\frac{\partial L}{\partial \beta} = \Sigma_{21} \alpha - \lambda_2 \Sigma_{22} \beta = 0$$

The solution of these partial differentials results an Eigen value problem and solution of that problem will give ρ^2. The vectors α and β can be obtained

from the equations by substituting ρ^2.These vectors are canonical coefficients that maximize the correlation between the linear combinations of the variables.

Dependent variable sets are net income per employee (NIPE), growth in sales (GS), net income per share (NIPS) and EBIT margin (EM). Independent variable sets are number of employees (NE), inventory turnover (IT), receivable turnover (RT), total asset/total debt (TATD; 1/leverage), cash flow (CF), current ratio (CR), and property plant & equipment/total asset (PLTS). The table below shows the relationship between dependent and independent variables both individually and together. When we analyze countries together, the relationship between two sets of variables is found to be significant shown in the table 8. That indicates firm performance can be explained by these variables.

TABLE 8. CANONICAL CORRELATIONS SECTION

	Correlation	**F-Value**	**Level**	**Wilks'Lambda**
Turkey	0,82	3,04	0,000011	0,165
China	0,621	3,78	0,000000	0,442
Brazil	0,81	3,07	0,000011	0,143
All Three	0,647	6,3	0,000000	0,464

The table 9 shows the canonical loadings. Canonical variable for the criterion set is a linear combination of the four performance variables (NIPE, GS, NIPS and EM). The variables that are highly correlated can be said significant. EBIT Margin is the most important performance variable for

Turkish manufacturers. Then net income per employee comes second. Among the independent variables, the most important one for Turkish companies is current ratio and secondly total assets/total debt ratio. Other variables seem to be insignificant. The canonical loadings which are greater than 0, 40 is said to be significant in the literature.

For Chinese manufacturers, the most important dependent variables are net income per share, net income per employee and growth in sales respectively. The important variables in independent variable set are cash flow, inventory turnover, number of employees and receivable turnover respectively.

For Brazilian side, most important outputs are net income per employee, EBIT Margin and net income per share while most important inputs are current ratio, cash flow and total asset/total debt ratio.

If we consider three countries together, the most important outputs are EBIT Margin, net income per employee and net income per share and the most important inputs are current ratio, cash flow and total assets/ total debt ratio. Therefore, it is possible to rank these variables according to canonical loadings.

TABLE 9. CANONICAL LOADINGS

	Turkey	**China**	**Brazil**	**All three**
	U	**U**	**U**	**U**
NE	-0,203	0,581	0,234	0,136
IT	-0,097	0,593	-0,567	-0,365

RT	-0,172	0,447	0,234	-0,06
TATD	0,776	0,142	0,2	0,575
CF	-0,192	0,719	0,281	0,392
CR	0,986	0,124	0,562	0,903
PLTS	0,052	0,112	0,101	0,036
	V	**V**	**V**	**V**
NIPE	0,693	0,443	0,941	0,542
GS	-0,065	0,44	0,191	0,082
NIPS	0,248	0,765	0,521	0,402
EM	0,916	-0,101	0,649	0,565

The relationships which are acceptable for all columns are as follows:

NIPE>GS

NIPS>GS

CF>NE

TATD>PLTS

CR>PLTS

3.4.4.2 Results of weighted DEA

The solution was applied with DEA-Solver Pro5.0 software. The model used was Output Orientation with Assurance Region (AR-O-C) with constant returns to scale. The software removed four companies due to fact that they have zero data. The average efficiency score for the remainder 213 companies was found 0,769 and have a standard deviation of 0,151. 27 out of 213 companies are found to be efficient. They have efficiency score of "1"

according to DEA theory. Of the efficient companies, 17 are Chinese, 8 are Brazilian and 2 are Turkish firms.

TABLE 10. SUMMARY of EFFICIENCY SCORES

Number of Firms	213
Mean of efficiencies	0,769
Efficiency standard deviation	0,151
Maximum	1
Minimum	0,315
Number of efficient firms	27
Number of inefficient firms	186

The table 10 shows the descriptive statistics of efficiency scores. According to the table, the average efficiency score for Chinese firms is 0,784, for Brazilian firms 0, 79 and for Turkish firms 0, 71. Standard deviations are 0,142, 0,134 and 0,176 respectively. In total, confidence interval at 95% level for efficiency scores is between 0,748 and 0,789. The minimum efficiency score belongs to a Chinese firm (=0,315).

TABLE 11. DESCRIPTIVE STATISTICS of EFFICIENCY SCORES

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
China	125	0,784	0,142	0,013	0,758	0,809	0,315	1
Brazil	42	0,790	0,134	0,021	0,748	0,831	0,555	1
Turkey	46	0,710	0,176	0,026	0,657	0,762	0,344	1
Total	213	0,769	0,151	0,010	0,748	0,789	0,315	1

If we want to test whether three countries' efficiency scores are equal to each other, we will use ANOVA test. According to ANOVA test results, the null hypothesis indicating three countries' efficiency scores are equal to each other is rejected. That means it can be accepted that at least one country has a different mean efficiency. The test was run at 1% significance level.

TABLE 12. ANOVA (EFFICIENCY SCORES)

	Sum of Squares	**Degrees of freedom**	**Mean Squares**	**F**	**Significance**
Between groups	,206	2	,103	4,657	,010
Within groups	4,637	210	,022		
Total	4,843	212			

Efficiency score comparison table shows the result of Tukey test, which assumes variance are equal, and the result of Tamhane test, which assumes variances are not equal. According to Tukey test, the difference of efficiency scores between China-Turkey and Brazil-Turkey is significant statistically at 1% and 5% level. According to Tamhane test, significance level of difference between China-Turkey is 4% and between Brazil-Turkey is 5%.The table 13 does not show any significant difference between China and Brazil.

TABLE 13. COMPARISON of EFFICIENCIES

	(I)country	(J) county	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower	Upper
Tukey HSD	China	Brazil	-,00607	,02650	,972	-,0686	,0565
		Turkey	,07378(*)	,02563	,012	,0133	,1343
	Brazil	China	,00607	,02650	,972	-,0565	,0686
		Turkey	,07985(*)	,03171	,033	,0050	,1547
	Turkey	China	-,07378(*)	,02563	,012	-,1343	-,0133
		Brazil	-,07985(*)	,03171	,033	-,1547	-,0050
Tamhane	China	Brazil	-,00607	,02422	,992	-,0652	,0531
		Turkey	,07378(*)	,02896	,039	,0029	,1447
	Brazil	China	,00607	,02422	,992	-,0531	,0652
		Turkey	,07985	,03320	,054	-,0011	,1608
	Turkey	China	-,07378(*)	,02896	,039	-,1447	-,0029
		Brazil	-,07985	,03320	,054	-,1608	,0011

* The mean difference is significant at the .05 level.

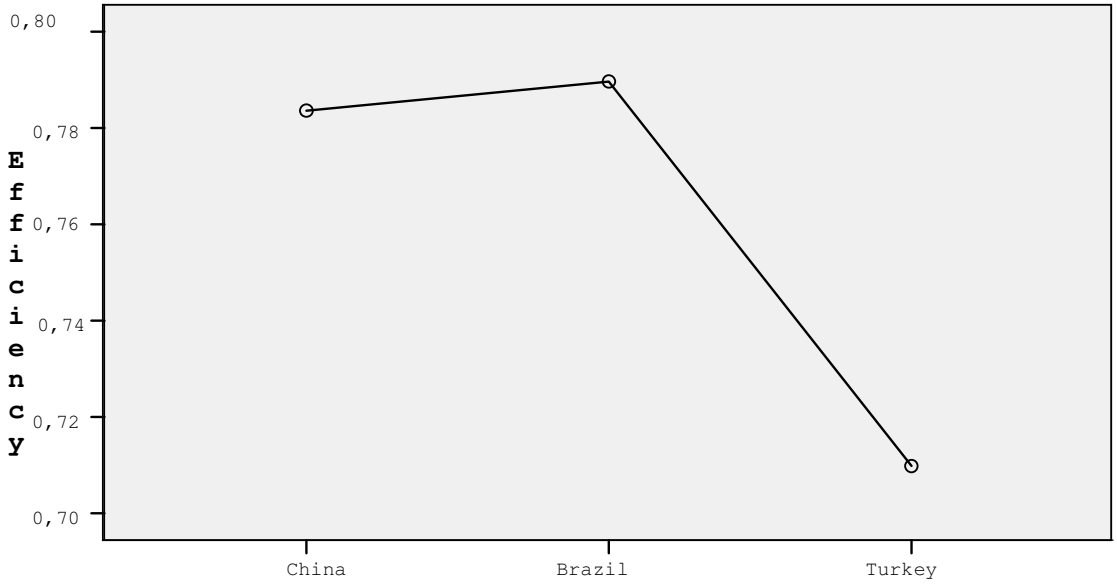
According to grouping tables, Brazil and China can be regarded as one group (namely they have equal efficiency level). Turkey's efficiency level is different from that group.

TABLE 14. GROUPINGS

	Country	N	Subset for alpha = .05	
			2	1
Tukey HSD(a,b)	Turkey	46	,7098	
	China	125		,7836
	Brazil	42		,7897
	Sig.		1,000	,975

Means for groups in homogeneous subsets are displayed.
a Uses Harmonic Mean Sample Size = 56,024.
b The group sizes are unequal. The harmonic mean of the group sizes is used.

FIGURE 6. EFFICIENCY GROUPS



Lastly, potential recovery rates were presented for three countries. How much firms must increase their outputs holding inputs constant and how much they must decrease their inputs holding outputs constant. These recover rates are shown at the end of table as percentage.

When compared to Brazilian and Chinese firms, Turkish firms should have less of:

36, 84 % inventory turnover

28, 94 % receivable turnover

30, 65 % total assets/total debt ratio

17, 94 % cash flow

30, 24 % current ratio

38, 67 % plant, property to assets ratio

to be efficient or Turkish firms must have more of

6, 24 % net income per employee

3, 66 % growth in sales

1, 75 % net income per share

16, 63 % EBIT Margin

to be efficient.

The table 15 shows those rates for Turkish companies. The tables which show recovery rates for other countries' companies include in the Appendix. There is also a table for the frequencies for efficient companies showing that how many times they include in the reference set of inefficient companies.

TABLE 15. RECOVERY RATES (downturn in inputs) for TURKISH COMPANIES

DMU	Score	Excess NE S-(1)	Excess IT S-(2)	Excess RT S-(3)	Excess TATD S-(4)	Excess CF S-(5)	Excess CR S-(6)	Excess PLTS S-(7)
T4	0,67	0,00	5,67	0,00	0,00	0	0,43	0,06
T5	0,90	0,00	0,39	0,00	7,01	0	1,43	0,00

T6	0,52	0,00	0,00	0,00	0,00	0	0,00	0,29
T7	0,76	0,00	0,61	0,00	0,00	1010773025	0,00	0,00
T8	0,71	0,00	0,00	2,15	9,01	0	0,72	0,00
T9	0,84	0,00	0,00	0,00	0,00	516327994	0,42	0,00
T10	0,58	0,00	14,25	0,00	0,00	497553682	0,00	0,00
T11	0,70	0,00	0,57	1,93	0,00	0	0,00	0,00
T12	0,54	0,00	0,00	0,00	11,80	0	1,15	0,00
T13	0,92	0,00	2,31	0,00	0,00	0	0,04	0,00
T15	0,80	0,00	0,09	0,00	0,00	0	0,70	0,18
T16	0,98	0,00	0,00	0,84	1,00	0	0,00	0,00
T17	1,00	0,00	0,00	0,00	0,00	0	0,00	0,00
T18	0,73	0,00	0,24	0,00	27,80	0	3,43	0,00
T20	0,45	0,00	3,51	0,99	0,00	0	0,00	0,00
T22	0,89	0,00	1,14	0,00	0,00	0	1,20	0,00
T24	0,81	0,00	1,77	0,00	0,00	0	0,00	0,81
T25	0,88	0,00	0,00	42,51	4,70	0	0,00	0,17
T26	0,55	0,00	0,00	0,00	0,00	643825745	0,56	0,00
T27	0,49	0,00	6,58	1,51	0,00	0	0,00	0,00
T28	0,79	0,00	3,50	1,64	0,00	0	0,00	0,00
T31	0,56	0,00	16,72	0,00	0,00	0	1,11	0,00
T32	0,88	0,00	0,00	0,00	0,00	0	0,67	0,00
T33	0,57	0,00	0,00	26,68	1,53	0	0,55	0,00
T34	0,88	0,00	2,48	0,00	5,61	0	3,26	0,00
T35	0,43	0,00	0,00	0,00	0,12	0	0,00	0,00
T36	0,82	0,00	7,45	10,01	0,00	0	0,21	0,29
T38	0,68	0,00	0,24	0,00	0,00	0	0,21	0,00
T40	0,76	0,00	0,00	3,05	40,47	0	5,13	0,00
T42	0,62	0,00	4,07	0,00	0,00	0	0,00	0,00
T43	0,86	0,00	0,34	0,00	0,00	0	0,00	0,00
T45	0,75	0,00	1,78	0,00	6,13	0	0,74	0,00
T46	0,34	0,00	10,86	0,00	0,00	0	0,00	0,00
T47	0,54	0,00	0,57	0,00	0,00	0	0,00	0,00
T48	0,90	0,00	2,65	0,00	0,00	0	0,00	0,00
T49	1,00	0,00	0,00	0,00	0,00	0	0,00	0,00
T50	0,74	0,00	4,63	0,00	0,00	0	0,08	0,06
T51	0,39	0,00	11,70	0,00	0,00	313370138	0,00	0,00
T52	0,52	0,00	0,00	0,00	0,00	96287812	0,62	0,01
T53	0,82	0,00	2,10	0,00	0,00	13981443	0,06	0,24
T54	0,42	0,00	0,00	2,24	0,00	0	0,00	0,00
T57	0,85	0,00	1,10	0,00	8,00	0	2,31	0,00
T58	0,72	0,00	10,88	0,00	0,00	0	0,00	0,00
T59	0,77	0,00	0,00	0,23	0,00	0	3,57	4,86
T60	0,84	0,00	3,24	0,00	0,00	0	0,00	0,00
T61	0,47	0,00	0,31	0,00	0,00	116282369	0,00	0,00
Average downturn (%)		**0,00**	**36,84**	**28,94**	**30,65**	**17,94**	**30,24**	**38,67**

TABLE 16. RECOVERY RATES (increase in outputs) for TURKISH COMPANIES

DMU	Score	Shortage NIPE S+(1)	Shortage GS S+(2)	Shortage NIPS S+(3)	Shortage EM S+(4)
T4	0,67	0	0,00	0,00	0,25
T5	0,90	0	0,00	0,00	0,14
T6	0,52	0	0,00	0,00	0,25
T7	0,76	304402	0,00	0,00	1,27
T8	0,71	0	0,00	0,00	0,26
T9	0,84	0	0,00	0,00	0,19
T10	0,58	29850	0,00	0,00	0,00
T11	0,70	0	0,00	0,00	0,07
T12	0,54	0	0,00	0,00	0,07
T13	0,92	0	0,12	0,14	0,00
T15	0,80	0	0,00	0,00	0,11
T16	0,98	272399	0,00	0,00	1,22
T17	1,00	0	0,00	0,00	0,00
T18	0,73	0	0,00	0,00	0,18
T20	0,45	0	0,00	0,00	0,00
T22	0,89	0	1,06	0,61	0,41
T24	0,81	0	0,00	0,00	0,06
T25	0,88	125032	0,00	0,00	0,71
T26	0,55	0	0,00	0,00	0,32
T27	0,49	130933	0,00	0,00	0,96
T28	0,79	13301	0,00	0,00	0,23
T31	0,56	0	0,28	0,00	0,14
T32	0,88	0	0,32	0,00	0,16
T33	0,57	0	0,00	0,00	0,43
T34	0,88	0	0,00	0,00	0,22
T35	0,43	0	0,00	0,00	0,02
T36	0,82	0	0,00	0,45	0,00
T38	0,68	0	0,00	0,00	0,23
T40	0,76	0	0,00	0,00	0,32
T42	0,62	0	0,00	0,00	0,49
T43	0,86	0	0,00	0,00	0,13
T45	0,75	0	0,00	0,00	0,17
T46	0,34	0	0,00	0,59	1,81
T47	0,54	0	0,00	0,00	0,34
T48	0,90	0	0,00	0,00	0,24
T49	1,00	0	0,00	0,00	0,00
T50	0,74	0	0,00	0,00	0,28
T51	0,39	0	0,00	0,00	0,50
T52	0,52	0	0,00	0,00	0,22
T53	0,82	96435	0,00	0,47	0,00
T54	0,42	838525	0,00	0,00	4,63
T57	0,85	0	0,04	0,00	0,19

T58	0,72	0	0,00	0,00	0,27
T59	0,77	0	0,00	0,09	0,55
T60	0,84	0	0,00	0,00	0,10
T61	0,47	0	0,00	0,00	0,52
Average increase (%)		**6,24**	**3,66**	**1,75**	**16,63**

CHAPTER 4

CONCLUSION

The aim of this study is based on three dimensions. First is about manufacturing sector. Manufacturing lies in the base of emerging markets. It is a reflection real economy life of a country especially when talking about developing countries. Secondly, financial side of these firms which is mostly ommitted in the literature were investigated. When surveyed in the literature of manufacturing, operational metrics are often met. Thirdly, an international comparison was applied in terms of developing markets. Globalization moved competition to the global arena. Firms today should compete with not also local competitors but also global ones. That means firms face a fierce competition environment. To survive in the business, firms must use their resources efficiently. In this context, emerging markets Brazil, China and Turkey were compared in terms of financial efficiency. These countries are included emerging market index and newly industrialized countries.

FIGURE 7 NEWLY INDUSTRIALIZED COUNTRIES

Continent	Country	GDP (PPP) (Millions of USD, 2007	GDP per capita (USD, 2007)	GDP per capita (PPP) (USD, 2007)	Income equality (GINI) 2006	Human Development Index (HDI, 2007)	List of countries by GDP (real) growth rate	List of countries by GDP (real) growth rate per capita
South America	Brazil	1,835,642	6,937	9,695	54	0.800 (high)	5.40	2.04

Asia	China	6,991,036	2,460	5,292	44.7	0.777 (medium)	11.10	9.95
Europe	Turkey	887,964	9,629	12,888	38	0.775 (medium)	5.20	4.10

Source: http://en.wikipedia.org/wiki/Newly_industrialized_country#Current_NIC_countries

Efficiency means to get maximum output with a given input. Efficient firms are also profitable and fast growing firms. Management literature mentions about relationship between competitiveness and efficiency, performance analysis and increased efficiency (Okada, 2005, Sekkat 2007). As efficiency is the power of transforming inputs into outputs, it directly affects cost of a firm. When looking at the real world, it is seen that China, with a huge economic growth, threatening the power of competitiveness of other developing countries. It has several advantages, including labor cost, labor efficiency, cost of building factories, massive investments in new plant and equipment, large markets attracting local and foreign investment, the ability to carry out reforms, the ability to build and rebuild cities, world-leading infrastructure in some regions, and others (Enright, 2006). As stated in International Business Report (2007), Brazilian manufacturers think Chinese economic expansion will decrease their business (34%) while most think that it will have no impact (57%). 27% of Turkish firms think that China will decrease their business and 14% think that Brazil will affect Turkish firms negatively. The positive expectations of Turkish firms are

relatively low when compared to expectation of negative impacts. Turkish firms expect positive impact from China with 16% and Brazil with 5%.

As compared to Brazil and China, Turkey has significantly lower efficiency level. Namely with a given input level, Brazil and China produces more so they have greater competitiveness power. To survive in the business, Turkish firms should give importance to efficiency. This empirical analysis revealed the motivation factor for Turkish firms: If our competitors have the equal input level, they will produce and be more successful more than us.

APPENDIX A

TABLE 17. STATISTICS on INPUT/OUTPUT DATA

	NE	IT	RT	TATD	CF	CR
Max	31563	273.7	59.8	47.61905	3522211700	5.7
Min	44	0.2	1.2	0.024394	0	0
Average	4327.157	6.415668	8.605991	5.497343	341182689	1.388018
SD	5124.467	18.79753	9.952894	5.485617	352198345	0.8857

	PLTS	NIPE	GS	NIPS	EM
Max	0.840168	894775.7	2.067682	7.443861	3.008
Min	0.002469	402454.8	0.335064	0	1.392
Average	0.397389	615310	1.031015	2.623986	2.407
SD	0.179838	40279.54	0.249904	0.743058	0.144

TABLE 18. FREQUIENCIES in REFERENCE SET for NON WEIGTED MODEL

Reference	Frequency to other DMUs
C2	1
C3	60
C6	1
C14	3
C31	17
C45	2
C46	1
C55	62
C56	85
C58	1
C59	17
C65	81
C74	2
C75	9
C77	5
C79	17
C82	2
C87	14
C102	0
C105	40
C108	0
C111	40

C112	1
C127	3
C128	65
C133	22
C140	34
C141	1
C145	9
C158	9
B1	0
B5	9
B6	53
B7	19
B10	29
B16	27
B19	16
B29	5
B33	6
B34	1
B45	0
B47	6
T2	102
T9	1
T13	0
T16	1
T17	13
T25	1
T32	8
T34	2
T48	7
T49	0
T53	2
T57	2
T59	0

TABLE 19. EFFICIENCY SCORES of COMPANIES IN NONWEIGTED DEA MODEL

C1	0.598287	**C96**	0.715275	**T33**	0.839008
C2	1	**C98**	0.763418	**T34**	1
C3	1	**C99**	0.835147	**T35**	0.455093
C4	0.84999	**C100**	0.734778	**T36**	0.737096
C6	1	**C102**	1	**T38**	0.63461
C10	0.842748	**C104**	0.713896	**T40**	0.704869
C11	0.957296	**C105**	1	**T42**	0.748134
C12	0.800857	**C106**	0.875874	**T43**	0.97964
C13	0.743485	**C107**	0.947537	**T45**	0.772296
C14	1	**C108**	1	**T46**	0.679642
C15	0.759039	**C109**	0.941475	**T47**	0.637028

C16	0.68473	**C110**	0.772429	**T48**	1
C18	0.874072	**C111**	1	**T49**	1
C19	0.920672	**C112**	1	**T50**	0.875327
C22	0.909982	**C113**	0.715959	**T51**	0.506896
C23	0.573078	**C114**	0.890884	**T52**	0.57892
C24	0.696842	**C115**	0.80666	**T53**	1
C25	0.72514	**C117**	0.872893	**T54**	0.68626
C26	0.595962	**C118**	0.710446	**T57**	1
C27	0.944543	**C120**	0.790695	**T58**	0.737486
C28	0.602821	**C121**	0.480119	**T59**	1
C29	0.783809	**C122**	0.870158	**T60**	0.861122
C30	0.762911	**C123**	0.734008	**T61**	0.634277
C31	1	**C124**	0.633078		
C32	0.716411	**C125**	0.665105	**B23**	0.823007
C35	0.7461	**C127**	1	**B24**	0.766587
C36	0.696848	**C128**	1	**B25**	0.813438
C37	0.562548	**C129**	0.537491	**B26**	0.961797
C39	0.908597	**C130**	0.935247	**B27**	0.933149
C40	0.80923	**C131**	0.811256	**B29**	1
C42	0.751401	**C132**	0.763496	**B30**	0.837481
C43	0.704504	**C133**	1	**B31**	0.8392
C44	0.796269	**C134**	0.492578	**B32**	0.720532
C45	1	**C135**	0.525743	**B33**	1
C46	1	**C136**	0.612693	**B34**	1
C48	0.89623	**C137**	0.642307	**B35**	0.608456
C49	0.817333	**C139**	0.742023	**B36**	0.869498
C50	0.671415	**C140**	1	**B37**	0.610748
C51	0.808064	**C141**	1	**B38**	0.816144
C53	0.706357	**C142**	0.858512	**B40**	0.597839
C55	1	**C143**	0.53926	**B41**	0.716264
C56	1	**C144**	0.607207	**B42**	0.763957
C58	1	**C145**	1	**B44**	0.907252
C59	1	**C146**	0.360091	**B45**	1
C61	0.749153	**C148**	0.757211	**B46**	0.863981
C62	0.657346	**C149**	0.856786	**B47**	1
C64	0.792696	**C150**	0.536425	**B48**	0.909935
C65	1	**C152**	0.735439	**B49**	0.959295
C66	0.952695	**C154**	0.765461	**B50**	0.76275
C67	0.929539	**C155**	0.810971	**T2**	1
C68	0.895592	**C156**	0.769193	**T4**	0.688711
C69	0.767515	**C157**	0.807703	**T5**	0.970287
C70	0.674715	**C158**	1	**T6**	0.638222
C71	0.702696	**C160**	0.794148	**T7**	0.840894
C72	0.852246	**B1**	1	**T8**	0.709773
C73	0.868214	**B3**	0.693414	**T9**	1
C74	1	**B4**	0.675046	**T10**	0.866782
C75	1	**B5**	1	**T11**	0.700498
C76	0.695641	**B6**	1	**T12**	0.575596
C77	1	**B7**	1	**T13**	1

C78	0.953763	**B8**	0.67349	**T15**	0.697757
C79	1	**B9**	0.917914	**T16**	1
C80	0.813119	**B10**	1	**T17**	1
C81	0.800423	**B11**	0.754916	**T18**	0.7287
C82	1	**B13**	0.723403	**T20**	0.500818
C83	0.6886	**B14**	0.775715	**T22**	0.902466
C86	0.997712	**B15**	0.825154	**T24**	0.761699
C87	1	**B16**	1	**T25**	1
C89	0.858539	**B18**	0.759037	**T26**	0.566826
C91	0.755097	**B19**	1	**T27**	0.548201
C92	0.705535	**B20**	0.686317	**T28**	0.847577
C93	0.642193	**B21**	0.667977	**T31**	0.536304
		B22	0.686003	**T32**	1

TABLE 20. EFFICIENCY SCORES of COMPANIES IN WEIGTED DEA MODEL

C1	0.724696	**C96**	0.687925	**B23**	0.791253
C2	0.794029	**C98**	0.57744	**B24**	0.759288
C4	0.859424	**C99**	1	**B25**	0.759313
C6	0.693008	**C100**	0.731185	**B26**	0.871146
C10	0.646055	**C102**	0.946344	**B27**	0.741604
C11	1	**C104**	0.477038	**B29**	0.929038
C12	0.763446	**C105**	1	**B30**	0.813543
C13	0.725762	**C106**	0.675264	**B31**	0.857935
C14	1	**C107**	0.785226	**B32**	0.737403
C15	0.780035	**C108**	0.908071	**B33**	1
C16	0.768557	**C109**	0.847774	**B34**	0.740512
C18	0.825095	**C110**	0.766978	**B35**	0.575031
C19	0.856563	**C111**	0.967855	**B36**	0.722653
C22	0.924431	**C112**	0.891182	**B37**	0.66272
C23	0.581153	**C113**	0.833606	**B38**	0.829257
C24	0.624048	**C114**	0.888846	**B40**	0.554778
C25	0.739369	**C115**	0.630851	**B41**	0.738732
C26	0.605928	**C117**	0.929131	**B42**	0.675126
C27	0.796249	**C118**	0.666905	**B44**	0.801914
C28	0.777025	**C120**	0.728419	**B45**	1
C29	0.765752	**C121**	0.516258	**B46**	1
C30	0.765874	**C122**	0.764127	**B47**	1
C31	1	**C123**	0.755175	**B48**	0.842767
C32	0.637802	**C124**	0.672391	**B49**	0.687788
C35	0.695288	**C125**	0.704403	**B50**	0.752325
C36	0.693836	**C127**	0.95168	**T4**	0.666865
C37	0.65069	**C128**	1	**T5**	0.896128
C39	0.879777	**C129**	0.630922	**T6**	0.522642
C40	0.831675	**C130**	0.875289	**T7**	0.756218
C42	0.790426	**C131**	0.867352	**T8**	0.710414
C43	0.720541	**C132**	0.753545	**T9**	0.837773

C44	0.787552	**C133**	1	**T10**	0.583718
C45	0.999061	**C134**	0.488308	**T11**	0.695901
C46	1	**C135**	0.505455	**T12**	0.544279
C48	0.797157	**C136**	0.587302	**T13**	0.915588
C49	0.841665	**C137**	0.649014	**T15**	0.80145
C50	0.638912	**C139**	0.788354	**T16**	0.982724
C51	0.798917	**C140**	1	**T17**	1
C53	0.587546	**C141**	0.729096	**T18**	0.729731
C55	1	**C142**	0.690339	**T20**	0.454638
C56	1	**C143**	0.777419	**T22**	0.893964
C58	0.943473	**C144**	0.697451	**T24**	0.812293
C59	1	**C145**	0.892199	**T25**	0.884026
C61	0.712984	**C146**	0.314814	**T26**	0.55344
C62	0.626503	**C148**	0.676875	**T27**	0.491272
C64	0.823101	**C149**	0.803186	**T28**	0.791476
C65	1	**C150**	0.478664	**T31**	0.556701
C66	0.820541	**C152**	0.769138	**T32**	0.880108
C67	0.858233	**C154**	0.727183	**T33**	0.5691
C68	0.641081	**C155**	0.827696	**T34**	0.881702
C69	0.768339	**C156**	0.847974	**T35**	0.429941
C70	0.656096	**C157**	0.735885	**T36**	0.815677
C71	0.679519	**C158**	0.995779	**T38**	0.681679
C72	0.859543	**C160**	0.584297	**T40**	0.764511
C73	0.776501	**B1**	0.981045	**T42**	0.619714
C74	1	**B3**	0.693414	**T43**	0.856081
C75	1	**B4**	0.596988	**T45**	0.752548
C76	0.745153	**B5**	1	**T46**	0.344488
C77	1	**B6**	1	**T47**	0.536238
C78	0.974394	**B9**	0.749509	**T48**	0.903524
C79	1	**B10**	0.761292	**T49**	1
C80	0.77127	**B11**	0.779169	**T50**	0.736492
C81	0.772558	**B13**	0.735286	**T51**	0.394512
C82	0.82311	**B14**	0.674692	**T52**	0.518058
C83	0.715383	**B15**	0.664014	**T53**	0.815434
C86	0.893612	**B16**	1	**T54**	0.421629
C87	0.779646	**B18**	0.652982	**T57**	0.847619
C89	0.840343	**B19**	1	**T58**	0.723229
C91	0.737769	**B20**	0.660541	**T59**	0.766852
C92	0.69604	**B21**	0.616802	**T60**	0.840179
C93	0.668481	**B22**	0.755714	**T61**	0.470613

TABLE 21. FREQUIENCIES in REFERENCE SET for WEIGTED DEA MODEL

Reference	Frequency (including itself)	Reference	Frequency (including itself)
C11	19	**B5**	8
C14	3	**B6**	46
C31	59	**B16**	69
C46	21	**B19**	10
C55	54	**B33**	3
C56	1	**B45**	5
C59	33	**B46**	1
C65	78	**B47**	2
C74	2	**T17**	6
C75	27	**T49**	15
C77	25	**C105**	19
C79	1	**C128**	104
C99	1	**C133**	2
		C140	132

TABLE 22. RECOVERY RATES (downturn in inputs) for CHINESE FIRMS

No.	DMU	Score	Excess NE S-(1)	Excess IT S-(2)	Excess RT S-(3)	Excess TATD S-(4)	Excess CF S-(5)	Excess CR S-(6)	Excess PLTS S-(7)
1	C1	0.724696	0	2.854639	2.8819	0	207686004	0	0.296826
2	C2	0.794029	0	1.10126	0	0	0	0.130218	0
4	C4	0.859424	0	0	0	0	0	0.667135	0
5	C6	0.693008	0	0	3.643566	2.456672	0	3.33E-02	0
6	C10	0.646055	0	1.619879	4.319879	2.473859	0	0.53499	0
7	C11	1	0	0	0	0	0	0	0
8	C12	0.763446	0	6.534762	0	0	0	0	0
9	C13	0.725762	0	3.66787	0	0	0	0	0
10	C14	1	0	0	0	0	0	0	0
11	C15	0.780035	0	6.469476	0	1.263648	0	0	0
12	C16	0.768557	0	4.620333	42.65091	0	0	0	0
13	C18	0.825095	0	3.089505	0.584549	0	0	0	0.48417
14	C19	0.856563	0	0	0	0	0	0.637642	0
15	C22	0.924431	0	2.115256	0	0	0	0	0.181032
16	C23	0.581153	0	0	26.01886	0	0	0	0.170692
17	C24	0.624048	0	0	0	0	0	0	0
18	C25	0.739369	0	0	10.74558	0	0	0	0.119325
19	C26	0.605928	0	0	14.38232	6.218878	0	0	0
20	C27	0.796249	0	0.1818	0	0	0	0.278089	0
21	C28	0.777025	0	0.799881	6.250965	0	100718426	0	0.256413
22	C29	0.765752	0	2.180801	0.354271	0	0	0	0

23	C30	0.765874	0	0.673366	0	0	0	0	0
24	C31	1	0	0	0	0	0	0	0
25	C32	0.637802	0	0	0	0	0	0	0
26	C35	0.695288	0	0.818145	0	0	0	0	0
27	C36	0.693836	0	0	2.533659	0	0	0	0.225604
28	C37	0.65069	0	0	1.692264	0	235131407	1.73E-02	0
29	C39	0.879777	0	0	0	0	0	0	0
30	C40	0.831675	0	1.509984	0	0	330829946	0.397887	0.225506
31	C42	0.790426	0	0.635355	26.44545	0	0	0	0.15547
32	C43	0.720541	0	0.453457	0	0	0	0	0
33	C44	0.787552	0	3.441617	2.645187	0	0	0	0.298439
34	C45	0.999061	0	0	0	1.590753	0	1.5997	2.72E-02
35	C46	1	0	0	0	0	0	0	0
36	C48	0.797157	0	2.837159	5.008442	0	0	0	0
37	C49	0.841665	0	0.569155	0	0	0	0	0
38	C50	0.638912	0	0.755596	2.155596	0	0	1.225707	0
39	C51	0.798917	0	2.800964	20.65091	0	0	0	0
40	C53	0.587546	0	0	2.943241	2.713556	0	0.114891	0
41	C55	1	0	0	0	0	0	0	0
42	C56	1	0	0	0	0	0	0	0
43	C58	0.943473	0	0	12.53554	1.7285	0	0	0.29883
44	C59	1	0	0	0	0	0	0	0
45	C61	0.712984	0	0	2.926927	1.40457	0	0	0
46	C62	0.626503	0	0	0.999273	0.059754	0	0	0
47	C64	0.823101	0	0.872682	0	0	0	0	2.73E-02
48	C65	1	0	0	0	0	0	0	0
49	C66	0.820541	0	1.125039	0	0	0	1.011909	0
50	C67	0.858233	0	0	0	1.890268	0	0	0
51	C68	0.641081	0	0	0	4.764212	14914002	0	0
52	C69	0.768339	0	0	7.141291	0	0	0	0
53	C70	0.656096	0	0	0	2.49393	0	0.619755	0
54	C71	0.679519	0	0	0.815981	2.85224	0	0	0
55	C72	0.859543	0	0	49.93894	0	0	0	0
56	C73	0.776501	0	0.307765	0	0	51984053.5	0.394983	0
57	C74	1	0	0	0	0	0	0	0
58	C75	1	0	0	0	0	0	0	0
59	C76	0.745153	0	2.661194	0	0	0	0.450327	0
60	C77	1	0	0	0	0	0	0	0
61	C78	0.974394	0	3.945665	9.540505	0	0	0	1.82E-02
62	C79	1	0	0	0	0	0	0	0
63	C80	0.77127	0	0	0	8.228743	0	0	0
64	C81	0.772558	0	0	0.169816	0	0	0	0
65	C82	0.82311	0	0.740232	6.532749	0	0	0	0.171935
66	C83	0.715383	0	0.391939	1.823903	0	0	0	0.109571
67	C86	0.893612	0	0	0	1.05199	0	0	0.304252
68	C87	0.779646	0	3.288218	0	0	13072677.5	0.58155	0
69	C89	0.840343	0	0	0	1.596432	0	0	0
70	C91	0.737769	0	0	6.941637	0	0	0	0
71	C92	0.69604	0	0	0	0	0	0	0

72	C93	0.668481	0	3.331634	31.81394	0	0	0	0.138262
73	C96	0.687925	0	0	0	0	0	0	0
74	C98	0.57744	0	3.105033	11.15858	0	100249298	0	0
75	C99	1	0	0	0	0	0	0	0
76	C100	0.731185	0	0	0	0	0	0	0
77	C102	0.946344	0	1.989716	0	0	0	0.362305	9.78E-02
78	C104	0.477038	0	0	0	3.010051	0	0	0
79	C105	1	0	0	0	0	0	0	0
80	C106	0.675264	0	0	13.93546	6.548665	0	0	0
81	C107	0.785226	0	0	0	0	76852981.9	0.33079	0.161603
82	C108	0.908071	0	0	0	0	0	0	0
83	C109	0.847774	0	1.85062	1.030472	0	0	0	0.192099
84	C110	0.766978	0	1.145094	0	0.128559	0	0	0
85	C111	0.967855	0	1.053165	0	0.803652	0	0	0
86	C112	0.891182	0	1.051722	0	0	0	0	0
87	C113	0.833606	0	2.411359	4.35989	0	0	0	0.197531
88	C114	0.888846	0	0	0	1.589379	0	0	0
89	C115	0.630851	0	0	0	0	0	0	0
90	C117	0.929131	0	1.293606	6.328206	0	0	0	0.444367
91	C118	0.666905	0	0	5.127247	3.036976	0	0	0.086862
92	C120	0.728419	0	3.80138	0	0	0	0	0
93	C121	0.516258	0	5.935386	10.04008	0	0	0	0
94	C122	0.764127	0	1.285412	0	0	0	0	0.067534
95	C123	0.755175	0	1.760816	16.74186	0	0	0	0
96	C124	0.672391	0	2.147882	0	0	0	0	0
97	C125	0.704403	0	0	14.24177	0	0	0	0.100775
98	C127	0.95168	0	1.278118	0	0	0	9.62E-02	0.138291
99	C128	1	0	0	0	0	0	0	0
100	C129	0.630922	0	0.184605	51.55372	0	70658336.1	0	0
101	C130	0.875289	0	1.48094	0	0	0	0	0
102	C131	0.867352	0	0.612837	0	0	102305206	0	0.459918
103	C132	0.753545	0	0	0	0	114305557	0	0.16877
104	C133	1	0	0	0	0	0	0	0
105	C134	0.488308	0	0	17.86466	1.186283	0	0	0
106	C135	0.505455	0	1.103453	36.31285	0	0	0	0
107	C136	0.587302	0	0	3.767402	8.020497	0	0	0
108	C137	0.649014	0	0	0.274762	0	0	0	0.125334
109	C139	0.788354	0	1.540713	8.432699	0	0	0	0.10759
110	C140	1	0	0	0	0	0	0	0
111	C141	0.729096	0	0.663075	52.73687	0	31840732.4	0	0
112	C142	0.690339	0	2.003453	1.747417	0	0	0	0
113	C143	0.777419	0	3.69612	28.94094	0	85813615.2	0	0.309671
114	C144	0.697451	0	0	0.444733	2.179034	0	1.245796	0
115	C145	0.892199	0	1.951535	0	0	0	0	0
116	C146	0.314814	0	0.345762	3.025886	0	0	0	0
117	C148	0.676875	0	0	0	4.01185	0	0	0
118	C149	0.803186	0	0	0	1.528925	0	0	0
119	C150	0.478664	0	0	0	0	0	0	0
120	C152	0.769138	0	3.027058	0	0	0	0	0

121	C154	0.727183	0	1.407234	0	0	0	0	0
122	C155	0.827696	0	0	0.639265	0	0	0	8.48E-02
123	C156	0.847974	0	1.637392	8.228421	0	0	0	0.275302
124	C157	0.735885	0	0.27386	0	0	0	5.52E-02	0
125	C158	0.995779	0	0	0	0.911318	0	0	0
126	C160	0.584297	0	0	3.45586	0.74504	0	0.273358	0

TABLE 23. RECOVERY RATES (increase in outputs) for CHINESE COMPANIES

Shortage NIPE S+(1)	Shortage GS S+(2)	Shortage NIPS S+(3)	Shortage EM S+(4)	No.	DMU
9273.88	0	0	0	**1**	**C1**
0	0	0	0.275222	**2**	**C2**
0	0	7.77E-03	0.169298	**4**	**C4**
0	0	0	0.187788	**5**	**C6**
0	0	9.07E-03	0.220588	**6**	**C10**
0	0	0	0	**7**	**C11**
0	0	0	0.234175	**8**	**C12**
0	0	0	0.225022	**9**	**C13**
0	0	0	0	**10**	**C14**
0	0	5.63E-03	0.27486	**11**	**C15**
0	0	0	0	**12**	**C16**
0	0.166047	2.50E-02	7.47E-02	**13**	**C18**
0	0	4.64E-03	0.1701	**14**	**C19**
0	0	0	0	**15**	**C22**
0	0	0	0	**16**	**C23**
0	0	0	0.128807	**17**	**C24**
0	0	0	1.99E-02	**18**	**C25**
0	0	3.45E-03	0.159942	**19**	**C26**
0	0	0	0.150282	**20**	**C27**
9957.641	0.226447	0	0	**21**	**C28**
0	0	0	7.56E-02	**22**	**C29**
0	0	0	9.83E-04	**23**	**C30**
0	0	0	0	**24**	**C31**
0	0	0	0.131163	**25**	**C32**
0	0	0	0.209055	**26**	**C35**
0	0	0	7.17E-02	**27**	**C36**
23476.04	0	0	0	**28**	**C37**
0	6.48E-02	0	0.132892	**29**	**C39**
0	0	0	4.34E-02	**30**	**C40**
0	0	0	0	**31**	**C42**
0	0	0	0.148905	**32**	**C43**
0	0	0	0.021524	**33**	**C44**
0	0.610621	8.75E-03	0.268979	**34**	**C45**
0	0	0	0	**35**	**C46**
0	0	0	0.146266	**36**	**C48**

0	0	1.99E-03	0.015369	**37**	**C49**
0	0	0	0.25724	**38**	**C50**
7514.285	0	0	0	**39**	**C51**
0	0	0	0.232144	**40**	**C53**
0	0	0	0	**41**	**C55**
0	0	0	0	**42**	**C56**
13696.53	0.578688	6.18E-02	0	**43**	**C58**
0	0	0	0	**44**	**C59**
0	0	0	6.11E-02	**45**	**C61**
0	0	3.98E-03	0.233267	**46**	**C62**
0	0	0	0.104736	**47**	**C64**
0	0	0	0	**48**	**C65**
0	0	0	0.111779	**49**	**C66**
0	0	9.10E-03	0.169266	**50**	**C67**
0	0	7.93E-02	4.69E-02	**51**	**C68**
0	0	4.22E-02	0.207254	**52**	**C69**
0	0	0	0.207173	**53**	**C70**
0	0	5.15E-03	0.189085	**54**	**C71**
0	0.331656	0	0	**55**	**C72**
0	0	0	0.235307	**56**	**C73**
0	0	0	0	**57**	**C74**
0	0	0	0	**58**	**C75**
0	0	0	5.11E-03	**59**	**C76**
0	0	0	0	**60**	**C77**
0	0	0	0.07765	**61**	**C78**
0	0	0	0	**62**	**C79**
0	0	0	0.127149	**63**	**C80**
0	0	0	0.119135	**64**	**C81**
0	0	4.84E-03	4.25E-02	**65**	**C82**
0	0	0	1.88E-02	**66**	**C83**
0	0	0	0.122731	**67**	**C86**
0	0.638252	0	0.201896	**68**	**C87**
0	0	0	4.00E-02	**69**	**C89**
0	0.377762	0	0	**70**	**C91**
0	0	0	3.37E-02	**71**	**C92**
0	0	0	0.198179	**72**	**C93**
0	0	0	5.75E-02	**73**	**C96**
37681.63	0	0	0	**74**	**C98**
0	0	0	0	**75**	**C99**
0	0	5.74E-04	0.260642	**76**	**C100**
0	0	0	0.100167	**77**	**C102**
0	0	0	0.452044	**78**	**C104**
0	0	0	0	**79**	**C105**
0	0	0.037156	0.355419	**80**	**C106**
0	0.264973	4.16E-02	6.39E-02	**81**	**C107**
0	0	1.38E-03	1.17E-03	**82**	**C108**
4862.092	0	1.66E-02	0	**83**	**C109**
0	1.162297	0	0.386612	**84**	**C110**
0	0	1.49E-02	0.495297	**85**	**C111**

0	0	0	0.133764	**86**	**C112**
10666.39	0	0	0	**87**	**C113**
0	0	5.10E-03	0.242495	**88**	**C114**
0	0	0	0.166016	**89**	**C115**
9724.03	0.56411	2.07E-02	0	**90**	**C117**
0	0	0	0.213358	**91**	**C118**
0	0	0	0.193768	**92**	**C120**
13918.59	0	0	0	**93**	**C121**
0	0	0	5.78E-02	**94**	**C122**
0	0.465371	0	5.52E-02	**95**	**C123**
0	0	2.69E-02	0.179541	**96**	**C124**
0	0	0	0.152641	**97**	**C125**
0	0	1.09E-02	0.208058	**98**	**C127**
0	0	0	0	**99**	**C128**
18784.85	0	0	0	**100**	**C129**
0	0	0	0.229362	**101**	**C130**
0	1.045616	0	0.161751	**102**	**C131**
36158.89	0	3.19E-02	0	**103**	**C132**
0	0	0	0	**104**	**C133**
9384.632	0	0	0	**105**	**C134**
22344.26	0	0	0	**106**	**C135**
0	0	0	0.267852	**107**	**C136**
0	0	0	0.114614	**108**	**C137**
0	0	0	0	**109**	**C139**
0	0	0	0	**110**	**C140**
17890.62	0	0	0	**111**	**C141**
15183.18	0	7.78E-02	0	**112**	**C142**
18758.15	0	0	0	**113**	**C143**
0	0	0	0.213654	114	C144
0	0	0	0.128362	115	C145
0	0	0	0.341753	116	C146
0	0	0	0.118555	117	C148
0	0	9.53E-03	0.26034	118	C149
0	0	0	0.442577	119	C150
0	0	0	2.32E-02	120	C152
0	0	3.79E-02	2.79E-04	121	C154
0	0	0	0.040797	122	C155
0	5.18E-02	1.34E-03	0	123	C156
0	0	0	0.161822	124	C157
0	0	0	4.47E-02	125	C158
0	0	0	0.239797	126	C160

TABLE 24. RECOVERY RATES (downturn in inputs) for BRAZILIAN FIRMS

No.	DMU	Score	Excess NE S-(1)	Excess IT S-(2)	Excess RT S-(3)	Excess TATD S-(4)	Excess CF S-(5)	Excess CR S-(6)	Excess PLTS S-(7)
127	B1	0.981045	0	0	0	4.009991	0	0	0
128	B3	0.693414	0	0	0	0	442218111	2.162297	6.86E-02
129	B4	0.596988	0	0	0	0	1547759061	0	0
130	B5	1	0	0	0	0	0	0	0
131	B6	1	0	0	0	0	0	0	0
134	B9	0.749509	0	0.443215	9.93E-03	0	0	0	0
135	B10	0.761292	0	0	0	22.29021	0	0	0
136	B11	0.779169	0	3.714753	0.333286	0	0	0	0.230407
137	B13	0.735286	0	0.242895	0.858276	0	0	0	0.253865
138	B14	0.674692	0	10.53193	0	2.608702	0	0.486945	0
139	B15	0.664014	0	2.910887	6.730229	0	0	0	0
140	B16	1	0	0	0	0	0	0	0
141	B18	0.652982	0	0	0	20.0155	0	0	0
142	B19	1	0	0	0	0	0	0	0
143	B20	0.660541	0	0	0	0	103097022	0.368511	0
144	B21	0.616802	0	4.254206	0	0	0	0.966924	0
145	B22	0.755714	0	0	0	0.400746	0	0.171947	0.25934
146	B23	0.791253	0	0	3.610463	0.758457	0	0	0.128759
147	B24	0.759288	0	0	9.83613	5.828718	0	0	0
148	B25	0.759313	0	0	0	0	0	5.23E-02	0
149	B26	0.871146	0	1.119575	0	0	3236407943	0.565291	0
150	B27	0.741604	0	2.976507	0	0	0	3.01359	0
151	B29	0.929038	0	2.374601	0.916352	0	0	0	0
152	B30	0.813543	0	2.092667	0	0	0	1.039948	0
153	B31	0.857935	0	2.003837	0	0	475676146	1.536744	0
154	B32	0.737403	0	0	0	2.2959	0	0.796765	0
155	B33	1	0	0	0	0	0	0	0
156	B34	0.740512	0	5.171202	0	0	0	0.48357	0
157	B35	0.575031	0	0	0	1.63007	0	0	0
158	B36	0.722653	0	10.70761	0	0	0	0	0
159	B37	0.66272	0	4.471848	0	0	0	0.327583	7.15E-02
160	B38	0.829257	0	0	0.367764	0	0	0	0.112728
161	B40	0.554778	0	4.170094	0	0	0	0	0
162	B41	0.738732	0	2.721895	0.409194	0	0	0	0.224341
163	B42	0.675126	0	4.206672	0.927332	0	0	0	0.170395
164	B44	0.801914	0	0	0	0.881124	0	0	0
165	B45	1	0	0	0	0	0	0	0
166	B46	1	0	0	0	0	0	0	0
167	B47	1	0	0	0	0	0	0	0
168	B48	0.842767	0	2.699701	0	0	0	0.945206	0
169	B49	0.687788	0	1.333868	0	0	0	0.377138	0

170	B50	0.752325	0	6.264831	3.035462	0	0	0	0.063339

TABLE 25. RECOVERY RATES (increase in outputs) for BRAZILIAN COMPANIES

No.	DMU	Shortage NIPE S+(1)	Shortage GS S+(2)	Shortage NIPS S+(3)	Shortage EM S+(4)
127	B1	512143.7	0.620426	0	2.448757
128	B3	0	0	0	3.58E-02
129	B4	481396.7	0	0	2.489411
130	B5	0	0	0	0
131	B6	0	0	0	0
134	B9	0	0	2.614298	0.126738
135	B10	0	0	0.129784	0.296556
136	B11	0	0	0	1.81E-02
137	B13	0	0	0	0.168348
138	B14	0	0	0	0.234639
139	B15	0	0	0	1.836736
140	B16	0	0	0	0
141	B18	0	0.186939	0	0.273621
142	B19	0	0	0	0
143	B20	2649.278	0	0	0
144	B21	0	0	5.55E-02	0.27175
145	B22	12565.59	0	0	0
146	B23	0	0	0.501011	0.200384
147	B24	0	0	0	0.188805
148	B25	0	0	0	5.44E-02
149	B26	71434.3	0	0	0.224243
150	B27	0	0	0	7.40E-02
151	B29	12272.69	0	0	0.15076
152	B30	0	0	0	0.281745
153	B31	18517.26	0	0	0
154	B32	0	0	0	0.152702
155	B33	0	0	0	0
156	B34	0	0	0	0.159544
157	B35	0	0	0	0.201337
158	B36	0	0	0	0.170567
159	B37	0	0	5.12E-02	0.11828
160	B38	0	0	7.60E-02	0
161	B40	0	0	0	0.224075
162	B41	0	0.492645	3.84E-02	5.68E-02
163	B42	0	0	1.705545	0.227985
164	B44	13525.78	0	0	0.089545
165	B45	0	0	0	0
166	B46	0	0	0	0
167	B47	0	0	0	0

168	B48	0	0	0	0.109574
169	B49	16965.04	0	0	0
170	B50	0	0	0	0

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