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BAHÇEŞEHİR UNIVERSITY

BANK EFFICIENCY WITH DATA ENVELOPMENT ANALYSIS IN TURKISH BANKING SYSTEM

Master's Thesis

HİLAL TURK

ISTANBUL, 2018

THE REPUBLIC OF TURKEY

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This is to certify that we have read this thesis and we find it fully adequate in scope, quality and content, as a thesis for the degree of Master of Capital Markets and Finance.

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ABSTRACT

BANK EFFICIENCY WITH DATA ENVELOPMENT ANALYSIS IN TURKISH BANKING SYSTEM

Hilal TÜRK

CAPITAL MARKETS AND FINANCE

Thesis Supervisor: Assoc. Professor Dr. Bülent ANIL

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The aim of this study is to estimate the impact of major macroeconomic and regulatory changes on technical efficiency of Turkish banks groups for two different periods in Turkey. In the first stage of the theses, the technical efficiency scores are estimated for 19 selected banks and long terms banks activity groups by using Data Envelopment Analysis (DEA) over the period of 2011 to 2016 and 1988 to 2016. In the second stage of the theses, we estimated one private banks all branches efficiency by using regression analysis model. The data was taken from one private bank, whose name has been kept as confidential and is not published on the Public Disclosure Platform. Therefore, to our knowledge, this analysis is the first that has ever taken place in Turkey. The panel data regression analysis result, the number of products and number of customer appeared as having a significant effect on the efficiency. Moreover, It was found that if branch operational groups are two or three even four, this did not have a significant impact on branch efficiency.

Key Words: Efficiency, Branch Efficiency, DEA, Turkish Banking Groups, Panel Data Analysis

ÖZET

TÜRK BANKACILIK SİSTEMİNDE VERİ ZARFLAMA TEKNİĞİ İLE BANKA ETKİNLİĞİNİN ÖLÇÜMLENMESİ

Hilal TÜRK

SERMAYE PİYASALARI VE FİNANS

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Bu çalışmanın amacı, makro ekonomik değişimlerin ve yapısal düzenlemelerin Türk bankaları üzerindeki teknik etkiliğinin iki ayrı periyotta incelemeyi amaçlamaktadır. Tezin ilk bölümünde, Veri Zarflama Tekniği ile önceden belirlediğimiz 19 farklı bankanın 2011-2016 yıllarındaki teknik etkinliğine bakılmış olup ayrıca Türkiye'de bulunan banka gruplarının 1988 den 2016 ya kadar olan süreçteki etkinliği analiz edilmeye çalışılmıştır. İkinci bölümde ise, ismi saklı tutulan Türkiye de bulunan özel bir bankanın gerçek verilerinden yararlanılarak şube etkinliği ölçümlenmeye çalışılmıştır. Burada regresyon yöntemi ile yapmış olduğumuz analiz sonuçları, şubede bulunan toplam müşteri sayısının ve ürün sayısının etkinlik üzerinde negatif etki yarattığı yönündedir. Buna ilave olarak, şubelerdeki işkolu sayısının yani operasyonel bölüm sayısı ele alınırsak etkinlik üzerinde bir etkisi olmadığı yönündedir.

Anahtar Kelimeler: Etkinlik, Şube Etkinliği, VZT, Türk Banka Grupları, Regresyon Analizi

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ABBREVIATIONS

DEA : Data Envelopment Analysis

DMUs : Decision Making Units

CCR : Charnes Cooper Rhodes

BCC : Banker Charnes Coop

CRS : Constant Returns to Scale

EMS : Efficiency Measurement System

IMF : International Monetary Fund

FX : Foreign Exchange

GDP : Gross Domestic Product

SDIF : Saving Deposit Insurance Fund

BAT : Bank Association of Turkey

BRSA : Bank Regulation and Supervision Agency

SME : Small and Medium sized Enterprises

BASEL: Basel Capital Accord

FDH : Free Disposal Hull

SFA : Stochastic Frontier Approach

DFA : Distribution-Free Approach

TFA : Thick Frontier Approach

OR : Operational Research

AI : Artificial Intelligence

CSW : Common Set of Weights

NPL : Non-Performing Loan

NIM : Net Interest Margin

DEAP: Data Envelopment Analysis Program

OLS : Ordinary Least Squares

ROE : Return on Equity

GMM: Generalized Method of Moments

GLS : Generalized Least Squares

LAD : Least Absolute Deviations

GP : Goal Programming

CR : Constrained Regression

1. INTRODUCTION

The last 30 years has brought significant changes to the Turkish economy, not in the least due to the policies dated January 24th, 1980, with the goal of liberalizing the economy. After only 7 years of positive measures, distortions unfortunately began to appear in the Turkish economy. The conditions for the public sectors borrowing began rising. Also, Central Bank resources were used to finance the deficit in the budget, if not domestic borrowing. Banks, using government debt instruments turned into a funding mechanism for the state. Ultimately, the current account deficit and the fiscal deficit became so large, and the growth was so dependent on foreign capital, that, together with the lack of strict regulations, a currency crisis took place in 1994. The banking sector was affected and a stabilization program was implemented with the IMF. The state guaranteed in full on all deposits ensure confidence.

The 1990s in the Turkish banking system featured easy and politically connected entry of banks, duty losses, open positions, low capital structure, maturity mismatches, high taxation, connected lending problems and risky balance (Günay and Tektaş, 2006). Not only were there structural problems, there was macroeconomic instability, high volatility in growth and real interest rates, high inflation, fiscal imbalances and balance of payment problems. Therefore, the government initiated program for disinflation supported by the IMF. The goal of the program was to improve many aspects such as growth, inflation, interest rates within three years. It was to do this through policy changes in many fields such as exchange rates, money, tax, pensions, privatization, banking system and regulation. Despite all efforts for stabilization, the economy did not recover. The interest rates remained high, the foreign exchange (FX) market was distorted, the budget deficit was large, and ultimately another crisis struck in 2000.

The crises in 2000 and 2001 had significant impacts on the financial sector, 75% of the destructive effects were felt in the Turkish banking sector. The year 2001 saw a decrease of 5.7% in the GDP in real terms, increase in inflation up to 54.9%, the Turkish Lira losing over half of its value, and finally 10% unemployment. Prior to the crisis, Turkish banks had borrowed from abroad to give to the public sector and profited off of the high amounts of arbitrage. A look at any balance sheet belonging to a bank revealed significant amounts of government securities. The crisis turned everything

topsy-turvy, and left the banks with portfolios worth much less than what they had begun with. It became more challenging to find funds from abroad, leading them to attempt to sell off the government securities they had in order to attain funds. The banking sector underwent changes in the asset size, now smaller by 27%, decreased loans by 48% and decreased deposits by 21%. The ownership of 20 banks went to the Saving Deposit Insurance Fund (SDIF) between 1999 and 2001.

In the aftermath, various measures were introduced to remedy the situation and ensure resilience for the future. First, a program for restructuring the sector was initiated. Social and economic reforms were introduced in the Turkish banking sector. The program focused especially on the reinforcing the capital structure of private banks, ensuring a stronger framework for the regulation system, restructuring of banks owned by the state and resolving banks now owned by the SDIF. The most notable changes were the policies introduced regarding private banks which would be modified, the Saving Deposit Insurance Fund (SDIF) and its function to improve the banks under its control improved auditing and the resolution of non-performing loans. (BAT, October 2009).

The purpose of the regulation program was restructuring the state banks and re-establishing the banks that had caused instability in the financial system under the SDIF and reinstate a stronger banking system in Turkey. For these reasons, the Banking Regulation and Supervision Agency set out many rules and obligations accompanied by certain constraints and obligations in the banking sector. The banks were left in the difficult position of having to adapt to a rapidly changing context. These changes also affected the commission and service fees received from the customers in the banking sector and caused heavy sanctions to be imposed on the banks, thereby decreasing the transactions banks could make money from and preventing them from turning as much of a profit.

Once the regulations caused the decreasing profits levels, after that banks started to estimate their efficiency in the sector. However, the rapid advances in technology, limited resources and developing country economies prevented banks from achieving the levels of profitability they desired.

To measure the efficiency of the banks, the resources were analyzed to also identify which bank items were ineffective and new scenarios were created for new resources by eliminating ineffective products and services. Also, the competition in the banking sector in Turkey, forced banks to use their resources more effectively.

Efficiency scores is a clear and important indicator of bank success and provide us to understand which banks are more successful and which are not. The more efficient use of products and services changed banks' profit projection. After efficiency analysis of bank we need to understand the reason behind the differences in success that appear following the calculations. Regression models will be used to understand which variables acts important roles in banking success.

The central goal of this thesis is to assess how efficiently banks are operating and identify what affects efficiency within the context of Turkish banks. The two steps of the study are given below.

In the first stage, we examine the technical efficiency of 19 Turkish banks for the period 2011 to 2016 by using Data Envelopment Analysis. After that we will evaluate the efficiency of bank groups; i.e., deposit banks, state-owned banks, privately-owned banks and foreign banks in Turkey during the period 1988 to 2016. With the long data set, we are able to analyze trends in the Turkish banks in the long term in terms of efficiency scores over a 28-year period. The focus is on post-crisis banking efficiency as well as a 28-year evaluation.

In the second stage, we investigate the determinants of branch efficiency by panel data regression. We selected one private bank, all of whose branches are in Turkey. We separated it into 4 groups: retail banking, private banking, small group banking like enterprise banking and SME banking. We selected branch input and output variables and created a model to understand branch efficiency to see which items influenced efficiency. This kind of information is very helpful for bank management while establishing strategy, the analysis carried out clearly shows that there are some group dynamics within the four categories themselves, such as number of personnel, number of product and number of customers.

Finally, the thesis will end with a comprehensive conclusion section. This work is important because it represents the first data which was taken from one private bank, whose name has been kept as confidential, and the author signed a confidentiality agreement in exchange for the information. Since this type of information is not published on the Public Disclosure Platform, which publishes all of the financial information of banks, all of the data here related to the branches were obtained confidentially and for the first time in Turkey. Therefore, to our knowledge, this regression analysis is the first that has ever taken place in Turkey, to the best of the researcher's knowledge.

2. THE HISTORY OF THE TURKISH BANKING SYSTEM

2.1 HISTORICAL REVIEW

In the first years of the Republic of Turkey, the banking system had been established through state banks. Since the 1950s, the system has become more dynamic with the institution of private banks into the banking system.

After the 1980s, the Turkish banking system underwent serious changes. The financial reform to the banking system was initiated by the government in the form of financial liberalization law. The new law focused on stabilizing the economic fluctuation in Turkey. In an effort to invigorate the slow economy, financial liberalism was implemented; the government made an effort to increase foreign investments in order to contribute to economic growth. The high inflation and interest rate caused trouble for the financial system and resulted in lack of liquidity in the market. The first step in the financial reform in Turkey was the liberalization of interest rates and the determination of interest rates by primary dealers to ensure a competitive market environment in the banking system (Günçavdı and Küçükçiftçi, 2002).

After the 1980s, the financial liberalization process in the world and increasing globalization caused international capital to be mobilized. There was a shift in the Turkish banking sector as well, which served to increase efficiency and competition within market firms in Turkey in addition to cutting edge technology, regulation and social and political change. However, Turkey was not immune to the financial crises that increased mobility of international capital made possible (Bostan and Bölükbaş, 2011).

In the 1990s, the world experienced several banking sector crises whose effects were felt the most strongly by developing countries. This was due to the banking system regulations being unable to protect customer deposits and banks' equity being insufficient to finance banking debt, which resulted in preventing the central bank from functioning properly (Fırat and Erdem, 2014).

In December 1999, Turkey signed a financial agreement with IMF to solve the high inflation rate problem and foster economic recovery. The goal of this agreement was to decrease the inflation rate to a single digit rate, ensure a sustainable public financial position and overcome the inefficiency of the economy in Turkey by 2002 (Seyidoğlu, 2003). Despite all efforts, large capital inflows, budget deficits, foreign exchange (FX) market distortions, budget deficits, large capital inflows and current account deficits led the year 2000 witnessed a crisis.

The 2001 economic crisis had major effects in Turkey. The economy shrank by about 9%, national income decreased by 51 billion USD, per capita income decreased 725 USD, 19 banks went out of business, 1.5 million people were left unemployed and inflation which had fallen to %30 increased to over 70%. The interest payouts made by the Treasury increased by 101% and the public net debt stock quadrupled what it was in 2000 (Karluk, 2005 as quoted in Fırat and Erdem, 2014).

After the economic crisis, the Turkish Banking system implemented a new economic program and banking system structure. The Banking Regulation and Supervision Authority (BRSA) was established in 2000 to control the Turkish banking system and serve as an authority with autonomy in order to regulate the Turkish Banking Sector. The supervision and regulation of banks had previously been done by the Treasury and The Central Bank. During the crisis, the control of many banks was taken over by the Saving Deposit Insurance Fund (SDIF) and also many banks' licenses were cancelled.

Furthermore, social and economic reforms were introduced in the Turkish banking system after the crisis and restructured banks were established through the re-organization in the banking sector. Among these reforms were changes to state-owned banks, capital equity ratios of private banks, some legislative measures for risk management and Basel Capital Accord (BASEL) is important. Turkey started to incorporate the infrastructural elements of BASEL. These new reforms affected banks' net profit, so banks now had to focus on improving their profit through efficiency and profitability measurement projects related to the balance sheets items.

The number of banks and branches decreased by 47, including deposit banks, development banks and investment banks, in the five years period between 2000 and

2005. With the addition of 4 participation banks, there were 51 banks in Turkey in 2005.

Table 2.1 below shows data detailing the sharp decrease in the number of banks, number of branches and employees from 2000 to 2016.

Table 2.1: Number of banks, branches and employees in Turkey (2000-2016)

	2000	**2005**	**2010**	**2015**	**2016**
Number of banks	**79**	**47**	**45**	**47**	**47**
Deposit banks	61	34	32	34	34
State-owned banks	4	3	3	3	3
Privately-owned banks	28	17	11	9	9
Banks in the fund	11	1	1	1	1
Foreign banks	18	13	17	21	21
Dev't. and inv. Banks	18	13	13	13	13
Number of branches	**7.837**	**6.247**	**9.465**	**11.193**	**10.781**
Deposit banks	7.807	6.228	9.423	11.151	10.740
State-owned banks	2.834	2.035	2.744	3.681	3.702
Privately-owned banks	3.783	3.799	4.582	4.299	4.132
Banks in the fund	1.073	1	1	1	1
Foreign banks	117	393	2.096	3.170	2.905
Dev't. and inv. Banks	30	19	42	42	41
Number of employees	**170.401**	**132.258**	**178.503**	**201.204**	**196.699**
Deposit banks	164.845	127.857	173.133	195.838	191.363
State-owned banks	70.191	38.046	47.235	58.211	57.586
Privately-owned banks	70.954	78.806	83.633	74.756	73.742
Banks in the fund	19.895	395	252	225	231
Foreign banks	3.805	10.610	42.013	62.646	59.804
Dev't. and inv. Banks	5.556	4.401	5.370	5.366	5.336

Source: The Bank Association of Turkey, 2016

After the restructuring period from 2002 to 2007 the Turkish banking system became stronger, more stable and high rate economic growth was accomplished, inflation decreased, public sector debt decreased and the Turkish banking sector became more immune to outside effects.

The Turkish banking system was affected less in the 2008 crisis than in 2001 because the new regulations and capital ratio structured by BASEL played important role. BASEL I was introduced in 1988 to better regulate the global banking system. In 2004, it was revised and became BASEL II, whose goal was to ensure the supervision process

was better and introduce market discipline as well as the capital requirements. When the 2008 crisis happened, economists saw that this regulation was not enough, leading to the BASEL III agreement in 2010. The BASEL rules in the banking sector have a very important role in ensuring a competition environment in terms of banking.

The global crisis in 2008 affected the USA and European economy, but the measures taken by Turkish banking system enabled the banks to continue operating with the least damage. After 2001, Turkey had put into practice the Transition to Strong Economy Program, reinforcing its banks in terms of capital adequacy. Also, since mortgage lending was not common in the Turkish banking sector and the crisis was global, the Turkish banking system was not as damaged as the systems of other countries (Fırat and Erdem, 2014).

In recent years, Turkish banks have undergone new regulations to ensure customer rights to ensure a stronger structure, which will ultimately help prevent any sector crises.

First of all, the Banking Regulation and Supervision Agency has set out new rules about credit cards and personal auto loans in February 2014. Installments for credit card payments are capped at 9 installments; i.e., the period of payment for purchases of goods and services with credit cards and in cash withdrawals will not exceed nine months, including any postponements or grace periods due to a certain fee after purchasing goods or services. As for car loans, they can be obtained up to 70% on cars up to 50 thousand TL. The remainder is to be paid in advance. Cars will not exceed 48 months of age. Finally, personal loans must be paid within 36 months. (The Official Gazette, 2013)

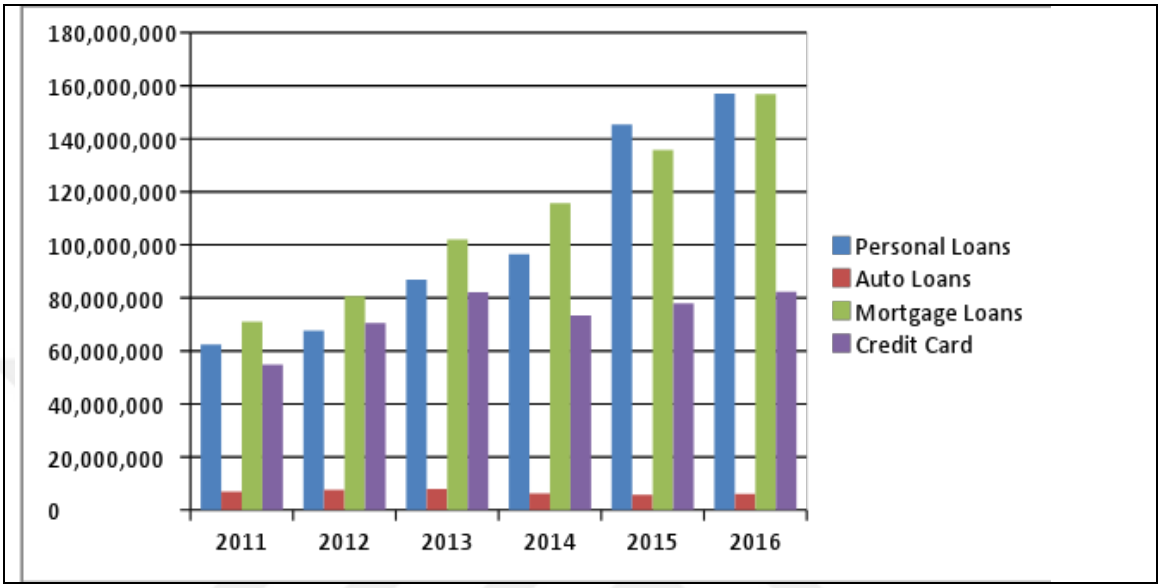
Table 2.2: Total loans in Turkish banking system, TL

	2011	2012	2013	2014	2015	2016
Personal Loans	62.380.564	67.666.213	86.789.461	96.454.779	145.412.794	157.019.064
Auto Loans	6.985.331	7.600.842	8.002.849	6.288.697	5.821.782	6.127.837
Mortgage Loans	70.946.034	80.709.710	102.091.941	115.745.627	135.817.448	156.920.525
Credit Card	54.803.140	70.449.032	82.144.563	73.323.192	77.891.626	82.358.262

Source: The Bank Association of Turkey, 2016

In Table 2.2 shows that after the regulation, the amount of auto loans and credit card debt decreased from 2013 to 2014 and 2015.

Figure 2.1: The chart of loans changes



Source: The Bank Association of Turkey, 2016

The figure 2.1 also shows that loans and credit card scale have been decrease after the new regulation.

These new rules affected the sector dynamics and shrank the banking sector revenues. Since then, banks have been questioning their efficiency and made less of a profit than in previous years. Currently, efficiency is seen as the most important way to maximize future profits.

3. BANK EFFICIENCY WITH DATA ENVELOPMENT ANALYSIS IN TURKISH BANKING SYSTEM

3. 1 LITERATURE REVIEW

Here, the empirical applications for efficiency measurements using DEA in the banking sector are discussed. Recently, research analyzing bank and financial institution efficiency especially focusing on cost and technical efficiency has increased. In addition to employing different methodologies, the studies have distinct assumptions of the estimated models, and use differing inputs and outputs. Many studies focus on bank efficiency regarding different aspects, such as how ownership, size and varying degrees or types of regulatory framework, mergers and acquisitions, deregulation, stock returns affect it. While some studies focus mainly on one specific country, some prefer to conduct cross-country studies in order to analyze the effects of country-specific environmental variables on efficiency. Cross-country studies geographical coverage is mainly based on specific groups such as Eurozone countries, Nordic countries, and Middle Eastern North African countries.

Berger and Humphrey (1997) present a comprehensive review of 130 studies which employ frontier efficiency analysis on financial institutions in 21 countries. Their sample comprises 69 studies which employ non-parametric techniques and 60 studies which employ parametric approached. Of the 69 non-parametric applications, 62 were DEA (Data Envelopment Analysis), 5 were FDH (Free Disposal Hull), and 2 used other approaches. Of the 60 parametric approaches 24 were SFA (Stochastic Frontier Approach), 20 were DFA (Distribution-Free Approach) and 16 TFA (Thick Frontier Approach). Many of the studies in the review show that the banking sector suffer from a large amount of inefficiency problems. Furthermore, Berger and Humphrey (1997) claim that different methods used to calculate efficiency do not give consistent findings to conclude results in a consistent, accurate and useful way.

A similar review study was conducted by Fethi and Pasiouras (2009). They review studies that examine bank performance by using operational research (OR) and artificial intelligence (AI) techniques over the period of 1998-2009. They find that DEA is by far

the most commonly-used OR/AI technique in assessing bank performance. 151 studies out of 196 use DEA techniques to estimate various measures of bank efficiency and productivity growth. Their result shows most DEA studies examine banks from the large EU banking sectors (Casu and Molyneux (2003) and Beccalli et al. (2006)).

Maudos, Pastor, Perez and Quesada (2002) investigated cost and profit efficiency in European banks over the period 1993-1996. The study sample is ten European Union countries that choose three outputs have been used loans, earning assets and deposit on the other hand input variables was cost of loanable funds, cost of labor and cost of physical capital. The article has used four groups of variables; banking size, different characteristic of banks (public–private–foreign), characteristic of markets and specialization. This study was focused on cost and profit efficiency function have shown the being of higher levels of efficiency in cost and lower levels in profits. Another finding was that medium size banks are highest level of efficiency both profit and cost.

Hartman, Storbeck and Byrnes (2001) studied that allocative and technical efficiency in branch banking on Swedish banking industry by using DEA method. The data panel is using 50 saving banks branches in Sweden. The article has demonstrated that small branch offices though limited in resource but it is tend to be the most efficiency financial intermediaries in the system. In 1994 and 1995 banking efficiency have been examined with banking size, small size group is found the most efficient, medium size group is operating ineffectively that they were use wrong resource and they would focus on minimum cost configurations, large size group is calculated the lowest levels efficient banks in the industry.

From 1993 to 2000, Chen, Skully and Brown (2005) examined three different efficiencies, cost, allocative and technical in forty-three Chinese banks. The period they chose focused on the deregulation of Chinese banking sector, it was shown that large and small banks are more efficient than medium size banks. However, in 1995, the Chinese banks deregulation positively affected the sector efficiency, after which in 1996 and 1997, post-deregulations the efficiency levels declined.

DeYoung and Hasan (1998) examined that commercial banks profit efficiency in USA between 1980 and 1994. The article focused on de novo banks efficiency that compares to establish and de novo banks profit efficiency. The average of established bank is found about 50% profit efficiency however, the average of de novo banks efficiency was only about 12% after first year of operation. On the other hand, its profit efficiency improves over the next two or three years. Also, after 9 years that article showed that established banks and de novo banks profit efficiency level is not differences between each other.

Yang (2009), studied bank branch operating efficiency using Data Envelopment Analysis (DEA) this article estimated that one of the biggest Canadian banks in Greater Toronto area. Statistics have been calculated 240 bank branches by DEA model. Four Input and nine output items had been chosen the result that BBC model is identified %89 technical efficiency. They found 113 branches effectively operating their business, 4 branches results are inefficiency uses their business, 66 branches operate under constant returns to scale, and the remaining 43 branches operate under decreasing returns to scale.

Ngo Dang-Thanh (2011) evaluated that effectiveness of the global banking system in 2010 by the DEA approach. It shows that how to global banking sector is effect the current crises. In this research, would focus on 3 stages. First of all, a dynamic DEA model is calculated to maximum effective scores that each country could achieve the observed factors. The second step is a Tobit regression focus to determine affecting to countries banking efficiency in the 64 different countries. The third step is defined to optimal common set of weights which should be used for compare and ranking countries based on their banking systems efficiency, by using the different (CSW) model to others. It has been included last economic crises that much more negative effect on the developed countries than the developing countries but they operated better than the developing countries. Result connected with the development of the banking sector in measure that means number of bank branches and more importantly in quality aspects that would including the NPL ratio, public credit,cost-income ratio, bank concentration and capital of bank. It is also involved the effect of economic development and this state level of income and inflation rates.

In the Turkish literature, research on efficiency has increased especially after the 1980s. Most studies on the efficiency of Turkish banks focus on the effect of liberalization policies that were applied after 1980. Studies on the efficiency of Turkish banks also investigated the effects of ownership status, size, crises, foreign bank entry and macroeconomic instability on the efficiency scores of banks. Turkish studies mainly focus on a certain period of time rather than long time periods; the ten years period following liberalization policies, period before and after crises, or the period after 2002 are the most prefer time periods to conduct studies about. To our knowledge, there are two recent studies that cover the period of 1990 to 2007, conducted by Fukuyama and Matousek (2011) and Aysan and Ceyhan (2007). Furthermore, there is gap in the Turkish literature regarding efficiency studies which examine the effects of the global crises on the Turkish banking efficiency scores.

In the 1980s, Turkey experienced the liberalization of its economy and the financial sector, resulting in a period of increasing macroeconomic instability in the country. Yıldırım (2002) investigated the efficiency of the Turkish banking sector between 1988 and 1999 and focused on technical and scale efficiency in Turkish commercial banks using nonparametric Data Envelopment Analysis. He concludes that state-owned banks perform better than private and public banks because technical and scale efficiency positively affects a bank's profit. In other words, Yıldırım (2002) suggests that efficient banks are more profitable.

In the most comprehensive study of its kind, Isık and Hassan (2002) utilized the stochastic frontier approach to analyze the cost and profit efficiency of the Turkish banking industry between 1988 and 1996. This study investigated the Turkish commercial banks profit efficiency and cost efficiency concept that was found profit efficiency is %84 percent for the Turkish banks. They choose four output variables and three input variables, it was two stage analysis of the efficiency estimate. First one is focus on output side, inefficiency along with input side inefficiency in Turkish banking sector, using the stochastic frontier approach. Second one is highly profitable and intensive financial market such as Turkey's, as a result of the limited number of banks in the system and surplus demand for bank resources from public sector, study show

that banks did not feel the pressure to operate in a very cost-effective way to stay in business.

Gunay and Tektas (2005) studied that crises period efficiency in Turkish banking sector. The study shows that world crises and the banking sector crisis that took some place in the world countries and then other perspective in this study financial structure of Turkey were emphasized in the sector crises. The relationship between private and public bank activities and bank crises has been examined in the study. Then, the experimental results are presented in a summary and suggestions that are needed today in order not to cause new crises in the banking sector are mentioned.

Bedhioğlu and Özcan (2009) estimated that Turkish banking sector efficiency which was categorizes to capital structure and scale size of banks such as foreign, private, public and small, medium and large. The data was shown that number of 29 trade banks have been continuously operating in the market that estimate between in the years 1999 and 2005 is used by DEA approach. Input indicators was such us number of personal, number of branch, interest expenses and non-interest expenses where the outputs were defined as total credit, total loans and net profit. The lecturer was estimate efficiency rate of those banks have been calculate to input part and CCR Model by classifying them according to their capital structure and scale size. As a result, that the most efficient banks have been find foreign banks and the following that public and private banks. However, other perspective that banking scale size, the most efficient banks have been find big size banks and followed by small and medium size banks. TEB (Türk Ekonomi Bankası), Vakıflar Bankası, Ziraat Bankası, Akbank, Koçbank, ABN AMRO Bank, Bank Mellat, JPMorgan Chase Bank and CitiBank are found that efficient and the other banks are inefficient by calculate input oriented CCR Model.

An article of Eken and Kale (2011) studied the performance of the bank branches of Turkish banks by the application of DEA. The aim of this article is to develop a performance model to branch efficiency and potential improvement capabilities of bank branches by identifying their profit and cost items. Data of 128 bank branches located in Istanbul city and Thrace region were analyzed between 2000- 2010. The result that they have estimated technical efficiency in production approached and profitability approached with different DEA models. % 41 branches are technically efficient with an

average of 0,896 in despite of high average efficiency %59 of 128 branches are not technical efficient that they found. Bank size is important to branch efficiency. Small, medium and large banks size are categorized by the data. Large branches seem to more efficient than small size branches and large branches located such as Istanbul more advantages than Thrace region because their efficiency figures become higher that they found.

Most recently, Fukuyama and Matousek (2011) measured technical and allocative efficiency scores of Turkish banks over the 1991-2007 periods by using the two stages model introduced by Fukuyama and Weber (2010). Fukuyama and Matousek (2011) also calculated the efficiency score by using DEA so that they could compare results obtained from a two stages network system with the traditional DEA approached. Their long dataset enables us to look at detailed overview of changes in the Turkish banking sector and to analyze the effects of banking crises. They found that Turkish bank efficiency was directly affected by changes in the Turkish economy. One year before the 1994 and 2001 crises, Turkish banks efficiency scores were dropped to low levels and after the consolidation and restructuring processes, Turkish banks efficiency reacted positively and efficiency has slowly improved. The study also claimed that deterioration of efficiency levels from 2004 to 2007 could be explained by strict regulatory rules imposed by BRSA. In the second part of their study, they investigate the determinants of bank efficiency by applying the bootstrap model. They found out that the NIM (Net Interest Margin) has statistically negatively significant variables, while the market share on loan market is positive, and branch number is negative.

In order to analyze the effect of global financial crises on efficiency scores of Turkish banks, Özkan and Günay (2012) calculated the efficiency scores of Turkish banks 2002 to 2009. efficiency scores were calculated by using DEA approach and the study incorporates NPLs into the model as an undesirable product. The findings of the study show that the number of efficient banks and overall efficiency follows an increasingly trend in the post crisis period, even in the global financial crisis. This increasing trend is explained by success of the Banking Sector Restructuring Process and the existence of the BRSA.

3.2 DATA and METHODOLOGY

There are many approaches that we can use to evaluate the efficiency of a banking system. Some commonly used parametric and non-parametric methodologies in studies examining banking systems are Stochastic Frontier Analysis (SFA), Thick Frontier Analysis (TFA), Distribution Free Analysis (DFA) and Data Envelopment Analysis (DEA) (Altıok, 2013).

The parametric and non-parametric approaches have been used to research studying for the efficiency measurement (Berger and Humphrey, 1997). The three most commonly using methods in literature in the Parametric frontier approach are:

1. Stochastic Frontier Analysis (SFA): It is used to evaluate banking efficiency by a considerable number of studies (Kumbhakar et al., 2001; Berger et al., 2003). The methodology of SFA is such that it uses one input-multiple outputs or one output-multiple inputs scenarios (Paul, 2015).
2. Thick Frontier Analysis (TFA): This approach is the least common method of the three. TFA does not estimate individual banking efficiency; it only estimates overall efficiency by using sample data (Bauer et al., 1998).
3. Distribution Free Analysis (DFA): Another parametric approach is DFA. DFA estimates the core efficiency or average efficiency for each bank as constant over time. This technique was developed by Schmidt and Sickles (1884) and Berger (1993).

The Non-Parametric Frontier Approach is a widely used DEA method in literature for measuring efficiency in the banking sector.

1. Data Envelopment Analysis (DEA): DEA is a linear programming based technique and mathematical approach to solving situations with multiple inputs and multiple outputs, non-parametric linear programming based technique for measuring the relative efficiency of set of similar units, usually referred to as decision making units (DMUs) and it has made important contributions to measuring bank performance (Paul, 2015, Toloo and Nalchigar, 2011). DEA measures efficiency by making a hypothetical comparison of the production

function using the highest values of outputs-benefit that would be generated by inputs-resources as given by order of observed input/output evaluate (Vassiloglou and Giokas, 1990). DEA is not only used to measure the efficiency of banking systems. It is applied in many industries such as health care, hospital, education manufacturing, restaurants, retail and so on. Also, the difference between typical statistical approaches and DEA is that the DEA compares each production with the best producers. Furthermore, one of the most important advantages of using the DEA method is its ability to take into account multiple characteristics of banks where multiple outputs and inputs are used (Jackson and Fethi, 2000).

Following many studies in the literature, we decided to use the DEA method in this study. The DEA offers better performance with small samples, also DEA is mathematical programing approach to calculate relative efficiency measures of decision making units (DMU) included in the sample, with multiple numbers of input and output which is the case in our study.

First of all, this method was developed by Farrell (1957) to deal with single input/output technical efficiency so that the estimation of technical and production frontiers could be connected. Farrell's idea was built upon by Charnes, Cooper and Rhodes (1978), in order to measure multiple inputs and multiple outputs, leading to the CCR (Charnes Cooper Rhodes) model using the constant return to scale (CRS) (Seiford et al., 1990). Others continued working on the model to improve its restrictions, and Banker, Charnes and Cooper (1984) came up with the BCC (Banker Charnes Cooper) model, which allowed for variable returns to scale.

3.2.1 CCR Model

As mentioned above, the most basic DEA model is the CCR model. The idea underlying the CCR model is as follows; it is possible to calculate the efficiency of a DMU as the maximum of a ratio of weighted outputs to weighted inputs. However, the same ratio for all DMUs can either one or less than one (Toloo and Nalchigar, 2011).

The constant returns to scale (CRS) is as follows:

j: number of DMUs in the sample,

i: number of inputs considered,

r: number of outputs considered.

Parameters:

v_i: the weight for input j (j= 1,...,m),

u_r: the weight for output i (i= 1,....,s).

Variables:

x_{ij}: value of output i for DMU j.,

y_{rj}: value of input r for DMU j.,

The objective of maximizing the ratio of virtual output to virtual input for a DMU can be expressed as:

Objective function;

$$Max = \sum_{r=1}^{n} u_r y_r / \sum_{i=1}^{m} v_i x_i \quad \textbf{(3.1)}$$

Subject to:

$$\frac{\sum_{r=1}^{n} u_r y_r}{\sum_{i=1}^{m} v_i x_i} \leq 1 \quad \textbf{(3.2)}$$

$$u_r \geq 0 \quad \textbf{(3.3)}$$

$$v_i \geq 0 \quad \textbf{(3.4)}$$

The first formula (3.1) explains the objective function of DEA that has “m” inputs and “n” outputs. This formula helps reveal a maximum ratio between the value of outputs to the value of inputs that belong to DMUs. The second formula (3.2) also explains the efficiency rate of DMUs that must be less than 1.

There are two CCR approaches in the literature for measuring efficiency: input oriented models and output oriented models. Input oriented models focus on how much inputs should be decreased given a certain amount of output whereas output oriented models explore the extent to which the outputs should be increased given a certain amount of input (Altıok, 2013).

The first function of input oriented CCR is help to find the greatest sum possible from decision making unit outputs. The formulas (3.4) and (3.5) given below show objective function and constraints of input oriented CCR.

$$Max = \sum_{r=1}^{n} ur\ yr \quad \textbf{(3.5)}$$

$$\sum_{i=1}^{m} vi\ xi = 1$$

$$\sum_{r=1}^{n} ur\ yr - \sum_{i=1}^{m} vi\ xi\ \geq 0 \quad \textbf{(3.6)}$$

$$ur, vi \geq\ 0$$

The second function of the output oriented CCR approach is help to find minimize the inputs of the decision making unit. The figure below shows formulas (3.7) and (3.8) as objective function and restraints of output oriented CCR.

$$Max = \sum_{i=1}^{m} vixi \quad \textbf{(3.7)}$$

$$\sum_{r=1}^{n} ur\ yr = 1$$

$$-\sum_{r=1}^{n} ur\ yr\ +\ \sum_{i=1}^{m} vixi\ \geq 0 \quad \textbf{(3.8)}$$

$$ur, vi\ \geq\ 0$$

The models all have a single set of weights. The DMU focus on selecting these weights in such a way that the highest possible score is obtained, while keeping the virtual input

at 1 as well as making sure the other DMUs' virtual outputs do not surpass their virtual inputs. The best score that can be obtained by efficient DMUs is 1, with inefficient DMUs obtaining scores less than 1 (Altıok, 2013).

3.2.2 BCC Model

As mentioned above, the Banker, Charnes and Cooper (BCC) model was developed in 1984 and is used in variable returns to scale type situations, in which an increase in input to effectiveness unit can result in disproportionate increase or decrease in outputs.

One of the main differences between the CCR model and the BCC model is that for BCC, there is a restriction of having all intensity variables, λi sum to 1. This means that there is removes the constraint that each DMU should be scale efficient (Chan, 2006).

BBC models are similar to CCR models, except that BBC models contain the cc_0 variable. In addition, the sum of λj equals to 1. With these changes, the structure of the efficient frontier is changed (Ulutas, 2006).

Input oriented BCC model formula aims to maximize the sum of weighted outputs of DMUs. The formulas given below (3.9) and (3.10) are objective function and constraints of input oriented BCC.

Objective Function,

$$Max \sum_{r=1}^{n} ur\ yr\ + c_0 \qquad \textbf{(3.9)}$$

Constraints;

$\sum_{i=1}^{m} vixi = 1$

$\sum_{r=1}^{n} uryr - \sum_{i=1}^{m} vixi + c_0 \geq 0$ **(3.10)**

ur, $v_i \geq 0$

Output oriented BCC model objective is to minimize the sum of weighted inputs of DMU. Formulas (3.11) and (3.12) are objective function and constraints of output oriented BCC.

$Max \sum_{i=1}^{m} vixi - c_0$ **(3.11)**

$$\sum_{r=1}^{n} ur\ yr = 1$$

$-\sum_{r=1}^{n} ur\ yr + \sum_{i=1}^{m} vi\ xi - c_0 \geq 0$ **(3.12)**

ur, $vi \geq 0$

On the CCR approach, any increase in inputs will result in an equal proportional increase in the outputs. The BBC model is not as strict and allows an increase in inputs to result in disproportionate change in outputs (Chan, 2006).

There are many approaches to define input and output variables, scale efficiency, scope efficiency and X- efficiency (also called technical and allocative efficiency) (Chen et al., 2005, Sathye, 2001). In the literature, the two most commonly used methods are the

‘intermediation’ and ‘production’ approaches.

The first approach views banks as an intermediator of financial services. Hence, funds supplied by depositors (deposits) are defined as input and the funds used by the credit customers (loans) are defined as output. In this approach banks attempt to profit by turning deposits into loans. The intermediation approach views the main function of the banking system as intermediation between those depositing funds and those borrowing funds, thus, it sees deposits and other resources as the input of the bank and credit, other assets as the output of the bank. Therefore, this approach uses currency not the account number, as the unit of input and output measurement.

In contrast, in the second approach, the banks are viewed producers of loans and deposit account services using capital and labor. When trying to calculate the cost efficiency of banks, the intermediation approach is preferred if the total cost of banking sector and the competitive power of banks are in question (Aly et al., 1990). Production approach treats banks as units that generate output such as deposit, credit, securities and other balance sheet items, and which use capital, labor and other items as input. In this approach, when measuring output, the number of accounts used as the basis.

3.3 RESULT

In the literature, many studies attempt to investigate determinants of bank efficiency by DEA analysis. These studies used two models for estimating determinants of efficiency. First of all, we estimated the efficiency scores of 19 banks for 6 years (from 2011 to 2016). These 19 banks by choosing input and output variables, which is loans, interest income, off-balance sheet items, deposit, interest expense and shareholders equity.

Secondly, the Turkish banking sector is classified in six groups: deposit banks, which take money deposits and make out loans in their own account and are not allowed to conduct commercial activities such as leasing and trading of real goods ; state-owned banks, are strengthened through injections and considerable amount of resources; privately-owned banks, banks in the fund, foreign banks and development and investment banks which do not collect deposits and are subject to special laws regarding their operations (BAT). Investment banks run activities related to corporate finance, foreign exchange, mergers and initial public offerings and development banks grant funding in the medium-term to industry. They also fund sectors the government prioritizes using government resources (Etkin et al., 2000).

This dissertation features a two-tiered analysis, the second part of which involves data published by the Bank Association of Turkey (BAT) from 1988 to 2016 regarding Turkish banks financial statements. All banks in Turkey are included such as deposit banks, state-owned banks, privately owned banks and foreign banks.

When using DEA methodology for efficiency analysis, which input and output items are selected is a crucial issue that can change the outcome completely. In terms of what inputs and outputs are; Berger and Humphrey (1997)'s approaches; namely, the production approach and intermediation approach for use when picking inputs and outputs define them clearly. The production approach focuses on the production of produce services for account customers using only labor and capital, i.e. physical inputs, to produce loans and deposit account services and therefore uses information on how many accounts of what type have been opened at the bank to estimate output. On the other hand, the intermediation approach sees banks as intermediary institutions enabling the movement of funds between savers – depositers- and investors who need loans.

The most important distinction between the two approaches is in terms of how inputs and outputs for banks are specified. According to many studies, loans and assets should be seen as outputs. The role of deposits is less clear, since deposit could be defined as an input, having been collected in return for interest payments and used to increase funds value, but also as an output since it means liquidity and payments services provided to depositors.

While describing these approaches, Berger and Humphrey (1997) admit both approaches have their shortcomings since banks also provide transactions processing services as financial intermediaries. However, they do state that is one needs to calculate bank efficiency, the production approach would be more conducive. In a review of 151 studies on bank performance, Fethi and Pasiouras (2010) find 95 that use deposits as an input variable and 20 that use deposits as an output variable.

The intermediation approach has been focused on in the Turkish literature by Zaim (1995), Işık and Hassan (2002), Kasman (2002), and most recently by Aysan and Ceyhan (2007). The intermediation approach also seems a popular choice in the many other efficiency studies in the literature. Here, we also use a model with three inputs and three outputs.

Data and Variables:

We used same variables for two analysis. First of all, input variables which are deposit, interest expense and shareholders equity.

Table 3.1: Input Variable Definitions

Variable	Definition
Deposit	Includes time and demand deposits
Interest Expense	Sum of interest expense
Shareholders' Equity	Sum of financial capital

First input variable deposit is included time deposit and demand deposit from 19 banks and the other banks groups.

Interest Expense is defined as a sum of 19 banks and the other banks groups, interest expense include interest paid to deposit, interest paid to Interbank Money Market Transactions, interest paid to loans and other interest expenses.

Shareholders' Equity is used because some banks utilize financial capital for the funding of loans instead of deposits or other borrowed funds. If want to avoid any ricks, banks could use capital and not deposits to finance their loans. Following from Mester (1996), Altunbaş et al. (2000), and Kasman and Yıldırım (2006), here we took financial capital as an input variable.

Secondly, output variables which are loans, interest income and off-balance sheet.

Table 3.2: Output Variable Definitions

Variable	Definition
Loans	Short term and Long term loans
Interest Income	Sum of Interest Income
Off-Balance Sheet	Guarantees and warranties/commitments

Loans are included both short term loans and long term loans. Short term loan is loans with less than one year maturity, long term loan that loans with more than one year maturity.

Interest income is we refer to Çukur (2005) that used three output such us loans, interest income and non-interest income.

In terms of what off-balance sheet variable involves, the majority comprise commitments, guarantees and warranties, derivative financial and foreign exchange items. With the goal of seeing if and how efficiency will be influenced, Pasiouras (2008) used off-balance sheet activities, ultimately finding that off-balance sheet items

lacked a significant impact. In the Turkish banking sector, however, the increase in non-traditional banking activities in recent years has led to the use of off-balance sheet items as an output variable. Here, we also included off-balance sheet items in our analysis, making use of the experience afforded by Aysan and Ceyhan (2007), Altunbaş et al. (2000), Işık and Hassan (2002) and Pasiouras (2008) study.

Table 3.3: Selected 19 banks input and output variables

Years												
2011-2016	Outputs						Inputs					
DMU	LOANS		INTEREST INCOME		OFF-BALANCE SHEET		DEPOSIT		INTEREST EXPENSE		SHAREHOLDER EQUITY	
	Sum	Mean	Sum	Mean	Sum	Mean	Sum	Mean	Sum	Mean	Sum	Mean
State-owned Deposit Banks												
Türkiye C. Ziraat Bankası A.Ş.	321.236.792	53.539.465	45.451.063	7.575.177	1.525.589.076	254.264.846	386.448.988	64.408.165	23.897.804	3.982.967	59.237.513	9.872.919
Türkiye Halk Bankası A.Ş.	238.824.150	39.804.025	27.650.774	4.608.462	2.047.541.423	341.256.904	256.481.394	42.746.899	14.913.165	2.485.528	37.966.653	6.327.775
Türkiye Vakıflar Bankası T.A.O.	238.726.708	39.787.785	26.959.515	4.493.253	2.741.181.547	456.863.591	220.652.156	36.775.359	15.022.751	2.503.792	35.110.420	5.851.737
Privately-owned Deposit Banks												
Akbank T.A.Ş.	287.187.754	47.864.626	32.932.821	5.488.803	2.292.306.316	382.051.053	280.004.327	46.667.388	17.248.515	2.874.753	17.856.748	2.976.125
Anadolubank A.Ş.	14.212.064	2.368.677	2.001.548	333.591	108.766.833	18.127.806	14.390.580	2.398.430	1.017.423	169.571	3.017.235	502.872
Fibabanka A.Ş.	14.221.888	2.370.315	1.470.206	245.034	172.775.947	28.795.991	12.278.640	2.046.440	853.195	142.199	1.545.999	257.666
Şekerbank T.A.Ş.	33.476.826	5.579.471	4.835.403	805.900	841.237.540	140.206.257	31.940.638	5.323.440	2.591.948	431.991	5.378.964	896.494
Turkish Bank A.Ş.	1.569.970	261.662	189.661	31.610	6.194.906	1.032.484	1.911.075	318.512	97.981	16.330	455.324	75.887
Türk Ekonomi Bankası A.Ş.	101.940.003	16.990.001	12.058.603	2.009.767	587.465.652	97.910.942	90.694.453	15.115.742	6.234.834	1.039.139	14.554.227	2.425.705
Türkiye İş Bankası A.Ş.	358.283.206	59.713.868	39.458.217	6.576.370	1.275.746.532	212.624.422	328.615.573	54.769.262	21.222.127	3.537.021	67.129.552	11.188.259
Yapı ve Kredi Bankası A.Ş.	276.052.367	46.008.728	28.765.869	4.794.311	1.326.384.994	221.064.166	244.922.028	40.820.338	15.373.826	2.562.304	47.356.807	7.892.801
Foreign Banks												
Burgan Bank A.Ş.	13.628.385	2.271.398	1.577.285	262.881	102.736.442	17.122.740	11.610.837	1.935.139	1.032.086	172.014	2.029.508	338.251
Denizbank A.Ş.	99.549.291	16.591.549	13.218.716	2.203.119	912.497.568	152.082.928	94.810.574	15.801.762	6.464.858	1.077.476	15.505.482	2.584.247
Deutsche Bank A.Ş.	2.384.482	397.414	576.509	96.085	122.677.750	20.446.292	1.458.169	243.028	146.039	24.340	1.250.241	208.373
HSBC Bank A.Ş.	44.315.978	7.385.996	5.998.868	999.811	445.638.124	74.273.021	42.288.240	7.048.040	2.864.263	477.377	5.976.065	996.011
ING Bank A.Ş.	64.242.490	10.707.082	7.292.683	1.215.447	616.345.369	102.724.228	45.756.732	7.626.122	3.303.836	550.639	9.032.707	1.505.451
Finans Bank A.Ş.	115.657.478	19.276.246	16.072.105	2.678.684	1.260.668.137	210.111.356	102.058.699	17.009.783	7.831.163	1.305.194	20.381.213	3.396.869
Turkland Bank A.Ş.	7.000.289	1.166.715	890.662	148.444	127.172.844	21.195.474	7.619.252	1.269.875	540.041	90.007	1.431.906	238.651
Türkiye Garanti Bankası A.Ş.	316.746.011	52.791.002	37.054.609	6.175.768	2.712.942.398	452.157.066	289.752.246	48.292.041	18.853.014	3.142.169	63.783.784	10.630.631

Table 3.4: All banks input and output variables (1988-2016 millions of US dollars)

Variables	1990 Sum	1990 Mean	1995 Sum	1995 Mean	2000 Sum	2000 Mean	2005 Sum	2005 Mean	2010 Sum	2010 Mean	2016 Sum	2016 Mean
Deposit Banks												
Outputs												
Total Loans	49.074	16.358	116.888	23.378	195.194	39.039	280.960	56.192	1.175.149	235.030	2.623.361	437.227
Interest Income	23.090	7.697	67.187	13.437	143.144	28.629	140.969	28.194	253.442	50.688	313.921	52.320
Off-Balance Sheet	43.802	14.601	147.513	29.503	537.792	107.558	1.436.648	287.330	6.207.011	1.241.402	19.718.141	3.286.357
Inputs												
Deposits	111.922	37.307	182.884	36.577	386.780	77.356	619.917	123.983	1.569.310	313.862	2.544.780	424.130
Interest Expense	18.616	6.205	45.514	9.103	105.228	21.046	92.755	18.551	147.528	29.506	163.875	27.313
Shareholders' Equity	11.033	3.678	26.126	5.225	40.146	8.029	109.441	21.888	276.749	55.350	470.857	78.476
Foreign Banks												
Outputs												
Total Loans	1.872	624	3.458	692	5.705	1.141	15.688	3.138	207.983	41.597	518.015	86.336
Interest Income	849	283	2.406	481	6.979	1.396	5.076	1.015	40.470	8.094	65.452	10.909
Off-Balance Sheet	2.990	997	11.411	2.282	64.805	12.961	108.934	21.787	1.350.573	270.115	4.915.866	819.311
Inputs												
Deposits	2.062	687	3.708	742	11.341	2.268	20.082	4.016	205.505	41.101	472.030	78.672
Interest Expense	578	193	962	192	3.663	733	2.390	478	19.958	3.992	31.355	5.226
Shareholders' Equity	488	163	1.475	295	3.183	637	6.758	1.352	45.958	9.192	92.426	15.404
Privately-owned Banks												
Outputs												
Total Loans	21.265	7.088	61.273	12.255	118.354	23.671	202.513	40.503	656.735	131.347	1.305.742	217.624
Interest Income	10.680	3.560	32.651	6.530	67.194	13.439	69.393	13.879	128.394	25.679	148.142	24.690
Off-Balance Sheet	27.107	9.036	102.495	20.499	360.371	72.074	1.075.397	215.079	3.196.199	639.240	8.470.178	1.411.696
Inputs												
Deposits	36.080	12.027	96.481	19.296	191.441	38.288	356.083	71.217	793.592	158.718	714.548	119.091
Interest Expense	8.359	2.786	19.501	3.900	38.301	7.660	43.236	8.647	74.963	14.993	78.572	13.095
Shareholders' Equity	5.930	1.977	16.317	3.263	37.396	7.479	70.345	14.069	156.951	31.390	244.501	40.750
State-owned Banks												
Outputs												
Total Loans	25.937	8.646	52.157	10.431	65.665	13.133	60.561	12.112	310.381	62.076	798.788	133.131
Interest Income	11.560	3.853	32.129	6.426	63.195	12.639	52.082	10.416	84.185	16.837	100.061	16.677
Off-Balance Sheet	13.705	4.568	33.607	6.721	69.014	13.803	231.323	46.265	1.651.989	330.398	6.314.312	1.052.385
Inputs												
Deposits	33.936	11.312	82.695	16.539	157.626	31.525	232.282	46.456	570.087	114.017	863.583	143.930
Interest Expense	9.680	3.227	25.051	5.010	55.616	11.123	44.053	8.811	52.603	10.521	53.834	8.972
Shareholders' Equity	4.615	1.538	8.334	1.667	8.716	1.743	31.543	6.309	71.417	14.283	132.315	22.052

3.4 CONCLUSION

An input oriented DEA model under the assumption of Constant Return to Scale (CRS) was used to obtain empirical results. The DEAP Computer Program, version 2.1 was used to calculate the efficiency scores.

The DEA efficiency scores are investigated for 19 banks from 2011 to 2016. The table shows the average of the technical efficiency scores of 19 banks. The banks with an efficiency score of 1 are regarded as fully efficient banks whereas banks with efficiency scores below 1 are regarded as banks with an inefficiency problem. These banks were randomly selected on the BAT system.

Table 3.5: Efficiency score 2011 to 2016

YEARS	2011	2012	2013	2014	2015	2016
DMU						
State-owned Deposit Banks						
Türkiye C. Ziraat Bankası A.Ş.	1.000	0.937	0.927	0.836	0.866	0.956
Türkiye Halk Bankası A.Ş.	1.000	0.963	0.874	0.836	0.827	0.976
Türkiye Vakıflar Bankası T.A.O.	0.892	0.897	0.939	0.863	0.937	0.993
Privately-owned Deposit Banks						
Akbank T.A.Ş.	0.783	0.811	0.844	0.913	0.840	0.865
Anadolubank A.Ş.	0.905	0.893	0.872	0.824	0.836	0.851
Fibabanka A.Ş.	1.000	1.000	1.000	1.000	1.000	1.000
Şekerbank T.A.Ş.	1.000	1.000	1.000	1.000	1.000	1.000
Turkish Bank A.Ş.	0.638	0.712	0.725	0.917	0.845	1.000
Türk Ekonomi Bankası A.Ş.	0.917	0.956	0.920	0.934	1.000	1.000
Türkiye İş Bankası A.Ş.	0.812	0.806	0.817	0.924	0.831	0.947
Yapı ve Kredi Bankası A.Ş.	0.927	0.872	0.848	1.000	0.845	0.960
Foreign Banks						
Burgan Bank A.Ş.	0.924	0.859	0.996	0.843	0.990	1.000
Denizbank A.Ş.	1.000	0.976	1.000	1.000	0.942	0.931
Deutsche Bank A.Ş.	1.000	1.000	1.000	1.000	1.000	1.000
HSBC Bank A.Ş.	0.966	0.996	0.974	0.920	1.000	0.976
ING Bank A.Ş.	1.000	1.000	1.000	1.000	1.000	1.000
Finans Bank A.Ş.	0.976	0.941	1.000	0.900	0.997	1.000
Turkland Bank A.Ş.	0.795	0.854	0.750	0.873	0.798	0.835
Türkiye Garanti Bankası A.Ş.	0.827	0.810	0.825	0.913	0.905	0.980

In this analysis, foreign banks were found to be more efficient than the other two groups, the privately-owned deposit banks and the state-owned deposit banks. The state-owned banks, when we look at the table only for 2011, TC. Ziraat Bank and Türkiye Halk Bank worked fully effectively. After 2011 their efficiency score decreased.

On the other hand, another state-owned bank, Türkiye Vakıflar Bank was not effective between 2011 and 2016.

Table 3.6: Efficiency scores of state-owned banks

YEARS	2011	2012	2013	2014	2015	2016
DMU						
State-owned Deposit Banks						
Türkiye C. Ziraat Bankası A.Ş.	1.000	0.937	0.927	0.836	0.866	0.956
Türkiye Halk Bankası A.Ş.	1.000	0.963	0.874	0.836	0.827	0.976
Türkiye Vakıflar Bankası T.A.O.	0.892	0.897	0.939	0.863	0.937	0.993

Of the privately-owned deposit banks selected, i.e., Akbank, Anadolubank, Fibabank, Şekerbank, Turkishbank, TEB (Türk Ekonomi Bank), Türkiye İşbank and Yapı ve Kredi Bank, only two were effectively run businesses in the analysis throughout the year.

Fibabanka and Şekerbank did not work completely efficiently from 2011 to 2016. Also, TEB worked efficiently in the last two years.

Akbank, Anadolubank and Işbank do not seem efficient, having an analysis score is below 1. Turkish bank achieved efficiency level only in the last year.

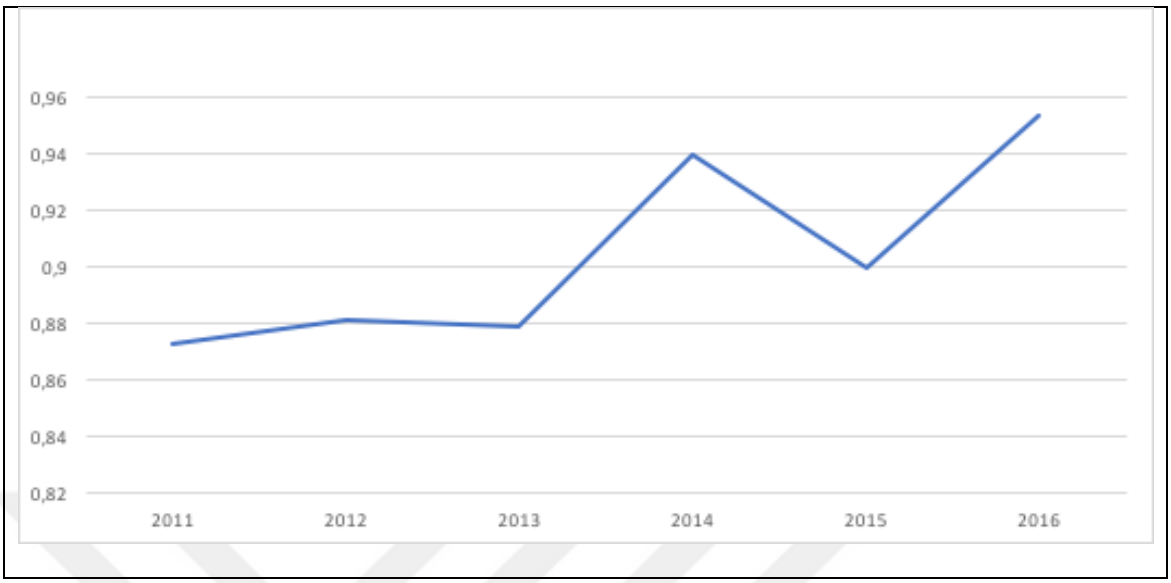
However, Yapı Kredi Bank only effectively worked in 2014.

Table 3.7: Efficiency scores of privately-owned deposit banks

YEARS	2011	2012	2013	2014	2015	2016
DMU						
Privately-owned Deposit Banks						
Akbank T.A.Ş.	0.783	0.811	0.844	0.913	0.840	0.865
Anadolubank A.Ş.	0.905	0.893	0.872	0.824	0.836	0.851
Fibabanka A.Ş.	1.000	1.000	1.000	1.000	1.000	1.000
Şekerbank T.A.Ş.	1.000	1.000	1.000	1.000	1.000	1.000
Turkish Bank A.Ş.	0.638	0.712	0.725	0.917	0.845	1.000
Türk Ekonomi Bankası A.Ş.	0.917	0.956	0.920	0.934	1.000	1.000
Türkiye İş Bankası A.Ş.	0.812	0.806	0.817	0.924	0.831	0.947
Yapı ve Kredi Bankası A.Ş.	0.927	0.872	0.848	1.000	0.845	0.960

We observe a sharp increase and decrease in mean efficiency scores from 2013 to 2016. The lowest efficiency levels only 2011 to 2013. Banking regulation and supervision agency set out new rules about loans in 2014, after the 2008 crisis.

Figure 3.1: Private-owned bank overall efficiency



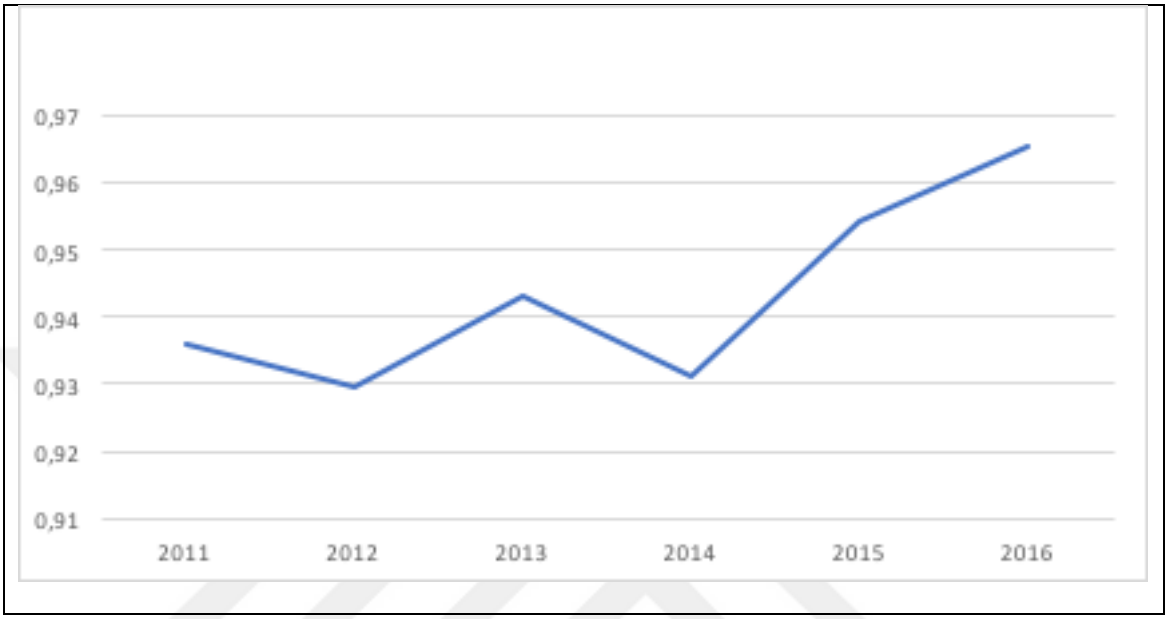
The foreign banks chosen were Burgan Bank, Denizbank, Deutsche Bank, Hsbc Bank, ING Bank, Finans Bank, Turkland Bank and Garanti Bank. We can say that Burgan Bank was efficient only in 2011. Deutsche Bank and ING Bank work fully efficiently the entire period selected and only these banks got a score of 1 in the efficiency analysis. Turkland Bank did not effectively work because these bank output and input variables lacked the scale of the other banks. Garanti Bank and Turkland Bank are the only two banks that did not achieve the efficiency level in 2011 to 2016.

Table 3.8: Efficiency scores of foreign banks

YEARS	2011	2012	2013	2014	2015	2016
DMU						
Foreign Banks						
Burgan Bank A.Ş.	0.924	0.859	0.996	0.843	0.990	1.000
Denizbank A.Ş.	1.000	0.976	1.000	1.000	0.942	0.931
Deutsche Bank A.Ş.	1.000	1.000	1.000	1.000	1.000	1.000
HSBC Bank A.Ş.	0.966	0.996	0.974	0.920	1.000	0.976
ING Bank A.Ş.	1.000	1.000	1.000	1.000	1.000	1.000
Finans Bank A.Ş.	0.976	0.941	1.000	0.900	0.997	1.000
Turkland Bank A.Ş.	0.795	0.854	0.750	0.873	0.798	0.835
Türkiye Garanti Bankası A.Ş.	0.827	0.810	0.825	0.913	0.905	0.980

The diagram shows that the efficiency of overall foreign banks sharply increased from 2014 to 2016. The new regulations seem not to have impacted the foreign group.

Figure 3.2: Foreign bank overall efficiency



The second analysis involved the calculation of the banking efficiency of groups.

In this study, the data was taken from Turkish banks' financial statements published by the Bank Association of Turkey (BAT) from 1988 to 2016. The sample includes all banks in Turkey: deposit banks, state-owned banks, privately-owned banks and foreign banks.

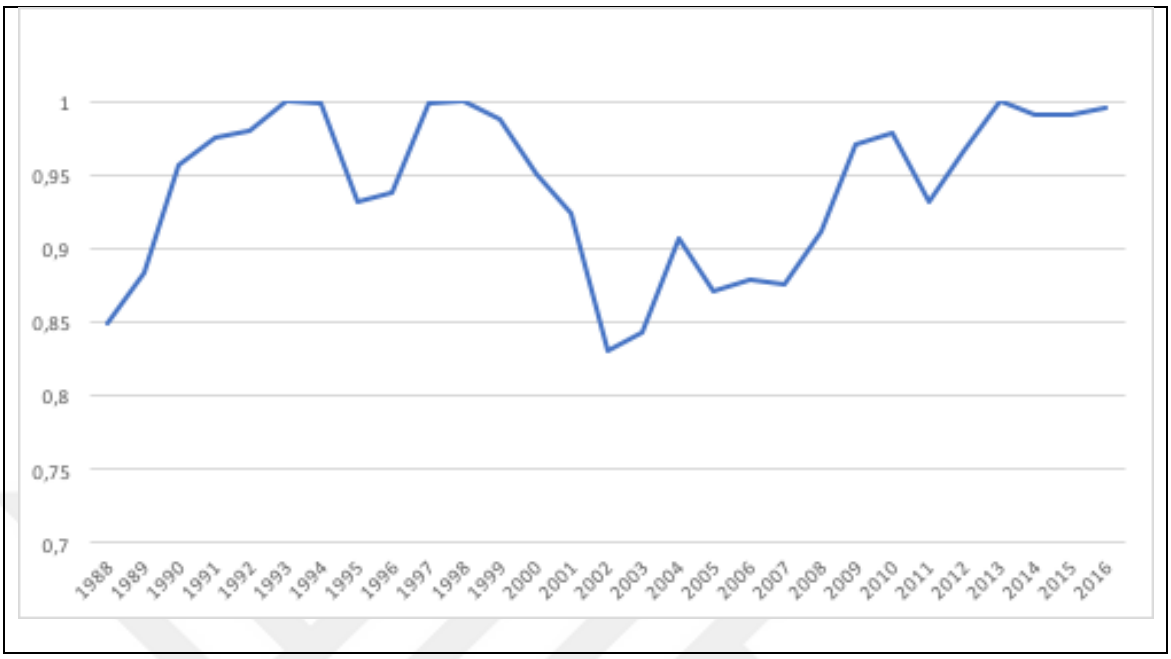
In table 2.11, the technical efficiency scores of Turkish Banking groups through the 1988-2016 period are given. We have four segments: deposit banks, foreign banks, privately-owned banks and state-owned banks in Turkey.

The mean values of all groups' efficiency scores are given in the bottom line of the table.

Table 3.9: Efficiency scores of Turkish banking groups

	Deposit Banks	Foreign Banks	Privately-owned Banks	State-owned Banks
Years				
1988	0.847	0.773	0.793	0.981
1989	0.796	0.963	0.839	0.935
1990	0.981	1.000	0.861	0.985
1991	0.993	1.000	0.906	1.000
1992	1.000	0.955	0.965	0.998
1993	1.000	1.000	1.000	1.000
1994	0.997	1.000	1.000	1.000
1995	0.932	0.863	0.931	1.000
1996	0.986	0.799	0.968	1.000
1997	0.997	1.000	1.000	1.000
1998	1.000	1.000	1.000	1.000
1999	1.000	1.000	0.952	1.000
2000	0.937	0.940	0.923	1.000
2001	1.000	0.694	1.000	1.000
2002	0.847	0.784	0.771	0.917
2003	0.799	0.927	0.706	0.941
2004	0.948	0.762	0.929	0.988
2005	0.907	0.722	0.963	0.890
2006	0.879	0.862	0.864	0.908
2007	0.879	0.900	0.835	0.890
2008	0.898	0.943	0.885	0.922
2009	1.000	0.883	1.000	1.000
2010	0.980	1.000	0.991	0.941
2011	0.931	0.889	0.909	1.000
2012	1.000	0.930	0.932	1.000
2013	1.000	1.000	1.000	1.000
2014	0.997	1.000	1.000	0.969
2015	1.000	1.000	1.000	0.965
2016	1.000	0.979	1.000	1.000

Figure 3.3: Estimation of overall efficiency scores over time

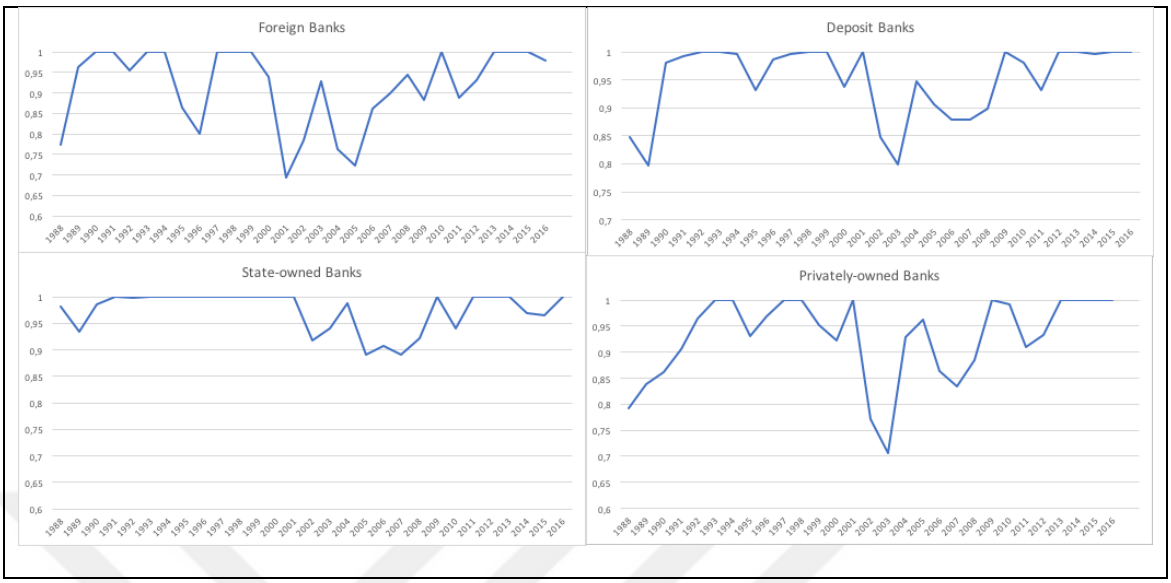


It should be noted that the mean technical efficiency scores seem to increase over time with a 0,80 to 1. Over the period given, Turkish banks increased their efficiency level from 0.85 to almost 1.

However, limiting the scope to overall efficiency scores might prove to be misleading since the given mean scores are the averages of the four bank types in Turkey. Some groups could show an increasing trend despite a decrease in other group, which appears as a neutralization and thus inaccurate results on overall scores.

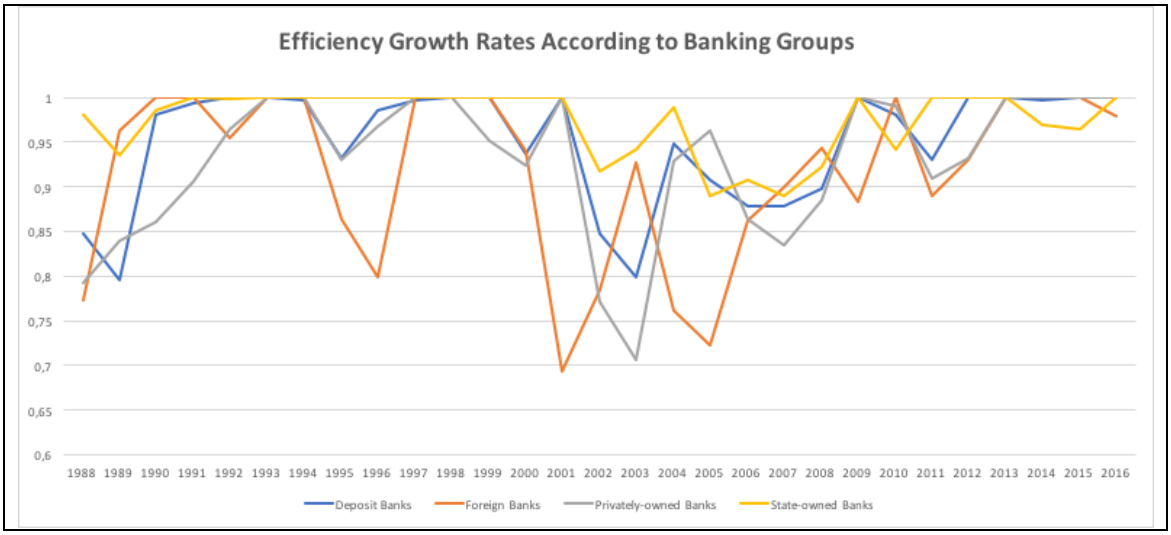
Analyzing the mean efficiency scores for each group of banks to compare relative changes in efficiencies would be beneficial in our study. These figures are the mean of the 4 groups of bank efficiency scores.

Figure 3.4: All groups efficiency charts



Having discussed the general trend of efficiency scores of Turkish banks, we can mention the fluctuations over the period of 1988 to 2016 instead of focusing on the overall changes in 29 years. Each efficiency score is calculated individually per year as the relative efficiency scores of banks.

Figure 3.5: Efficiency growth rates according to banking groups



We observe a sharp decrease in the mean efficiency scores from 1988 to 1990. These low efficiency levels for these periods were caused by the Turkish economy worsening

including the financial markets, which ultimately led to a crisis the year after. Some article shows that the crisis was not endogeneous to Turkey and that before it took place it evolved gradually and its influence continued afterwards. This improvement was also due to the injection of money by the Turkish government to bail out the banking sector after the crisis. (Işık and Hasan, 2002; Fukuyama and Matousek, 2011).

Despite the terrible impact of the 1991 economic crisis in Turkey on the banks, the analysis displays a surprising lack of effect on efficiency scores. In fact, our analysis shows that after the 1991 crisis the state-owned banks working fully efficiently between 1991 to 2001. Only the foreign banks founded in Turkey were affected after the crisis in 1996. They had the lowest efficiency scores in 1995 and 1996. However, it was found by several researchers that it was foreign banks that were the most efficient until 2001 (Kasman, 2002; Işık and Hasan, 2002; Aysan and Ceyhan, 2007). This makes sense when we take into account Mercan et al. (2003)'s finding that after 1996, foreign banks' performance began improving 1996. Therefore, it would follow that the analysis points to an that increased performance by foreign banks after 1996 until the 2001 crisis.

To recover forms the 2001 crisis, which lead to a devastating decrease in the banks' efficiency level, Turkey initiated the Banking Sector Restructuring Program on 15 May, 2001 for the creation of a healthy banking sector. The most notable aims of the program concerned; the rehabilitation and restructuring of the state banks followed by privatizing; the dissolution of the banks under the SDIF by any means possible such mergers, liquidation, sales or transfers; the establishment of a healthy private banking system; and finally reinforcing the structure for regulation and supervision and rendering the banking sector more efficient.

The efficiency scores in the analysis clearly show the effects of the financial restructuring program. After 2001, all banking groups are observed to have decreased efficiency. Mean efficiency scores decreased in 2002.

In 2002, private-owned banks experienced a sharp decrease in efficiency and then between 2002 and 2004 they display the lowest efficiency scores among all groups. The efficiency of other deposit banks, which worked full efficiently in 2001, decreased until 2009 after the crisis. Foreign banks exhibit inefficient performance in 2001 with a sharp

decrease. However, state-owned banks have the highest efficiency scores despite the 2001 crises in the sector.

According to the analysis, things were stable in Turkey and the banking sector between 2005 - 2008. This is also reflected in the efficiency scores of all bank groups with overall mean efficiency increasing in the sector.

In 2008, the global crisis had little impact on Turkish banking groups. We do not observe any efficiency decrease in banking groups in our chart table from 2007 to 2009. In 2009 also, some bank groups managed to achieve full efficiency level. Deposit banks, privately-owned banks and state-owned banks all scored 1 in terms of their efficiency level. The global financial crisis mostly affected foreign bank groups' efficiency scores in 2008 to 2009; i.e., foreign bank efficiency level was decreased while other groups' increased. On the other hand, in 2010, the foreign group had a mean efficiency score of 1 while others decreased. An interesting point to note here is that Turkish banks seem to have drastically different reactions to domestic crises than to global financial crises. Global financial crises have minimal effect on Turkish banks' efficiency scores while domestic crises efficiency scores are affected deeply in the all groups especially the foreign group.

This could be taken to mean that the Restructuring Program not to mention banks' effective risk management and the monitoring of the BRSA helped improved efficiency and made banks more immune to the detrimental effects of external shocks.

The past six years, efficiency scores show increased efficiency scores for all banking groups. Considering the fact that we took 0.90 to 1 as a good efficiency level, for this period, all groups are higher than 0.90 mean level. This is further proof that the Turkish banking sector was effectively working.

4. BRANCH EFFICIENCY WITH REGRESSION ANALYSIS

This chapter will examine some examples from the literature of studies carried out on branch efficiency around the world using regression analysis, followed by the data and methodology used in our analysis and will end with the results of the analysis.

4.1 LITERATURE REVIEW

In the literature, many studies examine branch efficiency by regression analysis scores on branch or bank specific, country specific, and environmental variables. Some commonly utilized models are Tobit, OLS, GMM, LAD or GLS. The basis for which model is selected is based on the data structure (Ipek, 2013).

Athanasios G. Noulas et al. (2008) estimate cost efficiency in branch banking by using some data from the 6 cities and 58 commercial bank branches in Greek. The aim of their study was to examine the bank in two steps: Step one is data envelopment analysis (DEA), which shows branch cost efficiency, and the second is the effect of size on the cost efficiency of the bank branches for the given period by using regression analysis. For the efficiency part in this study the input used were labor expenses, other operating expenses whereas the four outputs used were value of total deposits, financial products, loans and other types of loans. They found through the regression analysis that the branch size affects efficiency positively.

Wanke and Barros (2014) measured cost and product efficiency in Brazilian banks by using two-stage data envelopment analysis (DEA) and regression analysis in 2012. In the first stage, which was cost efficiency, the result showed that only 40 banks succeeded with 100% efficiency. Besides, in the second stage; i.e., product efficiency, the result was that none of the 40 banks achieved 100% efficiency. They compared cost and product efficiency using regression analysis. They set up four different hypotheses which focused on different decision making units for each calculation. H1 was that public ownership usually decreases costs. H2 was that foreign group ownership increases the cost and product efficiency in the banks. H3 was that bank mergers have a

positive effect on the banking efficiency level since it is reduced banking costs. H4 stated that bank size has a positive effect on efficiency.

Ariff and Can (2007) estimated cost and profit efficiency of 28 commercial Chinese banks during 1995-2004 using a non-parametric method and the second stage Tobit regression, which a commonly used for measuring branch efficiency. For the Tobit regression, they used ownership structure, size, credit risk, asset quality, capital risk, liquidity risk, profitability, operation cost, crisis dummy and WTO dummy, which means that banks deregulation long and recent years variables. The results showed that ownership structure is a very important variable for efficiency level in that state banks have the lowest efficiency and that medium sized banks are the most efficient. Most efficient banks are focused on fee based activities and usually these banks are more profitable. The other result was that reforms affected the banking market positively.

Drake and Howcroft (2002) investigated technical efficiency with the Tobit regression analysis to measure UK clearing bank branches categorized into two: pure technical and scale efficiency components, which can be found in Banker et al. (1984), and based on data envelopment analysis (DEA). The studied had 7 outputs which were the total number of counter transactions, lending account, deposit account, debits and standing items, clearing items, ancillary business and insurance products; 6 inputs which were number of branch interview rooms/dedicated sales areas, ATM, effective branch floor area, number of management grade staff, clerical grade staff and total branch stationery cost. Finally, when the author applied a non-parametric approach based on DEA, the result was that out of the sample of 190 branches, 107 branches (56.32%) were relatively inefficient. The second section is they categorized branch size group and focused on total lending size. The third section is Tobit regression analysis, as a result of which they found some important and interesting understanding of efficiency across the branch sample. The result was the existence of a negative relationship among all three measures of efficiency.

Pasiouras (2008) examined technical and scale efficiency of Greek commercial banks by using data envelopment analysis (DEA) and Tobit regression analysis over the period 2000 to 2004. The paper focused on five different models that were intermediation and profit oriented in a DEA context. The intermediation approach

models were; in Model 1 the inputs were fixed assets, customer deposit and short-term funding, number of employees and outputs were loans and other earning assets. Model 2's inputs were fixed assets, customer deposit and short-term funding, number of employees and the outputs were loans, other earning assets and off-balance items. The Model 3 inputs were fixed assets, customer deposit and short-term funding, number of employees and loan loss provisions and the outputs were loans and other earning assets. For the profit-oriented approach; The inputs for Model 4 were fixed assets, customer deposit and short-term funding, number of employees and loan loss provisions and the outputs were loans, other earning assets and off-balance items. The Model 5 inputs were employee expenses, other non-interest expenses and loan loss provisions, while the outputs were loans, net interest incomes, net commission income and other operating income. The second stage involved Tobit regression analysis in which they used two different combinations of factors on efficiency. The first analysis focused on variables related to financial characteristics: equity to assets, return on average assets, loan to assets and market power. The second analysis focused on banks' strategies and international operations, such as the number of ATMs and number of branches. The regression analysis results showed that balance sheet items in the outputs did not have an impact on the efficiency score, while loan loss provisions in the inputs resulted in a higher efficiency level. However, the profit-oriented model and intermediation model scores are both positively related to the efficiency measures by loan activity and market share. Also, the number of branches had a positive effect on bank efficiency while the number of ATMs had no effect on the efficiency level.

Giokas (2008) examined different efficiency model -operating efficiency- on a set of 171 retail bank branches using regression analysis. The focus of the study was on the effect of branch characteristics; i.e., profitability, size, market power and location, on operating efficiency. The findings of this were that more profitable and large branches have higher operating efficiency, while branches with more market power have lower efficiency. Also, location is a very important variable in terms of efficiency level: Branches in rural areas and on islands have significantly higher operating efficiency while those in urban areas have lower operating efficiency, as shown by their regression analysis.

Chang et al. (2011) investigated the efficiency of Taiwanese bank branches using data envelopment analysis (DEA) and Tobit regression analysis. Firstly, they focused on DEA approaches on the branch operating efficiency. The study sample consisted of three inputs: personal expenses, interest fees and incidental expenses, and six outputs: net profits, operating profit, interest gains, loans, deposits and non-performing loans ratio. The DEA model result showed that the non-performing loans ratio has a negative effect on the banking performance of individual branches. To improve branch operating efficiency, it is obviously important to reduce inputs and increase the output values. In this study they found input efficiency to be lower than output efficiency and finally, that personal expenses were the highest input variable. In the second part, the Tobit regression analysis focused on the market share of branches' deposits, branches employee numbers and geographical location. Geographical location is determined to urban and other location. Urban is denoted as 1, while other locations are 0. The results showed that branch operating performance improves with the deposit market share. Furthermore, the geographical location is negatively related to operating efficiency, and lastly, the number of employees is also negatively related with operating efficiency.

Tsolas and Giokas (2012), in their study utilizing least absolute deviations (LAD) technique as a known goal programming/constrained regression (GP/CR) and data envelopment analysis (DEA), analyzed 156 bank branches of Emporiki Bank in terms of urban vs. rural location for the period of 2001 to 2002. In this paper, the main goal was to compare the performance of the bank branches using transaction and production efficiency model. For each model they used inputs such as personnel costs, running costs, other operating costs, and deposit, loans and other transaction as outputs for this paper. The authors analysis two models; Model 1 for transaction efficiency and Model 2 for productive efficiency, with each model showing almost identical results.

4.2 DATA and METHODOLOGY

In the literature, many studies investigate branch efficiency using regression analysis that yields efficiency scores on branch-specific, country-specific and environmental variables, and so on. This study also used regression analysis in order to estimate the relationship between branch efficiency within different operational groups. Our sample includes 4 groups of branches and the total branch number is 593 over the period 2013-2016. The use of regression analysis makes sense as a method to compare the groups and investigate whether there are any group dynamics or trends.

In this section that I focused on two different models. In the first model is explain branch efficiency of relationship between all branches within operational groups. As potential determinants of branch efficiency, that I consider, number of personal, number of total customer and number of total product for the branch.

In the second model is explain the efficiency of all operational groups in branch. The second model was used number of personal, number of total customer, number of total product and dummy variable for branch operational group 1, 3 and 4. I included dummy variables for each operational group in order to investigate the effects of branch efficiency.

The data here was taken from one private bank, whose name has been kept as confidential, and the author signed a confidentiality agreement in exchange for the information. Since this type of information is not published on the Public Disclosure Platform, which publishes all of the financial information of banks, all of the data here related to the branches were obtained confidentially and for the first time in Turkey. Therefore, to our knowledge, this analysis is the first that has ever taken place in Turkey.

Table 4.1: Description of regression variables

Description of Regression Variables	
Variables	Description
Personnel Number	Number of personnel for each branch
Total Customer Number	Number of total customer for each branch
Total Product	Number of total product for each branch
Branch	A Dummy, 1 for 1 operational group and 0 for others *
	A Dummy, 1 for 3 operational group and 0 for others *
	A Dummy, 1 for 4 operational group and 0 for others *

The model formulated is:

Efficiency = output/input

For branch;

Output: Personal Cost, Operating Cost, NPL

Input: Non-interest Income, Interest income

The panel data regression would be expressed as formulated:

$$Y_{it} = \alpha + \beta X_{it} + u_{it} \quad \textbf{(4.1)}$$

$$i = 1,2,....N \quad \textbf{(4.2)}$$

$$t=1,2,.....,T \quad \textbf{(4.3)}$$

where i symbolize subjects as the cross-section dimension and *t* denotes time as the time series dimension. α is a scalar, β is K x 1 and X_{it} is the *it* th observation on K explanatory

variables. The error component model for the disturbances is represented by $u_{it} = \mu_i + v_{it}$ where μ_i denotes the unobservable individual specific effects over time and v_{it} denotes the remainder disturbance, μ_i is assumed to be identically and independently distributed , N (0, σ_μ^2 and is independent of v_{it} (Altıok, 2012).

In this studied the empirical test is concerned with the determinants of interest margin and efficiency of the one private bank branches.

The first model formulated is:

$$EFF1_{it} = \alpha_0 + \beta_1 PERSONEL\ NUMBER_{it} + \beta_2 TOTAL\ CUSTOMER\ NUMBER_{it} + \beta_3 TOTAL\ PRODUCT_{it} + \varepsilon_{it}$$

The second model formulated is:

$$EFF2_{it} = \alpha_0 + \beta_1 PERSONAL\ NUMBER_{it} + \beta_2 TOTAL\ CUSTOMER\ NUMBER_{it} + \beta_3 TOTAL\ PRODUCT_{it} + \beta_4 BRANCH1_{it} + \beta_5 BRANCH\ 3_{it} + \beta_6 BRANCH\ 4_{it} + \varepsilon_{it}$$

where,

EFF_{it} is the Efficiency of branch i at time t

$PERSONNEL\ NUMBER_{it}$ is the measure of how effect personal number branch efficiency for each branch i at time t

$TOTAL\ CUSTOMER\ NUMBER_{it}$ is the measure of customer number effect for each

branch efficiency i at time t

TOTAL PRODUCT$_{it}$ is the measure of total product number effect for each branch efficiency i at time t

BRANCH 1$_{it}$ is the measure of if one branch has one operational group that how effect for branch efficiency i at time t

BRANCH 3$_{it}$ is the measure of if one branch has three operational groups that how effect for branch efficiency i at time t

BRANCH 4$_{it}$ is the measure of if one branch has four operational groups that how effect for branch efficiency i at time t

β is a vector of parameters to be estimated, ε_{it} is the error term.

4.3 RESULT

I have analyzed the technical efficiency of some specific banks and Turkish banking groups in the previous section. Then in section two, I carried out regression analysis in order to estimate the relationship regarding branch efficiency among branches and among different operational groups. Our sample includes 4 groups of branches and the total branch number is 593 over the period of 2013-2016. The use of regression analysis lends itself well to comparing the groups and investigating whether there are any group dynamics or trends.

For this studied I obtained data from a private bank in return for a confidentiality agreement. Such information is not published found on the Public Disclosure Platform, so all of the data on the branches of this specific bank were obtained confidentially. This is the first time in Turkey that such an analysis has been carried out due to the relative inaccessibility of the information.

In the first regression analysis, we estimated branch efficiency within each operational group, as if it were a single branch, which meant that independent. As a result of this analysis, the number of products and the number of customers appeared as having a significant effect on the efficiency. The number of products and the number of customer served to decrease the efficiency level. On the other hand, the number of employees was not found to have a significant impact. However, staffing costs and other expenses affect efficiency negatively and are negatively proportional with efficiency.

Table 4.2: Regression analysis of branches

	Parameter Estimates			
Variables	Estimate	Standard Error	t Value	P >ItI
Personnel Number	0,4109559	0,416616	0,99	0,324
Total Product	**-0,0000571**	**0,000058**	**-0,99**	**0,324**
Total Customer Number	**-0,0000645**	**0,000079**	**-0,86**	**0,389**

The second analysis aimed to explore the effect of the operational group on branch efficiency. It was found that insignificant effect to branch efficiency of operational

group. If we took dummy variables, there to be two operational groups in a branch or three or even four, this did not have a significant impact on branch efficiency. Therefore, it cannot be said that the efficiency of a branch can be improved or decreased by opening or closing a section in a branch.

Table 4.3: Regression analysis of branches within operational groups

	Parameter Estimates			
Variables	Estimate	Standard Error	t Value	P >ItI
Personnel Number	294,5694	142,8505	2,06	0,039
Total Product	-0,1099075	0,0610369	-1,80	0,072
Total Customer Number	-0,2232695	0,06511	-3,43	0,001
Dummy Branch 1	**-1050,007**	**4581,742**	**-0,23**	**0,819**
Dummy Branch 3	**1198,055**	**2182,823**	**0,55**	**0,583**
Dummy Branch 4	**1290,499**	**2108,858**	**0,61**	**0,541**

5. CONCLUSION

This study aimed to analyze the long terms efficiency performance of the Turkish Banking system. We employed two DEA models and two regression data models in different periods.

The 3 inputs and 3 outputs DEA model was used in order to examine the efficiency scores of banks. The first DEA model was used on specific banks in 2011 to 2016, and the second DEA model was used to see the overall efficiency of bank groups during the period of 1988 to 2016. The sample includes all banks in Turkey: deposit banks, state-owned banks, privately-owned banks and foreign banks.

The regression analysis panel data model was used and efficiency measures were regressed on the branches of one private bank's variables such us total personal numbers, total number of products, total number of customers and operational groups dummies variables.

First of all, we investigated the efficiency of 19 Turkish specific banks in the recent years after grouping them according to their establishment type: 3 state-owned deposit banks, 7 privately-owned deposit banks and 8 foreign banks. Also, we observed the fluctuations in efficiency scores starting from 2011 until 2016. The second DEA analysis was more useful, the big picture help to us understand crisis period effect and after the crises period dynamics. This result can be leading in the sense that this instability before 2001 can be associated with the unstable structure of Turkish economy in terms of interest rate, regulations and growth rate, etc. In addition to second analysis shows that after restructure to banking sector and stable political and economic environment in Turkey explain why efficiency scores have been starting to common issue.

Important results my study; The section one, in last year that 9 banks were mean efficiency level 1 (Fibabanka A.Ş., Şekerbank T.A.Ş., Turkish Bank A.Ş., Türk Ekonomi Bankası A.Ş., Burganbank A.Ş., Deutsche Bank A.Ş., ING Bank A.Ş.,

Finansbank A.Ş.), 7 banks were 0.90 to 0.99 (Türkiye C. Ziraat Bankası A.Ş.,Türkiye Halk Bankası A.Ş.,Türkiye Vakıflar Bankası T.A.O., Türkiye İş Bankası A.Ş., Yapı ve Kredi Bankası A.Ş., Denizbank A.Ş., HSBC Bank A.Ş., Türkiye Garanti Bankası A.Ş.) and only 3 banks were under the 0.90 efficiency level (Akbank T.A.Ş.,Anadolubank A.Ş., Turkland Bank A.Ş.). The section two, overall efficiency score fluctuation started to 1988 to 2016. This analysis show that terrible impact of the 1991 economic crisis in Turkey on the banks, the analysis displays a surprising lack of effect on efficiency scores. After the 1991 crisis the state-owned banks working fully efficiently between 1991 to 2001. Only the foreign banks founded in Turkey were affected after the crisis in 1996. They had the lowest efficiency scores in 1995 and 1996.The 2001 economic crisis had major effects in Turkey, such as 1991 crises. Banking Sector Restructuring Program on 15 May, 2001 for the creation of a healthy banking sector. After 2001, all banking groups was observed to have decreased efficiency. Mean efficiency scores decreased in 2002. In 2002, private-owned banks experienced a sharp decrease in efficiency and then between 2002 and 2004 they display the lowest efficiency scores among all groups. The efficiency of other deposit banks, which worked full efficiently in 2001, decreased until 2009 after the crisis. Foreign banks exhibit inefficient performance in 2001 with a sharp decrease. However, state-owned banks have the highest efficiency scores despite the 2001 crises in the sector.

In 2008, the global crisis had little impact on Turkish banking groups. We do not observe any efficiency decrease in banking groups in our chart table from 2007 to 2009. The past six years, efficiency scores show that increased for all banking groups. Considering the fact that we took 0.90 to 1 as a good efficiency level, for this period, all groups are higher than 0.90 mean level. This is further proof that the Turkish banking sector was effectively working.

Last and I think important analysis is panel data regression analysis, our sample is taken one private banks that includes 4 operational groups of branches and the total branch number is 593 over the period of 2013-2016.

The use of regression analysis lends itself well to comparing the groups and investigating whether there are any group dynamics or trends.

I investigated two groups of regression analysis, as a result of first analysis, the number of products and the number of customers appeared as having a significant effect on the efficiency. The number of products and the number of customer served to decrease the efficiency level. On the other hand, the number of employees was not found to have a significant impact.

The second analysis aimed to explore the effect of the operational group on branch efficiency. If branch has more than one operational group it was not effect branch efficiency significantly.

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