

Evaluating the Technical Efficiency of Turkish Deposit Banks: An Application of DEA and Tobit Analysis

by

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ABSTRACT

This thesis investigates efficiency of Turkish Banks for the period of 2003-2010 by employing non-parametric DEA. Tobit regression is used as a second step to determine drivers of estimated efficiency scores. VRS efficiency scores have been interpreted for three separate sub-periods: 2003-2005 sub-period as “Contraction and Recovery”, 2005-2007 sub-period as “Growth and M&A”, and finally 2008-2010 sub-period as “Global Financial Crises and Its Complications”. State owned banks are found more efficient than other banks for the “Contraction and Recovery” sub-period. Foreign banks founded in Turkey have started to become more efficient after this period and most efficient group in “Growth and M&A” sub-period. However, efficiency of these banks decreases drastically with the effect of current global crises which we call “Global Financial Crises and its Complications”. As a second step, we used Tobit analysis to find out reasons behind efficiency scores. Capital adequacy ratio, income cost ratio, NPL ratio and branch ratio are significant for some period where liquidity, profitability and share in sector are not significant for none of periods.

Keywords: DEA, Tobit Regression, Bank Efficiency, Global Crises, M&A

ÖZET

Bu tezde 2003-2010 yılları arasında veri zarflama analizi kullanılarak Türk Bankalarının verimliliği ölçülmüştür. Tobit regresyon modeli kullanılarak bu verimliliklerin arkasındaki sebepler araştırılmıştır. Verimlilik skorları 3 dönem için ayrı ayrı yorumlanmıştır. Bu dönemler 2001 krizi sonrası toparlanma dönemi, 2005-2007 yılları arası büyüme, birleşme ve satın alma dönemi ve son olarak 2008-2010 yılları arası küresel finansal kriz ve komplikasyonları dönemi olarak sıralanabilir. 2001 krizi sonrası toparlanma dönemi için kamu bankalarının verimliliğinin yüksek olduğu gözlemlenmiştir. Büyüme döneminde ise Türkiye’de kurulmuş yabancı bankaların dışardan gelen yatırımların da etkisiyle yüksek etkinliğe ulaştığı gözlemlenmiştir. Son dönemde ise yabancı bankalar verimliliklerini düşürürken, kamu ve özel Türk bankaları küresel krizi daha az zararlarla kapatmıştır. Ölçülen verimlilik değerlerinin arkasındaki sebeplere baktığımızda, sermaye yeterlilik rasyosunun ve sorunlu krediler rasyosunun verimliliği ters yönde etkilediği gözlemlenmiştir. Likidite, karlılık ve sektör payının ise verimlilik üzerine önemli bir etkisi olmadığı sonucuna varılmıştır.

Anahtar Kelimeler: Veri zarflama Analizi, Tobit Regresyon, Banka Verimliliği, Küresel Kriz, Satın alma ve birleşmeler

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Introduction

Over the last decade, Turkish Banking Sector has been experienced major changes. 2001 crises, in particular, is a milestone for Turkish Banking because there has been many structural changes took place after the crises. First couple of years after crises became a recovery period for Turkish Banking Sector. Banking structuring process started with handling banks that have serious financial problem via Saving Deposit Insurance Fund (BAT, October 2009). Then capital structure of state owned banks were strengthened by injecting a considerable amount of money. Likewise, privately owned banks were strengthened via either injecting capital or allowing them to merge or be acquired by another bank. In parallel, there had been many legislative measures to improve supervision and audit system.

After all these measures, Turkish Banking Sector had started to gather strength and 2004-2006 years became very successful for Turkish Banking. There were many M&A activities took place and banks experienced healthy growth in this period. However, global financial crises put an end to this rosy picture and Turkish Banking Sector had started to have problematic days. This time, Turkish banking could handle crises with respect to its peers in emerging markets. After this period, Turkish banks started to grow again and outperformed their peers.

There are many turning points after 2000 for Turkish banking. There are two crises, two recovery processes and two growth process. We believe that it is important to see how Turkish banks respond to these changes in banking and economic environment. In order to do it, one needs to evaluate banks against their action. We need to understand why some banks grow very rapidly while of others have to deal with capital or liquidity problems. Turkey is a dynamic country where rapid changes occur most often and one needs to analyze these changes in order to digest the essence of Turkish banking.

We will be estimating efficiency score of Turkish Banks for the period of 2003-2010. Efficiency score is a clear indicator of bank success and enable us to understand which banks are more

successful and which are not. After efficiency analysis of banks we need to understand the reason behind these differences in success. Regression models will be used to understand which variables acts important roles in banking success. First of all, we will be giving literature review section that summarizes what happened in the literature for evaluating banks. Then before introducing data and methodology, we are going to mention what happened in Turkish Banking Industry. 2001 crises will be our starting point and 2010 will become our final analyze set date. In data and methodology section, we will be giving how we will be measuring the success of banks and which data will be used. Then we will be able to interpret result of our empirical study. Efficiency score will be given in detail and several explanations will be developed for this. Finally we will be finishing our thesis with giving a comprehensive conclusion section.

Literature Review

DEA applications have been applied by many authors to evaluate Turkish Banking sector. Oral and Yolalan (1990), measuring the operating efficiency and profitability of bank branches, find out that most profitable banks are the service-efficient bank branches and it has, together with profitability, significant effect on Turkish bank branches. Zaim (1995) investigated the effect of liberalization policies on the efficiency of Turkish commercial banks for the period of 1981 - 1990. Total number of employees, total interest expenditure, depreciation expenditure and expenditure on materials were used as inputs in Zaim's study. Four outputs are as following, total balance of demand deposits, total balance of time deposits, total balance of short-term loans and total balance of long-term loans. The study concludes that there has been observed positive effect of financial liberalization on both technical and allocative efficiencies of banks and state owned banks become more efficient than private banks. (State owned banks increased their efficiency score more than private ones during time)

Financial ratios, as a first time, were used by Yolalan (1996) to analyze the efficiency of Turkish commercial banks over the period 1988-1995. Inputs used in this study are non-performing loans/total assets, non-interest expenditure/total assets, outputs as (shareholders equity + net income)/total assets, net fees and commissions/total assets and liquid assets/total assets. Foreign

owned banks are more efficient banks according to the result, private banks follow foreign owned banks (as second most efficient) and state-owned banks are least efficient banks. Jackson and Fethi (2000) measure Turkish Banks technical efficiency for the year of 1998 using DEA and Tobit analysis. Results show that larger banks are more prone to operate at higher level of technical efficiency and capital adequacy ratio has a statistically significant adverse impact on the performance of Turkish Banks.

Denizer, Dinc and Tarimcilar (2000) examine the scale effect on efficiency by ownership over the period 1970 and 1994. Production and intermediation approaches have been adopted in this study and assumed that Turkish Banking system has a two-stage framework, as production stage and intermediation stage, in terms of banking operations. In the first stage, total own resources of the bank, total personnel expenses and the interest and the fees paid by the bank are used as inputs. Two outputs are produced by the DMUs at this stage which are total deposits and income from charges and commission collected. Second stage, intermediation, uses outputs of the first stage as inputs and leads total loans, banking related (interest and commission collected, and charges and commission for banking) as outputs. Results suggest that macroeconomic stability causes a severe scale problem in Turkish Banking system. Increasing macroeconomic stability has also been analyzed by Yildirim (2002) measuring the efficiency performance of Turkish Banking between 1988 and 1999. The empirical results show that there is a great variation in both pure technical efficiency and scale efficiency and instable macroeconomic conditions deteriorates well-being of banks causing efficiency scores to drop. Another conclusion of the study is, due to decreasing return to scale, scale inefficiency arises and an adverse effect on banking sector.

Isik and Hassan (2002), a well apperceived and inspiring study for this thesis, measure input and output efficiency of Turkish Banking sector adopting both non-parametric and parametric approaches. Aim of the study is to understand the impact of size, international variables, ownership, control and governance on profit, cost, allocative, technical, pure technical and scale efficiency measures. Their main finding is that dominant source of inefficiency in Turkish banking is stemmed from technical efficiency rather than allocative efficiency which are mainly attributed to diseconomies of scale. This study is the first that analyzes the profit efficiency of Turkish Banks.

Rangan *et al* (1988) used regression analysis to find out the variation in calculated efficiencies. The study captured a negative relationship between product diversity and efficiency, a positive relationship between bank size and efficiency. Aly *et al* (1990) put forward a positive relationship between urbanization and efficiency in addition to their consistent results with Rangan.

Regarding possible effect of foreign entry to Turkish Banking system, there are several studies worth to mention. According to Bonin *et al* (2005) and Levine (2001), improved corporate governance leads foreign banks to increase efficiency of banking sector. At this topic, Berger *et al* (2000) came up with a different result saying that while foreign banks are more efficient in developing countries, they are less efficient in developed countries. Aysan and Ceyhan (2007) used push and pull factors to investigate reasons behind foreign entry in Turkey. Turkey's location, its ever-growing population, increasing per capita income and EU accession process attract foreign banks to invest in Turkey.

Aysan *et al* (2011) used Panel Stochastic Frontier Approach to estimate efficiency and its relation to profitability of Turkish banks in the period of 2002-2007. This is the first study that uses Panel Stochastic Frontier Approach for banking efficiency in Turkey. Empirical findings suggest that domestic banks are more efficient than foreign banks and state banks, in particular, are more efficient within the group of domestic banks. Paper also finds no robust relation between efficiency and profitability. As an addition to relationship between efficiency and profitability, Abbasoglu *et al* (2007) also finds no significant relationship between efficiency and profitability.

Turkish Banking Industry

My thesis concerns for the period of 2003-2010. 2001 crises is out of scope in this thesis yet we will be starting to give how banking sector in Turkey has reshaped after 2001 crises and what happened after that.

Restructuring of the Banking Sector in Turkey

As end of 1999, the restructuring process in the banking system took place. Following disinflation programme, a comprehensive banking restructuring program had been implemented. Extensive amendments in the Banking Law primarily were completed (BAT, October 2009). The Banking Regulation and Supervision Authority (BRSA), started to operate in August 2000, was established as a regulatory and financial authority with administrative and financial autonomy in banking sector (BAT, October 2009). The Treasury and The Central Bank formerly were responsible for supervision and regulation of banks.

1- Banks Taken Under Saving Deposit Insurance Fund (SDIF): Starting point of banking restructuring process was to deal with banks facing with financial problems. Five commercial banks, at the end of 1999, were taken under SDIF control and also the banking licenses of two development and investment banks were cancelled. During the period of 1996-2003, 8 banks were liquidated. As of the end of July 2003, resources transferred to banks owned by SDIF reached around TL 40 billion (BAT, October 2009). Some banks were sold and the others were merged under the new establishment by SDIF called Birleşik Fon Bankası A.Ş. (United Fund Bank).

2- Restructuring of the state-owned banks: The capital structures of the state-owned banks were strengthened by injecting considerable amount of resources to these banks. The main reason behind weak financial structures of banks was their relations with Treasury. (It was because financial structures of these banks worsened by the Treasury that failed to repay its loans.) Political interventions, management weakness were some reasons for the Treasury using resources inefficiently. As a result, around TL 28.7 billion was transferred to the state-owned banks (BAT, October 2009). Merger activities and privatizations immediately took place.

3- Strengthening the capital of private banks: In addition to the state-owned banks, the private banks were having problems due to provisioning for non-performing loans and cutting loan supplies to the market by the state-owned banks during the restructuring process and meeting the capital adequacy requirements. Thus, as third measure, a program for reinforcement of the equity capital of private banks was adopted (BAT, October 2009). One bank was transferred to SDIF due to its shortage of capital. Costs generated by the restructuring in the private sector banks were split among SDIF and private sector banks.

4- Legislative measures: In order to improve supervision and audit systems, the legal and institutional regulations were enacted (BAT, October 2009). Risk taking and risk management processes also were subjected to change. International regulations, best practices and particularly the EU directives were adopted by the BRSA. For instance, transparency of balance sheets of banks increased. As of 2002, Turkey started to incorporate the infrastructural elements of new Basel Capital Accord (Basel-II)

5- The Financial Restructuring Programme: Real sector, non-bank sector, was also hurt due to the crisis in the economy in 2001. A program to restructure the companies' debt to the financial sector, named as "Istanbul approach", was implemented in June 2002. The aim of the program was to ensure manufacturing companies which were in financial stress to work in a productive way and boost real sector activities. The program was maintained for three years and a total of 331 companies benefited from the program.

Turkish Banking System in 2010

1- Number of Banks and Branches

Compared to 2009, number of Banks operating in Turkey as of 2010 remained the same at 45 including deposit banks, development banks and investment banks. With the addition of 4 participation banks, there are 49 banks in Turkey as of 2010.

Out of 49 banks, 32 banks are deposit banks where one bank is owned by The Saving Deposits Insurance Fund (SDIF). Remaining 31 deposit banks can be categorized as "State owned banks"

where there are only 3 banks, “Private Banks” where there are 11 banks and “Foreign Banks” where there are 17 banks operating.

Figure 1: Number of Bank Branches

	2002		2009		2010	
	Bank	Branch	Bank	Branch	Bank	Branch
Deposit banks	40	6,087	32	8,991	32	9,423
State-owned banks	3	2,019	3	2,530	3	2,744
Private banks	20	3,659	11	4,390	11	4,582
SDIF banks	2	203	1	1	1	1
Foreign banks	15	206	17	2,070	17	2,096
Development and investment banks	14	19	13	45	13	42
Total	54	6,106	45	9,036	45	9,465

Source: The Bank Association of Turkey

**Including branches in the Turkish Republic of Northern Cyprus and branches abroad*

With the help of growth momentum banks continued to expand their branch networks and create new employment. Number of branches in 2010 for deposit banks is 9,423 where it was 6,087 in 2002. CAGR of number of branches for deposit banks is 6% through 2002-2010 period. Foreign banks take the lead for growth of branch networks where number of branches increased to 2,096 from 206 in 2010. This corresponds a CAGR of 34%. Private and foreign banks continued to increase their number of branches with CAGR of 4% and 3% respectively. As for all banks, the population per branch was observed around 7,280 (BAT, October 2010).

2- Number of Employees

The number of employees in Turkish Banking System continued to increase as well as number of branches. As of 2010, there are 178,504 employees in total. Majority share of employees belong to deposit banks where there are 173,134 employees. This number was 118,329 in 2002.

Figure 2: Number of Employees

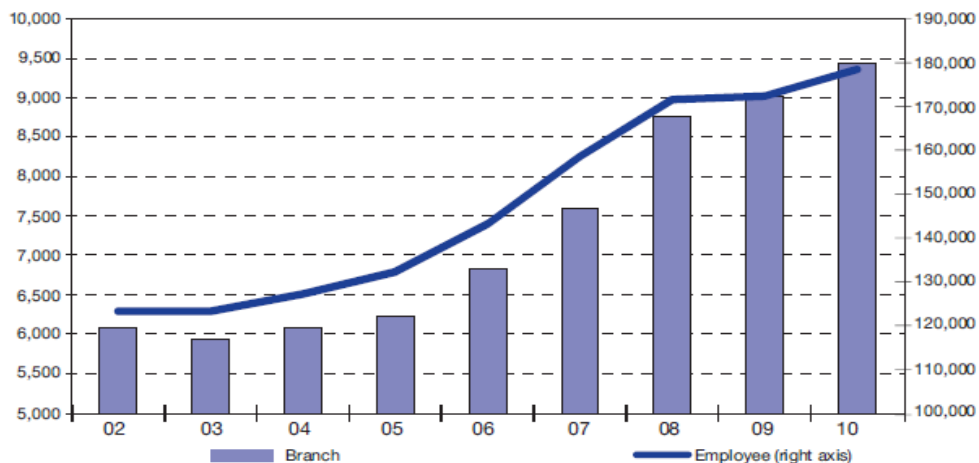
	2002	2009	2010
Deposit banks	118,329	167,064	173,134
State-owned banks	40,159	44,856	47,235
Private banks	66,869	82,271	83,633
SDIF banks	5,886	261	252
Foreign banks	5,416	39,676	42,014
Development and investment banks	4,942	5,339	5,370
Total	241,671	172,403	178,504

Source: The Banks Association of Turkey

Among the deposit banks, foreign banks are leading in terms of growth in number of employees with a CAGR of 29% through 2002-2010. State and private banks are not that aggressive in hiring new people with CAGR of 2% and 3% respectively. As of 2010, number of employees per bank in state owned banks are 15.700 where number of employees per bank in private banks are 7.600

As it is seen from Figure 3, there is a high correlation between number of branches and number of employees. That means opening new branches requires new people to employ and we can say that growth in banking industry in this period helped many people to find new jobs. Although 2007-2008 periods is global financial crisis period and Turkey was, more or less, affected adversely by this crisis, number of branches and number of employees continued to increase that shows how Turkish Banking Industry is growing strongly.

Figure 3: Number of Employees vs Number of Branches

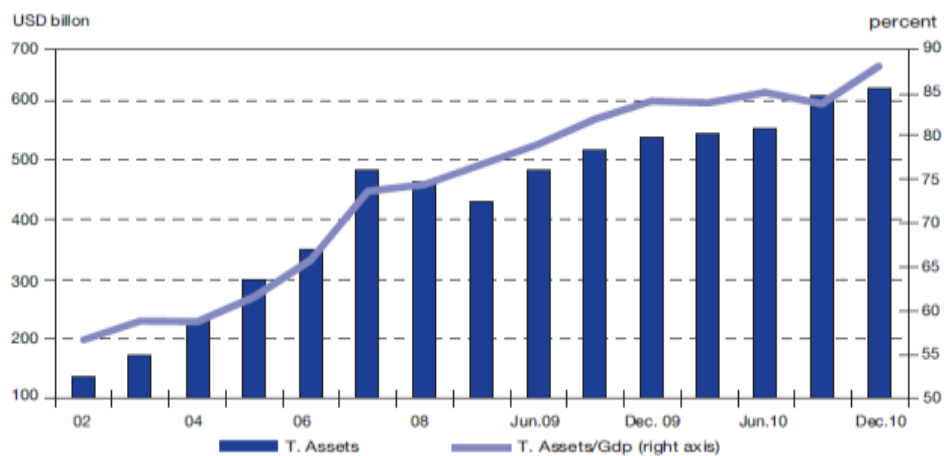


Source: The Bank Association of Turkey

3- Size of the Balance Sheet

Not only number of employees and branches increased in Turkish Banking Sector but also size of the balance sheets of Turkish Banks have showed a significant upward trend.

Figure 4: Total Assets and Total Assets GDP Ratio



Source: The Bank Association of Turkey

According to Figure 4, total assets in Turkish Banking System have increased with a CAGR of 22% by outperforming its emerging market peers. It is only seen a contraction in the size of Turkish Banking in the last decade of 2008 and early 2009. However, recovery process for banks in Turkey was fast for this period. More interesting and better result for Turkish Banking is that total asset to GDP ratio also increased significantly in 2002-2009 period. It is a well known fact that if a country grows then it is expected from that countries' banks to grow. In Turkey case, growth in Banking sector outperformed growth in GDP. This ratio continued to increase even in the global financial crises. As of 2010, size of the banks have almost reached GDP in Turkey and expected to exceed in 2015 (BRSA, 2010).

Figure 5: Balance Sheet Size

	TL million	USD million	Per. change (TL)	Per. change (USD)
Deposit banks	933,250	606,952	21	17
State-owned banks	299,378	194,705	19	15
Private banks	498,141	323,973	20	16
Foreign banks	135,730	88,274	26	22
Develop. and invest. banks	30,966	20,139	15	11
Total	964,216	627,092	20	17

Source: BRSA

Once again, the group of banks that shows fastest growth in terms of size of balance sheet is foreign banks with a growth rate of 26%. Growth rate of total assets for state owned banks and private banks are 19% and 20% respectively.

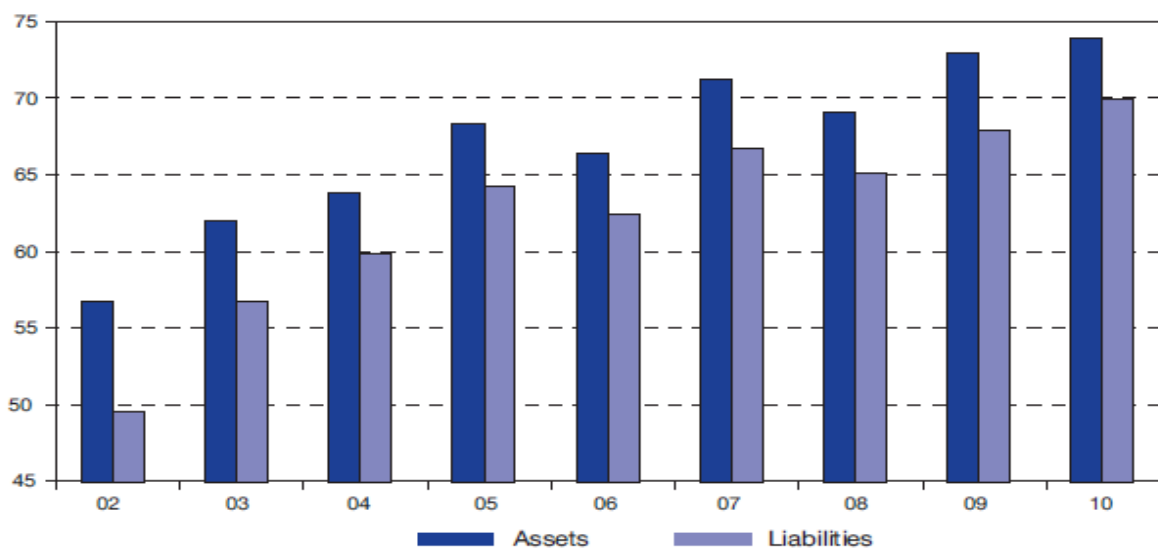
According to BRSA, “Depending on accelerated domestic demand and the fall in real interest rates, corporate customer demand for working capital and investments loans and the increased demand of retail customers for consumer loans” are the main drivers of growth in balance sheets of the banks. Even though deposits are still the main source of funding of banks in Turkey, there have been a significant improvement in ability to be able to borrow from international markets.

Also foreign creditors have increased their lending for project financing and all of these helped Turkish Banking System to more easily deepen its size and complexity.

4- Balance Sheet TL-FX Structure “FX Assets-FX Liabilities”

When we compare growth in TL items versus growth in foreign exchange items, TL items increased more rapidly than foreign exchange (growth 22% and 16% respectively). There is a strong demand for Turkish Lira in recent years and this causes TL to appreciate against other currencies. This appreciation might be one reason why TL items have increased faster than foreign exchange items.

Figure 6: Share of TL Items in Balance Sheet (2002-2010, percentage)



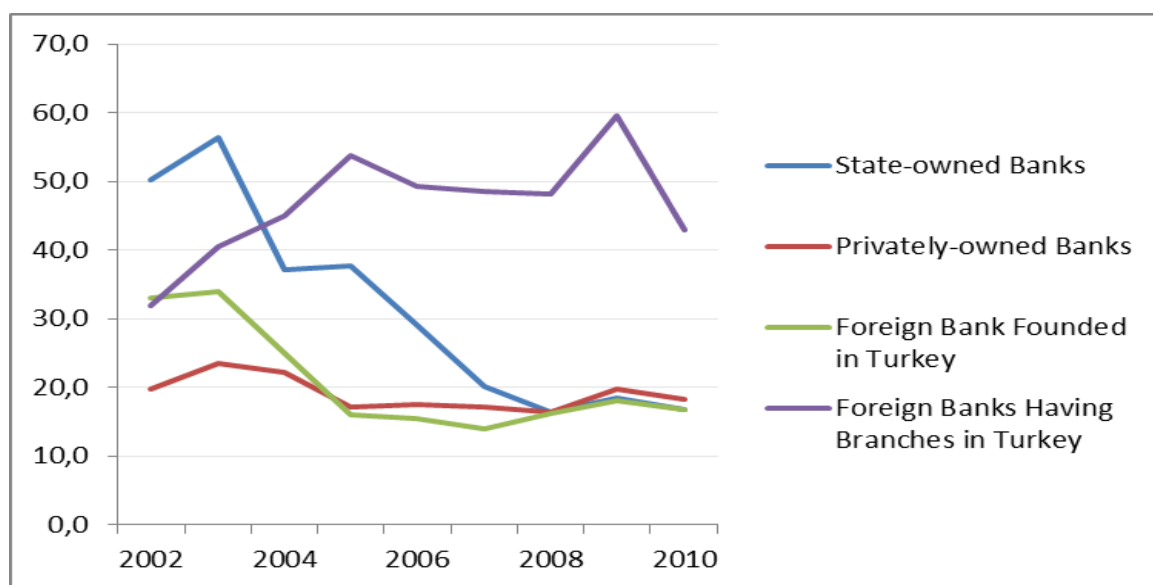
Source: The Bank Association of Turkey

TL-foreign exchange composition of banks shows great differences. For instance, state owned banks have a TL dominated balance sheet structure (80% belongs to TL items) where private banks have more balanced TL-foreign exchange composition (69% belongs to TL items) in their balance sheet. Similar differences can be seen in liabilities structure of banks. Share of TL liabilities for state owned banks is 79% where it is 66% for private banks.

5- Capital Structure

Capital adequacy ratio for deposit banks as of 2010 is 17.7%. State owned banks and privately owned banks have similar capital adequacy ratios with 16.7% and 18.2% respectively. However, foreign banks shows a different capital structure than other group of banks. Foreign banks having branches in Turkey, in particular, has a capital adequacy ratio of 43% where foreign banks founded in Turkey has a capital adequacy ratio of 16.8% which is very similar to average of Turkish Deposit Banking System. Therefore, it will be kept in mind that taking foreign banks as one group might be misleading since there are 2 groups within foreign banks (as founded in Turkey, having branches in Turkey) having very different characteristics.

Figure 7: Capital Adequacy Ratios (2002-2010, Percentage)

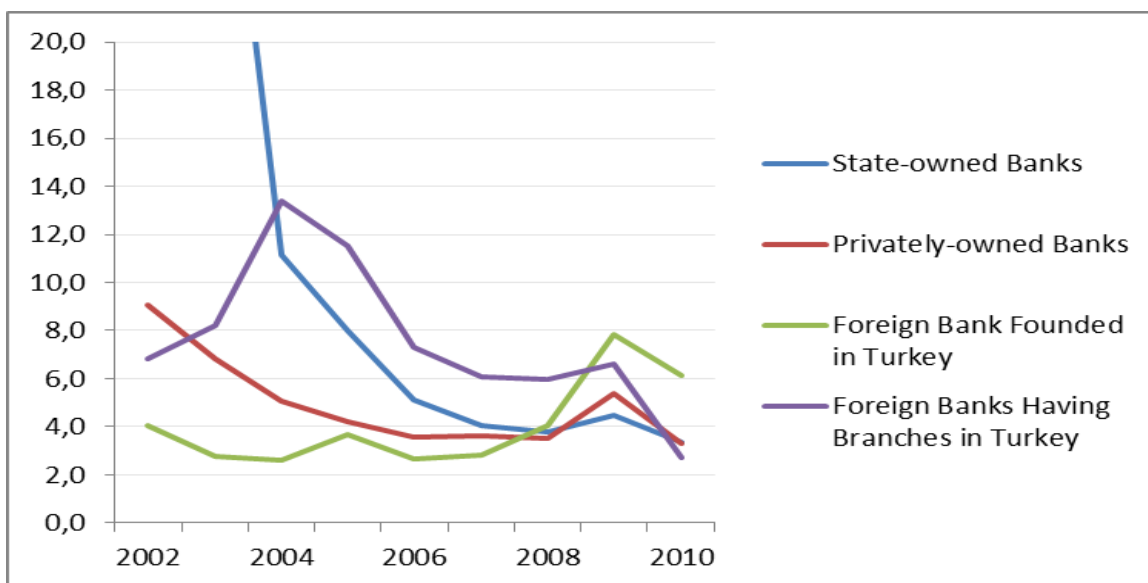


Source: The Bank Association of Turkey

6- Assets Quality

It is a well known fact that NPL ratio (non-performing loans) is one of important indicators of assets quality of banks. Since loans are main drivers of revenue for deposit banks, level of loans that do not come back to banks is very crucial for a balance sheet of bank. When we look at the ratio of loans under follow up within total loans and receivables, it is 3.8% for deposit banks as of 2010. This ratio is lower for state owned and privately owned banks (3.3% for both of group of banks). Foreign banks founded in Turkey shows a very different asset quality structure with a NPL ratio of 6.1% where this ratio is only 2.7% for foreign banks having branches in Turkey. This is another clear example why one should examine foreign banks under 2 different groups.

Figure 8: Non-Performing Loans Ratios (2002-2010, Percentage)



Source: The Bank Association of Turkey

7- Off-Balance Sheet Items

Off-balance sheet items have great importance for banks since it has become an driving source of revenue recently. As of 2010, the rate of increase in total off-balance sheet items is 67% which is

higher than increase in any ratio of banking system. Guaranties and warranties increased by 24% where commitments item outperformed other off-balance sheet items with a growth rate of 78%.

Figure 9: Off-Balance Sheet Items

	TL million	USD million	Per. change (TL) (USD)	
Off balance sheet items	887,450	577,166	67	61
Guaranties and warranties	142,126	92,434	24	20
Commitments	745,324	484,732	78	73
Derivatives	385,023	250,405	59	54
Other commitments	360,301	234,327	106	99

Source: BRSA

Under commitments, there are two sub-categories as derivatives and other commitments. Increase in commitments mainly stemmed from other commitments with a growth rate of 106% where derivatives grows at a rate of 59%. According to BAT, *“the increase in other commitments stemmed from accounting procedure of the opened up credit facilities' balances that were not actually extended yet”*.

Data and Methodology

There are many approaches that can be used to measure efficiency of banks. Stochastic Frontier Analysis (SFA), Distribution Free Approach (DFA), Thick Frontier Approach (TFA) and Data Envelopment Analysis (DEA) are some commonly used techniques of examining efficiency of banks. However, DEA is used in this study particularly for the following reason. DEA performs better when dealing with small samples which are the case in our study. For instance, we have only 23 commercial banks to analyze for 2010. As Maudos et al. (2002a) *“Of all the techniques for measuring efficiency, the one that requires the smallest number of observations is the non*

parametric and deterministic DEA, as parametric techniques specify a large number of parameters, making it necessary to have available a large number of observations.” (p. 511). In addition to having a small sample, one of the most important advantage of using DEA is its ability to capture the multiple characteristics of a bank where several inputs and outputs are used Jackson and Fethi (2000).

DEA is a mathematical programming approach that develops production frontiers and measures efficiency relative to these developed frontiers (Charnes et al., 1978). To construct the best-practice production frontier, a piecewise linear combination of actual input-output correspondence set is formed and this envelops the input-output correspondence of all decision making units (DMU) in the sample (Thanassoulis, 2001). DEA might be input oriented or output oriented. Input oriented approach tries to answer “*By how much can input quantities be proportionally reduced without changing the output quantities produced*” whereas output oriented model says “*By how much can output quantities be proportionally expanded without altering the input quantities used*” (Coelli et al, 1999). Important thing to notice here is that if CRS is used, two approaches will give the same result, they only differentiate under usage of VRS. However, Coelli et al (1999) states that suffering from statistical problems as simultaneous equation bias is not the case for a linear programming solution as it would be a problem in econometric orientation. CRS is appropriate to be used under the assumption that all firms are operating at an optimal level. Imperfect competition, constraint in finance may lead firms to operate at an inefficient level, therefore, VRS is used in this study as it would be a very restrictive assumption otherwise. Moreover Banker et al (1984) suggested Variable returns to scale (VRS) that is able to calculate technical efficiency (TE) free of scale efficient (SE) effects. Although there are decent studies adopting output oriented approach (e.g. Ataullah et al., 2004; Ataullah and Le, 2006) we will be using input oriented approach following most of the studies in banking.

One challenge of studying with DEA is that model assumes there is no measurement error in the data and is sensitive to outliers. Isik and Hassan (2002) omit observations that are considered as outliers. Same approach is used in this study.

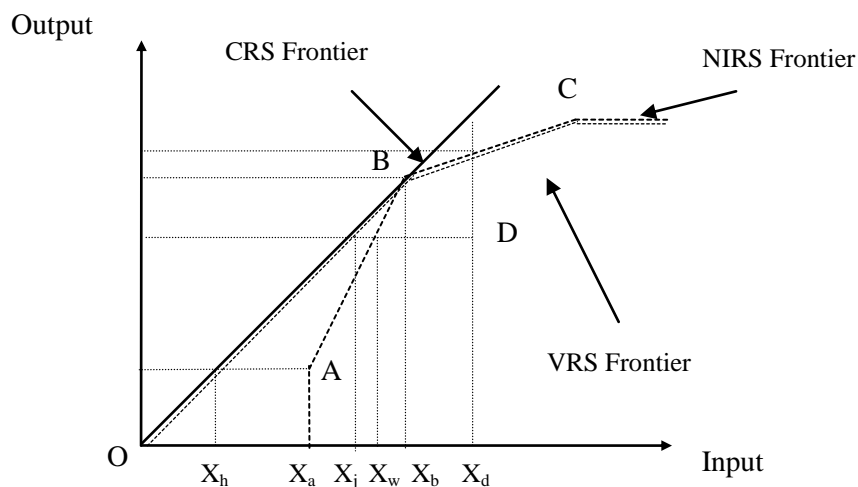
We used Tobit regression as a second step to DEA analysis to determine drivers of efficiency scores. Variable returns to scale (VRS) becomes independent variable and key ratios in banking become explanatory variables in the regression.

Fundamentals of Production Theory

Production function in microeconomics represents the relationships between inputs and outputs of a firm. It is a question of which combination of inputs give the same amount of outputs. These combinations increase the information about production and finally help how maximum amount of output can be attainable for a given set of inputs. Main aim here is to find best practice technology (frontier). Given technology and inputs, a frontier determines which set of outputs are feasible. In this feasible set, a firm may increase its profit by decreasing overall cost coming from inputs and not changing the ultimate outputs produced.

A firm may change its cost per unit by getting larger. For instance, if a bank increases its inputs by x times and increase in outputs is exactly x , then bank operates at Constant Return to Scale. If output increases more than x times, then it is Increase Return to scale. Contrary, it is Decrease Return to Scale if increase in outputs is less than increase in inputs. To see how implications of different scale assumptions change is shown in Figure 10. The line passing through origin represents the frontier under Constant Return to Scale assumption. Only B point becomes efficient under this assumption. The line in which X_a , A, B and C points form represents the frontier under Variable Return to Scale assumption. In this case, A, B and C points become efficient.

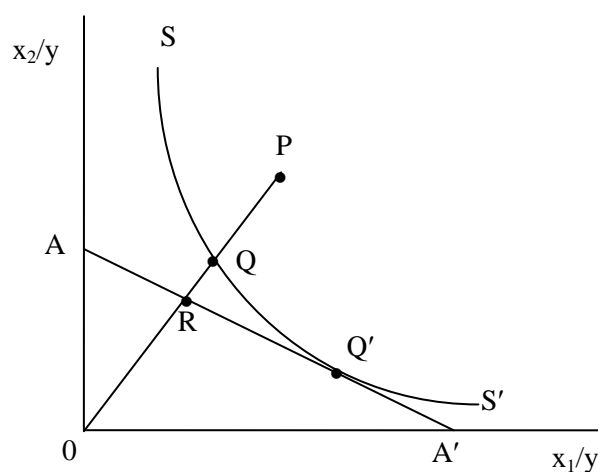
Figure 10: Graphical Representation of Economies of Scale



Source: Murillo (2004)

Battese, Coelli and Rao (1998, 5) explain the difference between efficiency and productivity. Being technically efficient does not imply being productive. This is the basis of Malmquist indices. Productivity is defined as ratio of outputs to inputs. Contrary to productivity, efficiency is introduced as a first time by Farrell (1957), as technical and allocative efficiency form overall economic efficiency by using single input and output.

Figure 11: Farrell's Input-Oriented Model



Source: Battese, Coelli and Rao (1998, 135) adapted from Farrell (1957, 254)

Nonparametric Efficiency Measurement: Data Envelopment Analysis

To deal with multiple inputs and multiple outputs, Charnes, Cooper and Rhodes (1978) came up with their famous CCR model that transforms Farrell's efficiency measurement into a linear programming (Seiford and Thrall, 1990). The linear model can be expressed for CCR model as following:

$$\text{Max } \Phi = \frac{\sum_{r=1}^{r=s} U_r Y_{ro}}{\sum_{i=1}^{i=m} V_i X_{io}} \quad (\text{x.1})$$

Subject to:

$$\Phi = \frac{\sum_{r=1}^s U_r Y_{ri}}{\sum_{i=1}^m V_i X_{ij}} \leq 1 \quad \text{where } U_r \geq 0, r=1, \dots, s$$

$$V_i \geq 0, i=1, \dots, m \quad (\text{x.2})$$

where:

o: A specific DMU to be evaluated

U_r : Weights of output r

V_i : Weights of input i

r: Number of outputs

i: Number of inputs

Φ : Efficiency score

X_{ij} : Amount of input i from DMU j

Y_{ri} : Amount of output r from DMU i

Objective function (Φ) maximizes efficiency scores of DMUs with a limitation that efficiency score must be in a compact set [0, 1]. This approach is called input-oriented efficiency measurement since it aims to maximize output. Output-oriented approach is the dual form of this model that can be expressed as following:

vector of inputs ($X_{ij} = X_{i1}, \dots, X_{ij}$) to produce r-vector of outputs ($Y_{ri} = Y_{r1}, \dots, Y_{ri}$).

$$\text{Min } \theta = \Phi_0 \quad (3.3)$$

Subject to:

$$\sum_{j=1}^n x_j y_{rj} \geq y_{r0}, r=1,2,\dots,s$$

$$\Phi_0 x_{i0} - \sum_{j=1}^n \lambda_j x_{ij} \geq 0, i=1,2,\dots,m$$

(3.4)

$$\lambda_j \geq 0, j=1,2,\dots,n$$

where : Φ_0 is the efficiency score for a particular DMU.

We have given two models so far and these models give Constant Return to Scale efficiency scores. To be able to interpret these scores, a restrictive assumption should be done which is all banks operate at an optimal scale. However Banker, Charnes and Cooper (1984) came up with a new assumption that relaxes the CRS assumption. This new Variable to scale (VRS) assumption puts $\sum_{j=1}^n \lambda_j = 1$ into the DEA model. Difference of this assumption from CRS is frontier is not restricted to pass through origin (Ali, 1994). Ray and Desli (1997) agree with this correction that CRS assumption might be misleading. Variations in market power, constraints on finance, externalities and imperfect competition are some examples that might cause technical efficiency to be measured in a wrong way. In our study, we consider these warnings and use VRS scores to measure efficiency. The resulting linear programming problem is expressed as:

$$\text{Min } \theta = \Phi_0 \tag{3.5}$$

Subject to:

$$\sum_{j=1}^n \lambda_j x_{ij} + s_i^- = \Phi_0 x_{i0}, j=1,\dots,n \tag{3.6}$$

$$\sum_{j=1}^n x_j y_{rj} - s_i^+ = y_{r0}, \quad r=1,2,\dots,s \quad (3.7)$$

$$\sum_{j=1}^n \lambda_j = 1, \quad \lambda_j, s_i^-, s_i^+ \geq 0 \quad (3.8)$$

X_{ij}: Amount of input i from DMU j

Y_{ri}: Amount of output r from DMU i

Φ: Efficiency score

S_i^- or S_i^+ : Negative and positive slacks respectively

For the identification of returns to scale:

$$\sum_{j=1}^n \lambda_j < 1, \quad \text{implies increasing return to scale (IRS) whereas,}$$

$$\sum_{j=1}^n \lambda_j > 1, \quad \text{implies decreasing returns to scale (DRS).}$$

Parametric Efficiency Measurement: Stochastic Frontier Analysis

Stochastic Frontier Analysis is another approach to measure efficiency. Rather than linear programming, SFA is a regression based model which relies on two functions; Production function and Stochastic function. Cobb-Douglas production form, introduced by Farrell's, becomes very crucial for Stochastic Frontier Analysis by computing parametric convex hull. We will not be giving many details about SFA since we did not use this technique in our analysis.

However, it is important to understand main differences between two models. Olgu (2006) gives a good comparison of two models with following table:

Table 1: Characteristic Comparison of DEA and Regression Models

	SFA	DEA
Assumptions on production frontier	strong	none
Test assumptions about frontier	yes	no
Assumptions about error terms	strong	none
Test distributional assumptions	yes	no
Test for inclusion of variables	yes	no
Allow for environmental variables	yes	yes
Multicollinearity problems	yes	no
Allow for multiple inputs/outputs	yes	yes
Provide information on peers	no	yes
Vulnerable to small number of observations	yes	moderately
Vulnerable to endogeneity bias	yes	yes
Test for endogeneity bias	yes	no

Source: Olgu (2006)

Data and Variables

Turkish Banking System consists of deposit banks, development and investment banks. There is a domination of commercial banks having 96.8% of total assets in the banking system as of 2010. We excluded development and investment banks in this study due to its relatively small size, immaturity of this sector in Turkey and having a different business structure (Isik and Hassan ,2002).Commercial banks consists of state-owned banks, privately-owned banks and foreign

banks which might be further classified as founded in Turkey and having branches in Turkey. As of 2010, 3 state-owned banks, 11 privately owned banks, 11 foreign banks founded in Turkey and 6 foreign banks having branch in Turkey are operating. Since they form only a negligible portion of banking system and show no upward trend during last 10 years, we also excluded banks having branch in Turkey. At first glance, foreign banks founded in Turkey seem small as size, however their share in the sector has been considerably increased during the last year. Therefore we did not exclude those banks in the analysis.

Table 2: Share in Sector (Asset Size)

Share in Sector, %	Total Assets							
	2010	2009	2008	2007	2006	2005	2004	2003
Banking System in Turkey	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Deposit Banks	96.8	96.6	96.8	96.6	96.8	96.8	96.3	95.9
State-owned Banks	31.0	31.3	29.4	29.2	29.6	31.4	34.9	33.3
Privately-owned Banks	51.6	51.8	52.4	52.3	54.8	59.7	57.4	57.0
Foreign Banks	14.1	13.5	14.8	15.0	12.2	5.2	3.4	2.8
Foreign Bank Founded in Turkey	13.5	13.1	14.4	14.5	11.7	4.7	2.8	1.8
Foreign Banks Having Branches in Turkey	0.6	0.3	0.5	0.5	0.5	0.6	0.6	1.0
Development and Investment Banks	3.2	3.4	3.2	3.4	3.2	3.2	3.7	4.1
State-owned Banks	1.8	2.0	1.8	1.9	2.0	2.0	2.6	3.0
Privately-owned Banks	1.2	1.2	1.2	1.2	1.0	1.1	1.0	0.9
Foreign Banks	0.2	0.2	0.3	0.3	0.2	0.2	0.1	0.2

Note: Banks under Deposit Insurance Fund consists only 0.1% of total assets so not shown in the table.

Source: Bank Association of Turkey

The sample ranges from 2003 to 2010 for the following reason. It is not aimed to see effect of 2001 crises in this thesis rather it is important to be able to capture effect of global financial crises intensified in 2008 on Turkish Banking System. Sample is collected from balance sheets of banks that are yearly reported.

Only thing left to be specified for our analysis is which outputs and inputs are used to execute DEA and what approach is to be adopted. There is a still disagreement in the banking literature regarding the proper definition of outputs and inputs. Two leading approaches are the “production approach” and the “intermediation approach” (Berger and Humphrey, 1997). In the production approach, banks use labor and capital as inputs in order to produce loan and deposits. On the

other hand, intermediation approach perceives banks as financial intermediates that collect funds and use labor to produce loan and other assets. According to Berger and Humphrey (1997), none of these approaches are sufficient to capture the dual role of financial institutions. To evaluate the efficiency of bank branches, production approach might be preferred which is not the case in our analysis that requires an overall evaluation of financial system that favors intermediation approach to be used. As a recent study, Drake et al. (2006) used the profit oriented approach and find out that profit oriented approach is better at analyzing strategic responses of financial firms under the circumstances of dynamic changes.

Inputs selected for DEA analysis are as following: (1) Total number of full time employees (Labor), (2) Total Deposits (Funds) and (3) Total Fixed Assets (Capital). Table 3 shows the definitions of these variables. Selection of input variables is relatively easier than selection of outputs. Because deposits are the main source of commercial banks and there is a general consensus in the literature for usage of number of employees and total fixed assets as labor and capital respectively.

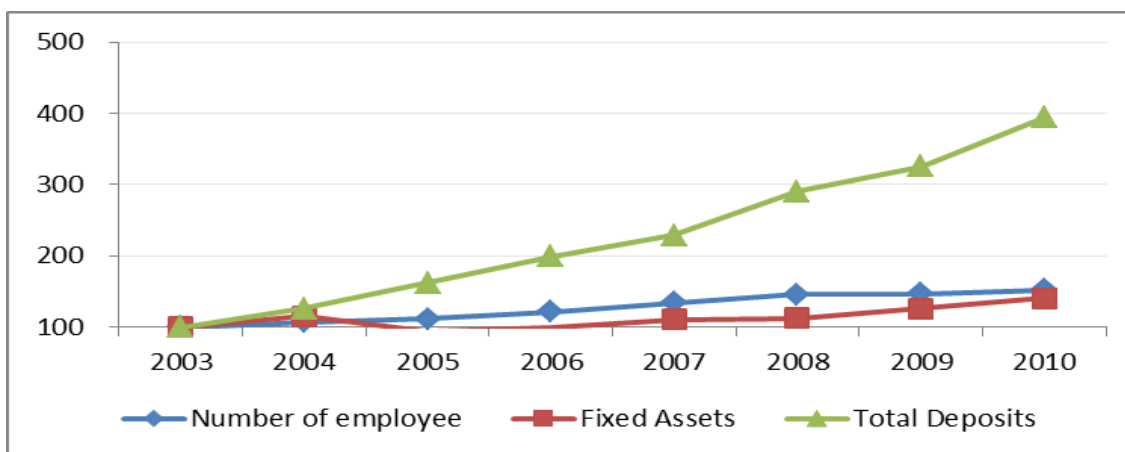
Table 3: Input Variable Definitions

Variable	Definition
Deposits	Sum of deposits (Time and Demand)
Number of Employee	Total number of full time employee
Fixed Assets	Value of physical capital after depreciation deducted.

Figure 12 represents the change in input values. We normalized values in 2003 to 100 so that relative changes in input variables have seen clearly. Total deposits, clearly, has shown an upward trend with a CAGR of 22% which have become the main source of Turkish commercial banks for lending activity. Fixed assets and number of employee, with CAGR of 5% and 6%

respectively, have been increasing but not as much as increase in deposits. This is expected in the sense that these two variables are not the main source of banking business.

Figure 12: Change in input variables through 2003-2010



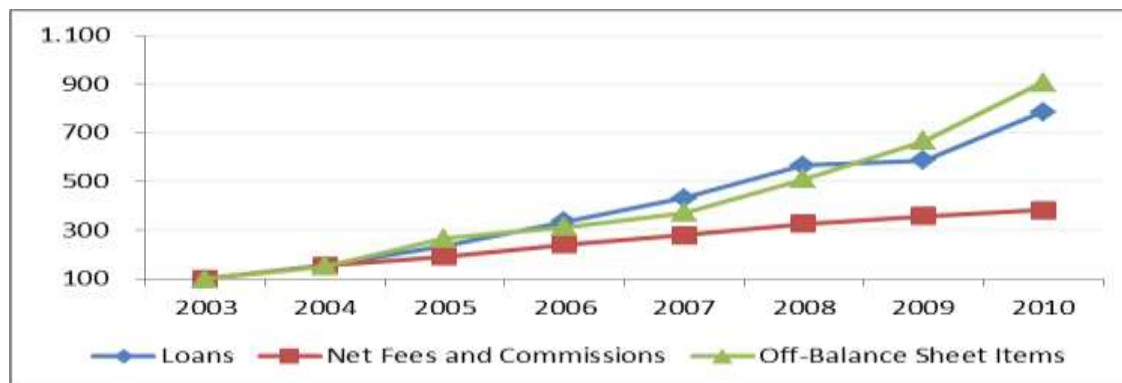
Outputs selected for DEA analysis are as following: (1) Total Loans, (2) Off-Balance Sheet Items and (3) Net Fees and Commissions. More detailed information is given in table 4. Including loans as output variable is straightforward since it is one of the main goals of Turkish commercial banks.

Table 4: Output Variable Definitions

Variable	Definition
Loans	Loans + Loans Under Follow-up (gross) - Specific Provisions
Off-Balance Sheet Items	Guarantees and warranties (letters of guarantee, bank acceptance, letters of credit, guaranteed pre-financing, endorsements and others), commitments, foreign exchange and interest rate derivatives (e.g., forwards, swaps)
Net Fees and Commission	Fees and Commissions provided from all sort of bank services

Change in output values can be seen in Figure 13. It has been observed that output variables have performed better with respect to input ones. Loans, main driver behind a banks' income, shows a CAGR of 34% and off-balance sheet items and net fees and commission accompany with CAGR of 37% and 21% respectively. To sum up, from raw data, it seems banks could create more outputs than inputs used which might be interpreted as efficiency increased. However, only DEA analysis can enable us to make such comments.

Figure 13: Change in output variables through 2003-2010



For Tobit regression, we used 8 key ratios that are commonly accepted ratios determining a banks' performance. Capital adequacy ratio is used for capital ratios and NPL ratio is used for asset quality. In table 5, you can see definitions of ratios that have been used in Tobit regression.

Table 5: Key Ratios and Definitions

Ratio	Label	Definition
Capital Ratios	V_1	Shareholders' Equity / (Amount Subject to Credit Risk + Market Risk + Operational Risk)
Asset Quality	V_2	Loans under follow-up (gross) / Total Loans and Receivables*
Liquidity	V_3	Liquid Assets / Total Assets
Profitability	V_4	Net Profit (Losses) / Total Assets
Income-Cost	V_5	Total Income / Total Expense
Income-Cost-2	V_6	Non-Interest Income (Net) / Total Assets
Share-in-sector	V_7	Total Assets
Branch Ratios	V_8	Total Employees / No. of Branches (person)

Source: Bank Association of Turkey

Considering small number of observations in our sample, we divided explanatory variables into two groups. Thus we regressed efficiency scores two times to two different set of variables. Capital adequacy ratio, NPL ratio, liquidity and profitability are characterized as first group because these variables could be defined as strategy related ratios and KPIs, Income-Cost ratios, share-in sector and Branch ratios formed second group as more operation related ratios. For any regression, it is important for explanatory variables having as low as correlations with other explanatory variables. Highly correlated variables in the same regression creates multicollinearity problem and would deteriorate results and of the regression (Gujarati, 1990). Therefore, correlation matrix showing relationships between these 8 variables in Table 6 and 7 has been constructed.

Table 6: Correlation Matrix – First 4 Variables

	V_1	V_2	V_3	V_4
V_1	1			
V_2	-0.367216229	1		
V_3	0.784861282	0.013261381	1	
V_4	-0.309600853	-0.097887109	-0.328603244	1

Note: Data in 2010 is used to calculate correlation values

Table 7: Correlation Matrix – Second 4 Variables

	V_5	V_6	V_7	V_8
V_5	1			
V_6	0.28154148	1		
V_7	0.605487088	0.040171675	1	
V_8	-0.26911105	0.055387061	-0.252525851	1

Note: Data in 2010 is used to calculate correlation values

As correlation matrices shows, there is no strong relationships between any variables except capital adequacy ratio and liquidity. However, this type of grouping is one of the best combinations that give lowest correlation.

Empirical Results

We examined Turkish deposit banking performance in terms of its capability to produce maximum output with minimum input. DEA analysis gives us two efficiency scores namely; Variable Return to Scale and Constant Return to Scale. It is explained why we interpreted VRS scores instead of CRS scores in the data and methodology section. Evaluation of VRS and CRS scores enable us to know which banks are experiencing Decreasing Return to Scale, Constant Return to Scale or Increasing Return to Scale. After determination of banks' scale, factors that

affect banking efficiency scores will be investigated. Tobit analysis will be used to extract reasons behind banking inefficiency.

In table 8, VRS efficiency scores of Turkish Deposit banks through 2003-2010 periods are given. We have three sub-segments under deposit banks which are state owned banks, privately owned banks and foreign banks founded in Turkey. Mean values of all deposit banks' efficiency scores are given in the bottom line of the table. In each year, we marked the group having highest efficiency scores and lowest efficiency table. For instance, in 2010, State owned banks are the most efficient bank group with a score of 0.95 while foreign banks founded in Turkey being least efficient with a score of 0.89. Mean is observed at 0.92.

Table 8: VRS Efficiency Scores

VRS Efficiency Scores	2003	2004	2005	2006	2007	2008	2009	2010
State Owned Banks	1.00	1.00	0.93	0.83	0.86	0.98	0.98	0.95
Privately Owned Banks	0.94	0.93	0.89	0.90	0.91	0.93	0.94	0.93
Foreign Banks Founded in Turkey	0.99	0.97	0.96	0.96	0.91	0.96	0.93	0.89
Deposit Banks	0.94	0.96	0.92	0.92	0.90	0.95	0.94	0.92

When we look at the general trend of efficiency scores of deposit banks, there is no increasing or decreasing trend over 2003-2010. Mean of efficiency scores of Turkish Deposit Banks are observed at 0.92 while it was 0.94 in 2003. Mean value fluctuates between 0.90 and 0.96 over this period. Therefore we cannot conclude whether there is an increase or decrease in overall efficiency in Turkish Banking. However, efficiency scores are differentiating in the level of different ownership. Furthermore while some groups of banks are more efficient for specific periods, those become least efficient for another period. This leads us, in our analysis, to divide 2003-2010 periods to sub-periods to better interpret efficiency scores and reasons behind those. As similar to Aysan (2011)' method, sub-periods are 2003-2005 as "*Contraction and Recovery*" sub-period, 2005-2007 period as "*Growth and M&A*" sub-period and finally 2008-2010 as "*Global Financial Crises and Its Complications*" sub-period.

2003-2005 Sub-Period: Contraction and Recovery

As a first impression from efficiency scores, state owned banks are fully efficient in 2003 and 2004 that makes them most efficient banks group in those years. This finding is in line with **Aysan (2011)**'s results. Moreover, one possible and reasonable explanation for that, state owned banks were supported by the government after 2001 crises. We explained in the Turkish Banking Sector Section that capital structure of state owned banks were strengthened by injecting considerable amount of resources to these banks. According to BAT, around TL 28.7 billion was transferred to these banks. **Matousek et al (2008)** also find out that restructuring programme, started in 2001, converted state owned banks into more efficient banks. In Figure 14 and 15, capital adequacy ratio and liquidity ratio of these banks are shown. These two key ratios are very important to see how a banks well-being after undergoing a financial crises.

Figure 14: Capital Adequacy Ratio

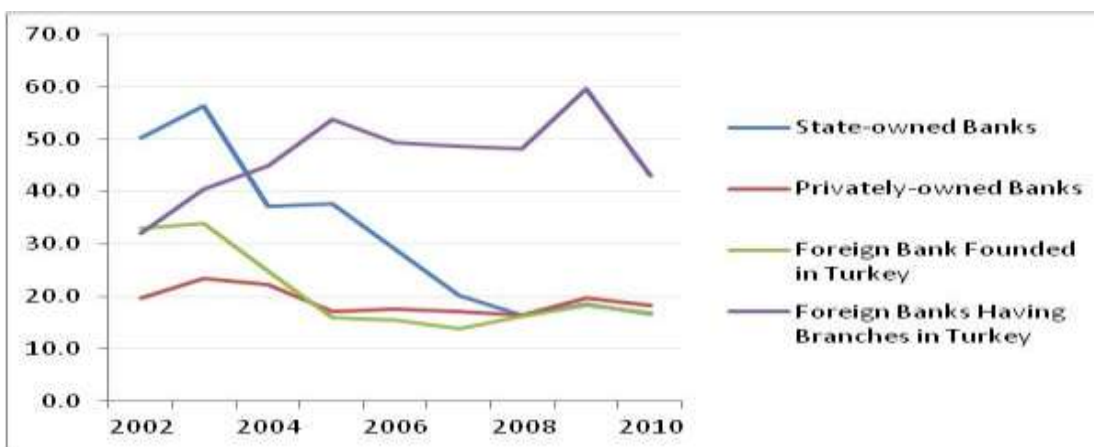
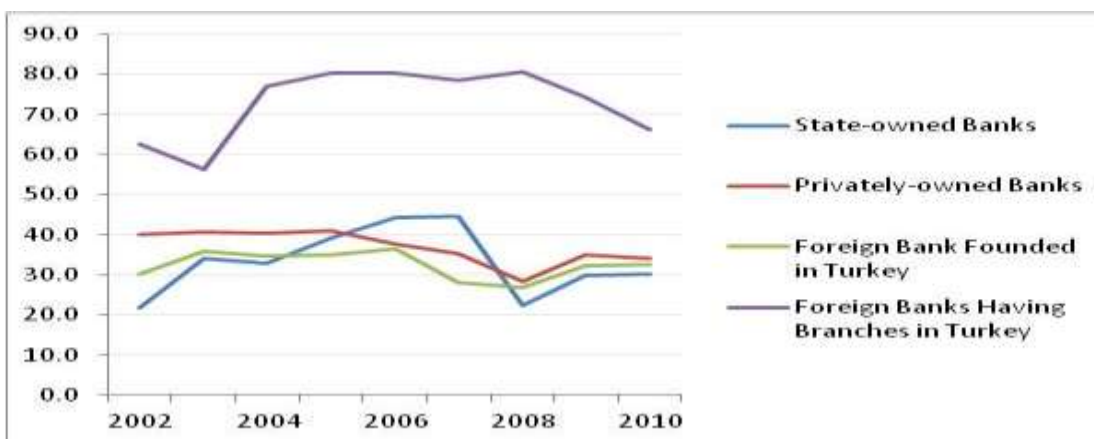


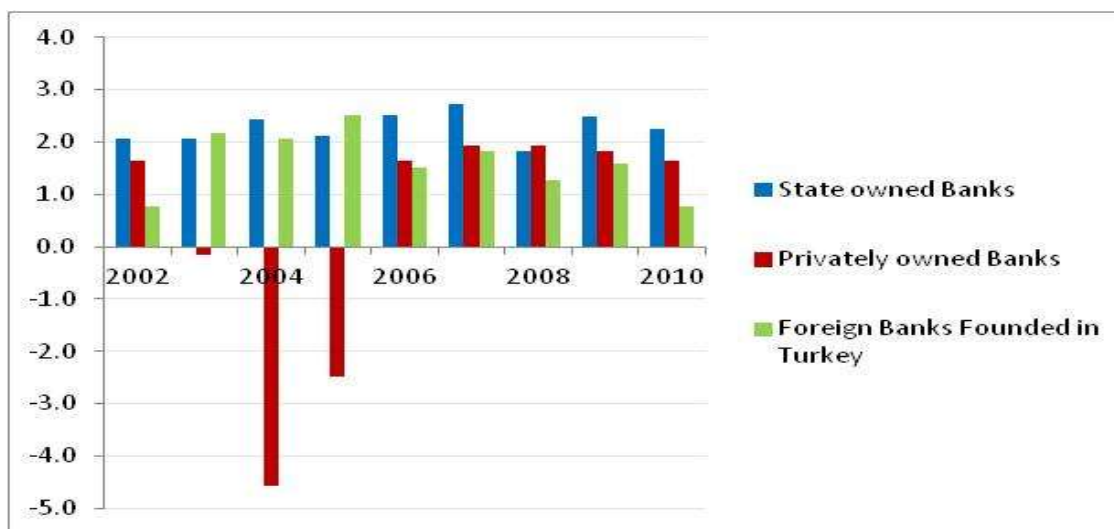
Figure 15: Liquidity Ratio



In Figure 14, it can be seen how state owned banks having high capital adequacy ratio. All groups of banks that we estimated efficiency scores shows same trend after 2001 crises. However state owned banks were always above the privately owned banks and foreign banks in terms of capital adequacy ratio in the period of 2002-2005. We do not imply that high capital adequacy ratio brings high efficiency scores. Effects of capital adequacy and other key ratios will be analyzed in Tobit regression. This is merely intended to see how state owned banks strengthened. In Figure 15, Liquidity ratios of deposit banks after 2001 are drawn. Excluding - one more time - foreign banks having branches in Turkey which is explained in Data and Methodology Section, we see how liquidity increased after 2001 crises. Highest degree of increase had been seen in state owned banks showing how capital injections helped these banks to remedy their problems remained from 2001. Again, this does not mean that liquidity is somehow related to efficiency scores of banks.

Secondly, we can see how privately owned banks are having least efficiency scores just after 2001 crises. This is a clear indication that privately owned banks were most adversely effected banks from 2001 crises and recovery process became slower with respect to state owned banks and foreign banks. Figure 16 shows how privately owned banks were having huge losses until 2006 while state owned banks and foreign banks founded in Turkey were undergoing profitable years.

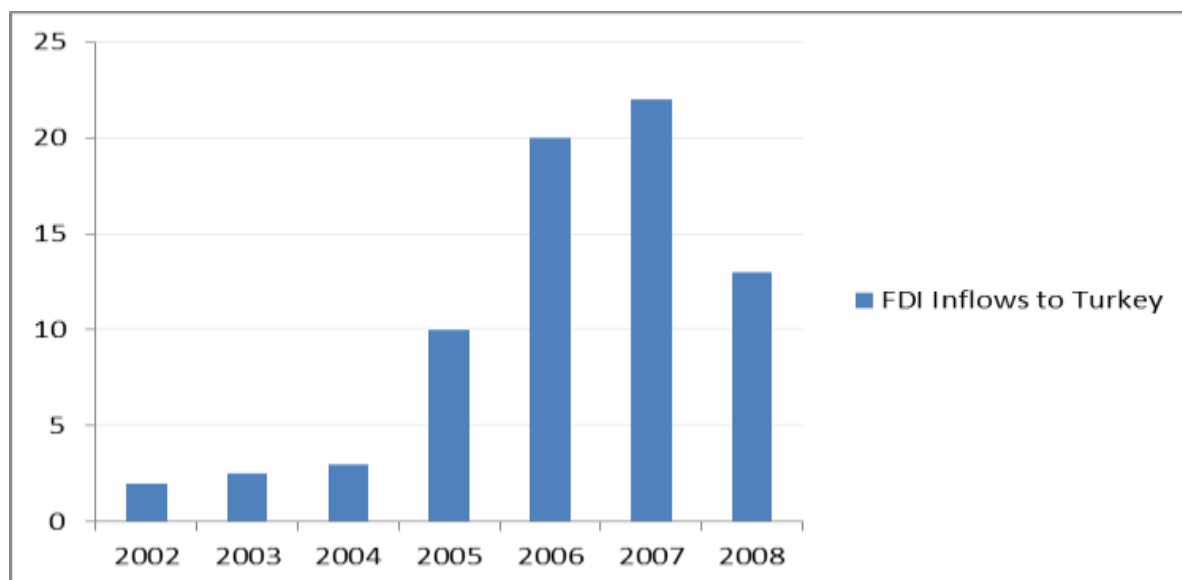
Figure 16: Profit Margin



2005-2007 Sub-Period: Growth and M&A

In this section, we analyze performance of banks from 2005 to 2007. Our DEA results show that foreign banks founded in Turkey dominates in terms of efficiency in 2004-2007 periods. This might be in line with strong flow of FDI to Turkey in this period. Figure 17 shows the FDI inflows to Turkey from 2002 to 2008. FDI inflows accelerated after 2004 and exceeded USD 20 billion in 2007. These FDI were in terms of different sectors such as manufacturing, banking or other services. Share of banking FDI is shown in table 9. In the period where there was a strong inflow of FDI, share of banking investment in total was 47% (2005), 39% (2006) and 59% (2007). More than half of the FDI in 2007 where maximum level of investment comes to Turkey are banking investments. Therefore, it is very reasonable for these inflows to change the composition of Turkish banking. According to Isik and Hassan (2003), there are advantages and disadvantages of foreign banks in Turkey. Starting with advantages, first of all, composition of asset portfolios are tended to more investment securities. This helps foreign banks to reduce their administrative and transactional costs comparing to loans. Foreign banks have advantages in terms of loans by lending bigger amounts to lesser parties. That also reduces monitoring and control costs. On the other hand, huge salaries or dependence on expensive purchased funds might provide a disadvantage in terms of input efficiency. Also, since the bank is new to the market, its primary goal might be to increase its penetration to local market and give up efficiency to success it. However, empirical result of Isik and Hassan (2003) suggest that foreign banks performed better than domestic banks in terms of technical efficiency. Our results suggest that foreign banks founded in Turkey have higher efficiency score than its domestic peers until 2008 which is the global financial crises in which foreign banks are adversely affected.

Figure 17: FDI Inflows to Turkey (In billions of US dollars)



Source: Central Bank of Republic of Turkey

Table 9: FDIs by sectors (In millions of US dollars)

	2002	2003	2004	2005	2006	2007
Banking	260	51	69	4,018	6,957	11,439
Other services	250	231	852	3,685	8,688	3,263
Manufacturing	110	448	190	785	1,866	4,207
Other	2	15	79	47	128	338
Total	622	745	1,190	8,535	17,639	19,247

Source: Treasury

We evaluate efficiency scores of banks as a group, not individually. Because of FDIs, there are banks that changed their groups. While a bank is considered as privately owned bank before M&A activities take place, then it might be considered as foreign bank. This depends of how much share of the bank is sold to foreigners. In our study, we also examine some case of M&A activities individually and see whether efficiency scores of these banks increase or not.

Denizbank, founded in 1938 and privatized in 1992, was under control of Zorlu Group until May 2006. Majority of Bank's share were sold to Dexia group and it became foreign bank founded in Turkey. While the mean of Denizbank's efficiency scores until acquisition is 0.95, it is increased to 1 for the period after acquisition took place. Denizbanks's share in the sector both in terms of asset, loan and deposit gained speed after acquisition. Finansbank, founded in 1987, which 76.99% of its shares were sold to National Bank of Greece in 2007 is one the banks that is regarded as foreign bank after acquisition. Surprisingly, bank has its lowest efficiency score in 2007 and there is decrease in the mean of efficiency scores after becoming a foreign bank. One reason might be that Finansbank did not increase its assets and loans following the acquisition. Also, profitability of banks decreased in 2007. These are in line with our input and output selections. Disbank, founded as privately owned bank in 1964, which 89.34% of its shares were sold to Fortis Bank and its name became Fortis Bank A.S at the end of 2005. According to presentation of Fortis Group to Investment Community in 2005, reasons behind taking over Disbank had explained as absolute size of Turkish Banking sector, low penetration of banking products, growth potential, market concentration and relative absence of foreign competitors. Mean of efficiency scores of Fortis Bank increased to 0.91 from 0.88 after acquisition. There are several domestic banks that were strengthened with FDIs such as Akbank, Yapı Kredi, Garanti Bank. However, we do not examine their efficiency performance since they are still privately owned banks.

2008-2010 Sub-Period: Global Financial Crises and Its Complications

Contrary to foreign banks being most efficient just before global financial crises, these banks have least efficiency scores during and after crises. This is a clear example of how contingent was the current global financial crises. One possible answer why foreign banks in Turkey are more prone to changes in economic environment is that these banks are more transparent to outside of Turkey. It is clearly because most of shares of banks belong to foreign investors.

State owned banks, one more time, is most efficient group of banks in this period. VRS efficiency scores are 0.98, 0.98 and 0.95 for the period of 2008-2010 making state owned banks almost fully

efficient banks as it was the case in 2003 and 2004. This result is in line with Ersoy (2011)'s study saying that technical efficiency of state owned banks continued to increase for the period of 2007 and 2008 while this was not the case for other group of banks. State owned banks were the least efficient banks during "Growth and M&A" sub-period (2005-2007). As a reminder of how VRS efficiency scores should be interpret is that these results give the relative efficiency scores of banks, not the individual scores. It selects one or more banks as most efficient and makes it fully efficient than others are ranked with respect to it. Therefore, we can say that state owned banks are more solid for the period of 2008-2010 while they were beaten by foreign banks founded in Turkey in 2005-2007. Privately owned banks, as opposed to others, have more smooth results make them second group of banks in terms of efficiency for the last two sub-period.

If we look at the efficiency score of all deposit banks in Turkey, there is no significant decrease because of current financial crises. Most of the studies investigating effects of current financial crises on Turkey say that Turkey had already undergone a severe banking crisis in 2001. Lessons learned and measures taken after this period gave an important advantage to Turkish banks in fighting against global crises. Banks gained stronger capital structure and equity capital structure. Also Turkey, despite having an improved banking system, is not well developed in terms of complex financial instruments. For instance, there is no deep mortgage sector in Turkey as it is in America. Loan securitizations, CDOs, subprime loans are additionally immature financial instruments in Turkey and it definitely helped in curbing effect of global financial crises passing through Turkey.

According to Aysan (2011), Turkish Banking Sector became more efficient and and competitive due to the regulatory framework constructed by BRSA, and this helped Turkish Banks to better manage global financial crises. Yuce (2009) mentions several reasons why banking sector survived from crises as following. Retail banking in Turkey is still immature and there are still appetite for banks to carry their business via traditional retail and corporate banking. This makes complex financial instruments not very attractive for the managers of Turkish Banks. Also asset quality was able to remain solid with respect to its peers in emerging markets. Moreover banks could hold their capital adequacy ratio well above targeted 12% and this became a buffer for any risk to balance sheet of banks.

Since we have VRS efficiency scores, we are able to interpret scale efficiency of banks. That is whether banks managers chose an inefficient level of production or not. If a bank experiences increasing return to scale that means it operates at less than optimum size. Likewise, if it experiences decreasing return to scale that means banks are bigger than it should be. In Table 10, you can see what percentage of banks in those groups experienced decreasing return to scale. All state owned banks, for all periods, have decreasing return to scale implying these banks are bigger than their optimum size. This result is in line with Isik and Hassan (2003) saying that scale inefficient banks are those non-small banks and suffering from diseconomies of scale.

Table 10: Percentage of Decreasing Return to Scale Banks

Percentage of DRS	2003	2004	2005	2006	2007	2008	2009	2010
State Owned Banks	100%	100%	100%	100%	100%	100%	100%	100%
Privately Owned Banks	75%	58%	58%	50%	42%	50%	67%	67%
Foreign Banks Founded in Turkey	17%	33%	42%	58%	50%	42%	58%	58%
Deposit Banks	61%	61%	65%	70%	61%	61%	78%	78%

Only less than half of foreign banks founded in Turkey experienced decreasing return to scale. Even though this number is 58% for two last years, foreign banks founded in Turkey seem to adjust their optimum size with respect to other group of banks. When we look at the general trend in Turkish Deposit Banking, percentage of banks having decreasing return to scale was not fluctuating until 2009 but it has substantially increased (owing to privately owned banks) for the last two years.

When we look at 2006 and 2007 period, in particular, we see that foreign banks founded in Turkey is for first time not having least percentage of DRS scores. In other words, there is a significant increase in percentage of decreasing return to scale and this might be because of M&A activities in this period. As we mention earlier, there were many FDI inflow to Turkey and size of the banks increased substantially. Since this increase in size was sudden, banks might not adjust their optimum size to become scale efficient.

Tobit Analysis

In this section, we will be investigating reasons behind efficiency scores. We used Tobit regression for this purpose. As we discussed in data and methodology section, we employed two Tobit regressions to see effect of several accounting ratios on Turkish Banking efficiency scores.

In the first group, there are capital adequacy ratio, non-performing loans ratio, liquidity ratio and profitability ratio. In Table 11, we can see the p-values of employed Tobit regression. In the 10% significance, we see that liquidity and profitability are not significant for all periods. Aysan (2011) also find no robust relationship between profitability and efficiency scores. It is important to note that Aysan's study is confined to global financial crises period so it does not confirm our result for the previous years. However, capital adequacy ratio is significant for the two last years and NPL ratio is significant for 2003, 2005 and 2006 years.

Table 11: P values of Tobit Regression – First Regression Results

P-Values	2010	2009	2008	2007	2006	2005	2004	2003
Constant	0,00	0,00	0,01	0,00	0,00	0,00	0,05	0,00
capital adequacy	0,07	0,09	0,70	0,43	0,76	0,86	0,17	0,13
NPL Ratio	0,24	0,36	0,92	0,63	0,05	0,08	0,41	0,08
Liquidity	0,25	0,26	0,47	0,52	0,44	0,88	0,49	0,62
Profitability	0,80	0,86	0,31	0,55	0,92	0,41	0,26	0,49

In Table 12, coefficients of significant variables are given. According to regression, capital adequacy ratio has a negative impact on efficiency scores. Likewise coefficient for NPL ratio is negative for all those 3 years. Karim *et al* (2010) particularly investigates relationship between non-performing loans and efficiency and find negative relationship (Emerging market data). Even though profitability is not significant in our analysis, Isik and Hassan (2003) find negative relationship between profitability and efficiency in their study. Jackson and Fethi (2000), on the contrary, find positive relationship between profitability and efficiency while finds negative relationship between capital adequacy and efficiency

Table 12: Coefficients of Significant Explanatory Variables

Coefficients	2010	2009	2008	2007	2006	2005	2004	2003
Constant								
capital adequacy	-0,034	-0,037						
NPL Ratio					-0,044	-0,031		-0,039
Liquidity								
Profitability								

In the second group, there are 2 Income cost ratios, share in sector and branch ratios. When we look at the p-values at 10% significance level, we see first Income cost ratio is significant for 2005, other income cost ratio significant at 2006 and 2007. Share in sector is not significant through 8 years. Atan (2004), on the contrary finds a positive relationship between share in sector and efficiency scores. Isik and Hassan (2003) also find a negative significant relationship between share in sector and efficiency. It is explained this relationship as *While small banks compete with large banks primarily in metropolitan markets, they do not compete in rural markets. Thus, strong competition might have induced more market discipline on small banks, leading to greater cost efficiency*". However branch ratio is significant for 2005-2007 periods.

Table 13: P values of Tobit Regression – Second Regression Results

P-Values	2010	2009	2008	2007	2006	2005	2004	2003
Constant	0,10	0,00	0,95	0,26	0,90	0,22	0,41	0,97
Income_Cost	0,55	0,89	0,49	0,65	0,59	0,05	0,95	0,36
Income-Cost-2	0,88	0,23	0,36	0,04	0,07	0,17	0,92	0,94
Share-in-sector	0,33	0,44	0,69	0,15	0,53	0,86	0,45	0,46
Branch	0,25	0,72	0,52	0,05	0,02	0,06	0,38	0,45

In Table 14, we can see the coefficients of significant variables. One interesting result is that while first income cost ratio which is Total Income/Total Expense has positive effect while second income cost ratio which is non-interest income/Total asset has positive effect. One possible explanation for this is that we used net fees and commission as output for DEA analysis. And non-interest income is more or less correlated with net fees and commission. Therefore, it is expected to see a positive effect of non-interest income on efficiency as it was already embedded into our model.

Branch ratio (total employees / # of branches) is significant for Growth and M&A period. This result is also expected since in this period, there are many hirings from foreign banks founded in Turkey. In other words, strong FDI inflow might be driving reason why branch ratio has a positive effect of efficiency scores.

Table 14: Coefficients of Significant Explanatory Variables

Coefficients	2010	2009	2008	2007	2006	2005	2004	2003
Constant								
Income_Cost						0,01		
Income-Cost-2				-0,10	-0,11			
Share-in-sector								
Branch				0,03	0,04	0,06		

Conclusion

In this thesis, we firstly used non-parametric DEA to measure efficiency of Turkish Banks for the period of 2003-2010. Secondly, we used Tobit regression to find out reasons behind estimated efficiency scores. When we look at the efficiency scores in general, we see no significant trend over 2003-2010 periods. Therefore we cannot conclude there is an overall increase in efficiency of Turkish Banking. However, interpreting efficiency scores for separate periods helped us to see how efficiency scores can differ across group of banks. For the first period that took place after 2001 crises, we found out that state owned banks are most efficient banks within all deposit banks. This result is consistent with studies in literature. Since state owned banks are supported by government just after 2001 crises, it is not surprising to see a solid capital structure for these banks. Privately owned banks, on the contrary, seems to have difficulties to get rid of effect of 2001 crises because their efficiency scores are underperformed their peers. For the second period where there is a strong growth in banking sector and many M&A activities took place, efficiency results are different than previous period. Foreign banks founded in Turkey at this time are most efficient bank group. This is consistent with strong FDI inflows to Turkey at this period. Over USD 20 bn FDI entered into Turkey in 2007 enough to indicate how there is a strong FDI inflows to Turkey. Moreover, more than half of the FDIs are in terms of banking sector that makes very reasonable to think why foreign banks founded in Turkey are most efficient bank group. This

result is not consistent when we look at banks individually. There are banks that are less efficient after converted from Turkish banks to foreign banks as well as there are banks that become more efficient after being regarded as foreign bank. State owned banks are least efficient banks in this period. We do not have a clear explanation why state owned banks, in particular, have low efficiency scores with respect to privately owned banks and foreign banks. For the third and last period where we see the effect of global financial crises, efficiency score ranking of group of banks changes one more time. State owned banks become again most efficient bank group while foreign banks founded in Turkey become least efficient. Since foreign banks are more transparent to outside and have strong bonds with foreign investors, it is expected these banks to be most adversely effected by global crises. One possible explanation why privately owned banks and state owned banks become solid during crises is that there are measures taken because of 2001 crises. There are studies in literature supporting this idea. When we look at the scale efficiency of banks, all of state owned banks for all periods are having diseconomies of scale meaning that they are bigger than optimum size. Foreign banks founded in Turkey seem best group of banks in managing size of the balance sheet to become scale efficient.

In the second stage, we used Tobit regression to find out reasons behind efficiency scores. Efficiency scores are used as dependent variables where explanatory variables are capital adequacy ratio, NPL ratio, liquidity ratio, profitability ratio, income cost ratios, share in sector ratio and branch ratio. Capital adequacy ratio, as consistent with literature, becomes significant in explaining efficiency scores. Coefficient of capital adequacy ratio is negative meaning that banks that have higher capital in their reserve have less efficiency scores. NPL ratio is also significant such that more non performing loans make banks less efficient. Liquidity and profitability ratios are not significant for any period. Regarding income cost ratios, there is an interesting result that while total asset over total cost is positively correlated with efficiency, non-interest income over total asset ratio is positively correlated. In other words, source of income is important in increasing efficiency or not. As contrary to most of studies in literature, we do not find any robust relationship between share in sector and efficiency. It means banks are not able to use scale advantage or small banks are not able to use advantage of being a small bank. Lastly, branch ratio is significant for consecutive three years. It is interesting that this period corresponds to Growth and M&A activities. We know there are many hirings from banks in this period and

this might be the reason why there is a significant relationship between branch ratio and efficiency

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