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ASSESSING THE ADVERSE EFFECTS OF INTERBANK FUNDS ON BANK EFFICIENCY THROUGH USING SEMIPARAMETRIC AND NONPARAMETRIC METHODS

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ABSTRACT

This chapter investigates the relationship between interbank funds and efficiencies for the commercial banks operating in Turkey between 2001 and 2006. Data Envelopment Analysis (DEA) is executed to find the efficiency scores of the banks for each year, and fixed effects panel data regression is carried out, with the efficiency scores being the response variable. It is observed that interbank funds (ratio) has negative effects on bank efficiency, while bank capitalization and loan ratio have positive, and profitability has insignificant effects. This chapter serves as novel evidence that interbank funds can have adverse effects in an emerging market.

JEL Classification Codes: C14 (Semiparametric and Nonparametric Methods), C67 (Input–Output Models), G21 (Banks; Other Depository Institutions; Micro Finance Institutions; Mortgages).

Keywords: Turkish Banking Sector; Interbank Funds; Data Envelopment Analysis; Efficiency; Panel Regression; Cluster Analysis, Two Step Procedure.

1. INTRODUCTION

The aim of this chapter is to assess the effects of interbank fundson the efficiency of banks. Together with investment securities, interbank funds are among the major components of other earning assets, which constitute one of the outputs used commonly in measuring the banks' efficiency. This chapter has two steps in analyzing the role of interbank funds on efficiency. First, the efficiency scores are calculated with a non-parametric method, namely through Data Envelopment Analysis (DEA). Then, the efficiency scores obtained in the first stage are regressed on the potential determinants of bank efficiency frequently suggested in the literature. In addition to the existing determinants of efficiency, this chapter particularly focuses on the role of interbank funds in explaining the efficiency scores. The regression specifications have also other independent

variables, such as the profitability ratio, number of branches, and loan ratio, which are shown to have a relationship with the efficiency of a bank in the existing studies.

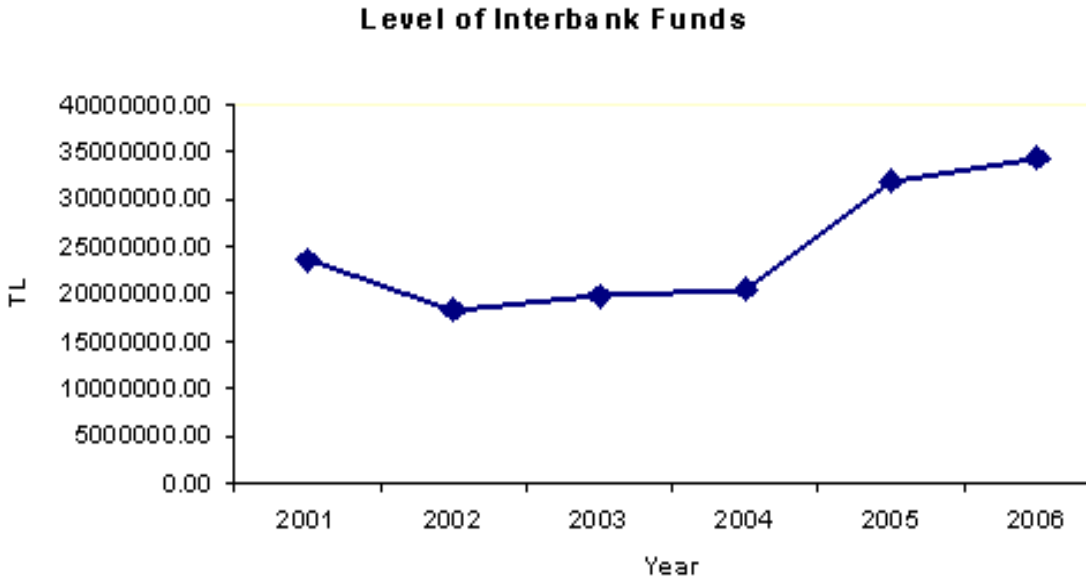
The reason why this chapter focused particularly on this component of other earning assets is attributable to the developments in Turkish banking sector, especially following the crises in 1994 and 2001. Banking industry in Turkey was strictly regulated before 1980. The government had restrictions on the foreign exchange reserves, interest rates paid by banks to depositors, market entry and even on the number of branches. Although this closed system appeared to provide a safe environment for the banks in the financial sector, it hindered the financial system to develop through competition and innovation. After 1980 a financial liberalization program was initiated in which limitations on foreign exchange reserves and market entries from abroad were removed. Accompanied with these regulations, by the establishment of Interbank Money Market in 1986, domestic banks also started to open new branches abroad and became able to borrow and lend among themselves. However, the financial system was still subject to government interventions, which eventually resulted in a financial crisis in 1994. These government interventions to the domestic debt market caused the system to be more prone to liquidity risk because of increased maturity mismatches between assets and liabilities. In the restructuring period of the crisis, monetary policies mainly aimed at shifting domestic borrowing from the Central Bank of Turkey to commercial banks. Starting from 1996, public debt was financed through short term government bonds and treasury bills with high interest rates. The main motivation of commercial banks in purchasing the government securities was to be immune to the credit risk while receiving high profits. However, this way of financing the public debt increased the vulnerability of the financial sector and together with other factors like currency risks and maturity mismatches, ultimately drove the Turkish economy into more severe crises[1] (Özatay and Sak, 2002; Turhan, 2008).

Interbank money market is a useful intermediary between banks when they have liquidity shortages. Figure 1 shows the change in the amount of interbank funds in Turkey between 2001 and 2006. For each period, the averages of the amount of interbank funds are taken. The initial observations point out that except 2001, interbank funds have an increasing trend and this fact

[1] Also see Al and Aysan (2006), Aysan and Ceyhan (2008-b), Aysan and Ceyhan (2008-c).

confirms the increasing importance of interbank funds in the recent years. In Figure 2, the real change in interbank funds is represented by its growth rate and the results confirm that interbank funds level shows an increasing trend from 2001 to 2006. Hence, we investigate whether this increase in the volume of interbank funds has an effect on efficiencies of banks in Turkey. The main problem with interbank money market is the volatility of its overnight rates. This volatility was attempted to be reduced in 1996 and 1997 to maintain the financial stability. However the consequences were not as expected.

In 2001, the government abandoned the strict monetary policy pursued and shifted to the floating exchange rate regime. The monetary policy before the crisis aimed at reducing the inflation and interest rates. Nevertheless, in November of 2000 an economic volatility shook this stable environment while the political tension erupted. The stabilization program adopted suffered from lack of credibility issue. In only one day, 7.5 billion dollar was drawn from Central Bank of Turkey and the overnight interest rates rose up to 7500 percent. The financial crisis also accounts for the decline in the interbank funds in 2001 since the overnight interest rates showed a dramatic hike.

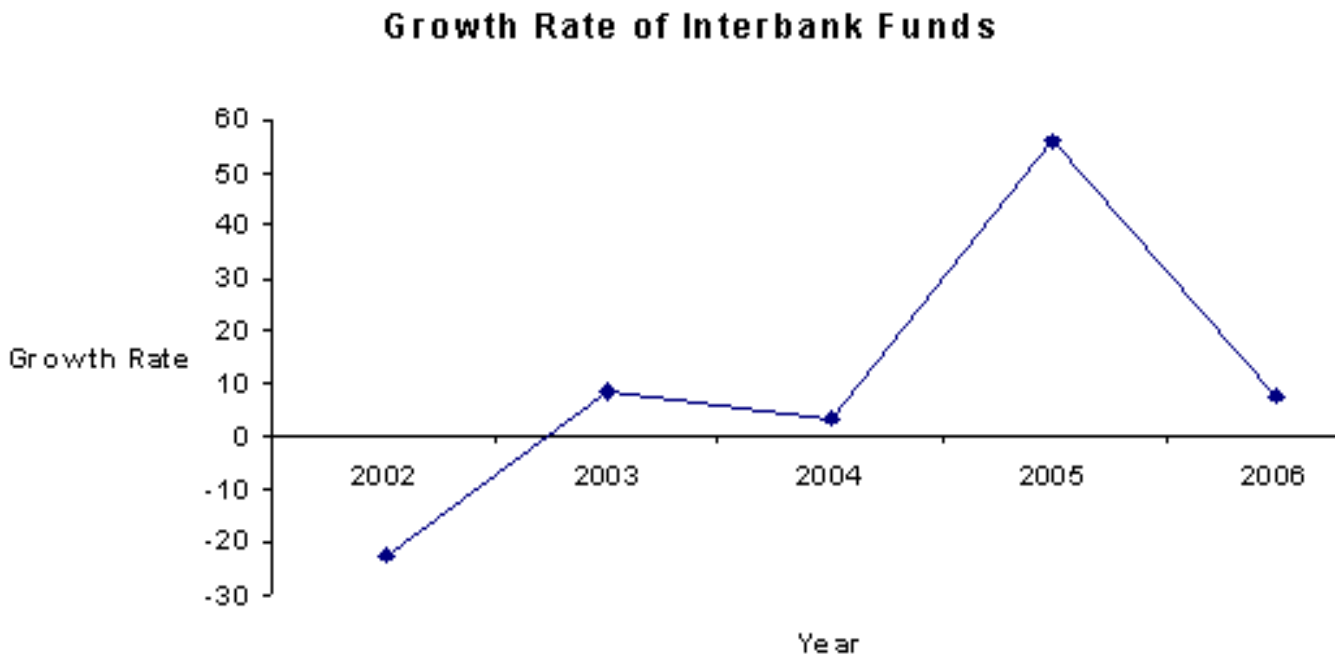


Source: Authors' calculation and Banks Association of Turkey.

Figure 1. Change in Interbank Funds between 2001 and 2006.

The 2001 economic crisis caused especially small and medium scale businesses around Turkey to be shut down and many people to lose their jobs. After the crisis, banks changed the way they report their balance sheets and started to use inflationary accounting. Due to this change, balance sheet items before 2001 are not consistent with those after 2001. In addition, political and macroeconomic environment is more stable since then. Hence taking pre- and post-2001 periods together may bias the efficiency scores, as the conditions changed dramatically. Due to this reason, this chapter only focuses on the post-crisis period.

As the system became free from government interventions and open to the global financial system, a more competitive environment was achieved. Previously, it was sufficient for banks to establish a good reputation for keeping their existing clients or reaching potential ones. However, after the liberalization efforts they need to offer more branches and become more technologically developed to compete with their rivals and survive in the market. Another major change was the improvements in how the banks operate. The main source of revenue for banks comes from loans, since banks invest the sizable fractions of the deposits collected in loans to the individuals and firms. Alternative ways of utilizing deposits are through government and other securities transactions and interbank funds. Hence, banks operating in Turkey shifted some of their resources from the traditional way of banking to these alternatives.



Source: Authors' calculation and Banks Association of Turkey.

Figure 2. Change in Growth Rate of Interbank Funds between 2001 and 2006.

In modeling the efficiency and choosing the set of inputs and outputs, this chapter relies essentially on Stavarek (2003) and Isik and Hassan (2002). Similar to Isik and Hassan (2002), the chapter improves Stavarek (2003) by incorporating off-balance sheet items and other earning assets into analysis. Other earning assets are critical in measuring the efficiency of banking in Turkey since its components play a considerable role in the banking operations in Turkey. The establishment of Interbank Money Market for Turkish Lira in 1986 enables banks to fund each other so that they can meet their liquidity needs in the short term. Hence interbank funds emerge also an alternative way of investing the available deposits. Another alternative to extending the loans as mentioned before is dealing with investment securities, that is, giving loan especially to the government or to other institutions through buying their issued papers. Off-balance sheet items need to be included among the list of outputs since their ignorance results in miscalculation of the efficiency scores.

This is the second study that investigates the effects of interbank funds on efficiency within a DEA framework, and the first study that combines DEA, panel regression, cluster analysis and data visualization in critical investigation of the banking sector in given country. The analysis of the sector during post-crises period, covering 2001-2006 is also novel.

The organization of this chapter is as follows. A selective review of the literature is presented in the following section. In section 3, the methodology used, namely Data Envelopment Analysis (DEA), is briefly explained. In section 4, the data set and the empirical setting are described and the reasons behind the selection of the variables in the two stages of the empirical model are given. In section 5, nonparametric estimation results are presented and analyzed with the regression specifications. In section 6, a cluster analysis of the banks in Turkey for the year 2006 is carried out based on the results of earlier sections. The results of the cluster analysis are also visually presented in this section, to provide comparisons between clusters. Conclusions are relegated to the final section.

2. LITERATURE REVIEW

The first group of studies related to this chapter present the historical development of the Turkish banking sector. Akin et al. (2009) provides a detailed history of the Turkish banking sector between 1980-2004. Steinherr et al. (2004) focus on the period between 1990-2004, including a discussion on the efficiency and competitiveness of the sector. Ozkan-Gunay and Tektas (2006) investigate the sector between the years 1990-2001 and observes sector-wide decline in efficiency. Evren (2007) analyzes the post-crises period, investigating the impact of post-crisis consolidation trend in the sector on the number of bank branches, i.e., availability of banking service. A very extensive cross-industry study on Turkey by the leading management consulting firm McKinsey (2003) shows that the banking sector as a whole has a labor productivity at only 42 percent of US levels. The study mentions macroeconomic instability and the distorting effect of high real interest rates as contributors to the low productivity.

Fethi and Pasiouras (2010) present a comprehensive review of 196 papers which employ operations research (OR) and artificial intelligence (AI) methodologies for evaluating bank performance. 151 of the reviewed papers use DEA or related techniques for estimating bank efficiencies. Since the authors list most of the papers on the topic, the applications of DEA for benchmarking financial institutions in a rich variety of countries is not detailed here, and the reader is referred to the mentioned review paper. Instead, as a second group of the papers in literature, the studies focusing on the Turkish banking sector will be presented.

Isik and Hassan (2002) examine the impact of bank size, corporate control and governance, holding affiliation, international presence, and ownership on the cost and profit efficiency of Turkish banks between 1988 and 1996. The authors compare cost efficiency with profit efficiency for the case of Turkish banks, and reveal that profit efficiency can be high regardless of cost efficiency, pointing out to an imperfect market with profit opportunities for all types and sizes of banks. The DEA model in this chapter is the same as in Isik and Hassan (2002), except that here, short term loans and long term loans are considered within a single output, total loans, and personnel expenses are taken as an input, rather than the number of employees. Additionally, the time frame considered in Isik and Hassan (2002) is 1988-1896, the pre-crises period, whereas the time frame considered here is 2001-2006, the post-crises period.

Isik and Hassan (2003-a) employ a DEA-type Malmquist index and examines the change in efficiency of Turkish banks during the 1981-2000 period, during which the sector was regulated. Their study reveals that all forms of banks have significantly increased their productivity after the deregulation, mostly due to improved resource management practices, rather than improved scales. Isik and Hassan (2003-b) investigates the impact of the 1994 crisis, observing a significant decrease in efficiencies during the crisis, affecting foreign banks and small banks the most, and public banks the least. Again using a DEA-type Malmquist Index, Alpay and Hassan (2006) compare the efficiencies of the Interest Free Financial Institutions (IFFIs) in Turkey with the conventional banks in the period 1990-2000. The authors conclude that are IFFIs have higher cost efficiency (47.5% versus 26.6%) and revenue efficiency (75.3% versus 42.9%). Isik (2008) compares the performance of de novo banks (banks that have joined the banking system after deregulation) against the performance of established banks.

Hauner (2005) is the only study found that investigates the impact of interbank funds (deposits) on efficiency. Hauner (2005) covers German and Austrian banks in the period 1995-1999 and concludes that "more cost-efficient banks draw a larger part of their funds from interbank deposits and securitized liabilities". The authors employ the ratio of interbank funds to total assets, whereas this chapter investigates the ratio of interbank funds only to other earning assets.

Benchmarking studies mentioned so far all adopted DEA-type models. On the other hand, Secme et al. (2009) evaluate five leading banks according to two methodologies for multi-criteria decision making, namely fuzzy Analytic Hierarchy Process (AHP) and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS). The authors incorporate measures of both financial and non-financial performance into their analysis.

Two artificial intelligence methods, also recognized as data mining methods, that deal with the grouping of a set of entities are cluster analysis (clustering) and classification (Han et al., 2005). Cluster analysis enables reduction of dimensionality by reducing a set of observations into clusters (groups) without any prior knowledge of any class information. Classification, on the other hand, aims at predicting the class of observations, given a subset of the entities whose class values are known, namely the training set. Cluster analysis has been applied in this chapter, since the main goal is to discover possible hidden structures in the considered data set, without any prior class information. Now, the literature that applies cluster analysis in the analysis of banking sector will be summarized.

Cluster analysis has been employed to reveal the strategic categories (clusters) among Spanish savings banks between 1998 and 2002 (Prior and Surroca, 2007), Polish banks between 1997-2004 (Hałac and Żochowski, 2006), and banks in California, USA between 1979–1988 (Li, 2008). The methodology has also been applied in investigating the stability of Czech banks between 1995 and 2005 (Černohorská et al, 2007) and the behavioural patterns of Russian banks between 1999-2007 (Aleskerov et al., 2008). Brown and Glennon (2000) is the study with the largest sample: ~11300 banks in the USA are clustered for the years 1990 and 1991 and the cost structures are compared across the clusters. Meanwhile, cluster analysis has been applied by Ho and Wu (2006) to reduce the number of financial indicators in benchmarking three major banks in Australia.

Lin (2006) differs from other studies that incorporate cluster analysis, in that clustering is based on the reference set of each inefficient bank, obtained from a DEA model, with the cluster centers being the efficient banks. Marín et al. (2008) is the only study that was encountered in literature that computes the efficiencies based on DEA, and then clusters banks, and finally compares the efficiencies and other characteristics across the clusters. This study encompasses DEA, factor analysis, cluster analysis, and bootstrapping in its analysis of 82 banks in Spain. This chapter follows the same approach of combining DEA and cluster analysis as Marín et al. (2008), and further presents the results of cluster analysis through data visualization, enabling the derivation of insights into the profiles of the identified clusters.

3. METHODOLOGY

The chapter has two phases in terms of the methodology used. In the first step, efficiency scores are estimated with and without other earning assets in the output set where the nonparametric technique of Data Envelopment Analysis (DEA) is used. DEA measures the relative efficiencies of a set of entities, namely decision making units (DMUs), as compared to each other. An efficient DMU, a DMU with an efficiency score of 1, is not necessarily efficient compared to the universal set of entities, but is efficient only when compared with the group of entities selected for the model. Input oriented BCC (Banker, Charnes, Cooper, 1984) model is selected from various types of DEA models, because it can handle negative values in the output set, which is the case for this chapter's data set. Aforementioned negative values exist in the data set of net interest income which is one of the outputs used for the estimation of efficiency scores in DEA. Net interest income of the banks represents the difference between interest revenues and interest expenses. When the amount of interest expense is greater than that of interest revenue, negative values of net interest incomes emerge in the data. That is why for some banks in certain years we have negative values in the data set of net interest income and hence we use BCC version of DEA.

The difference of BCC from other DEA models is that it assumes variable returns to scale, which means that its production frontier is piecewise linear and concave. Figure 3 illustrates the variable returns to scale nature of BCC model.

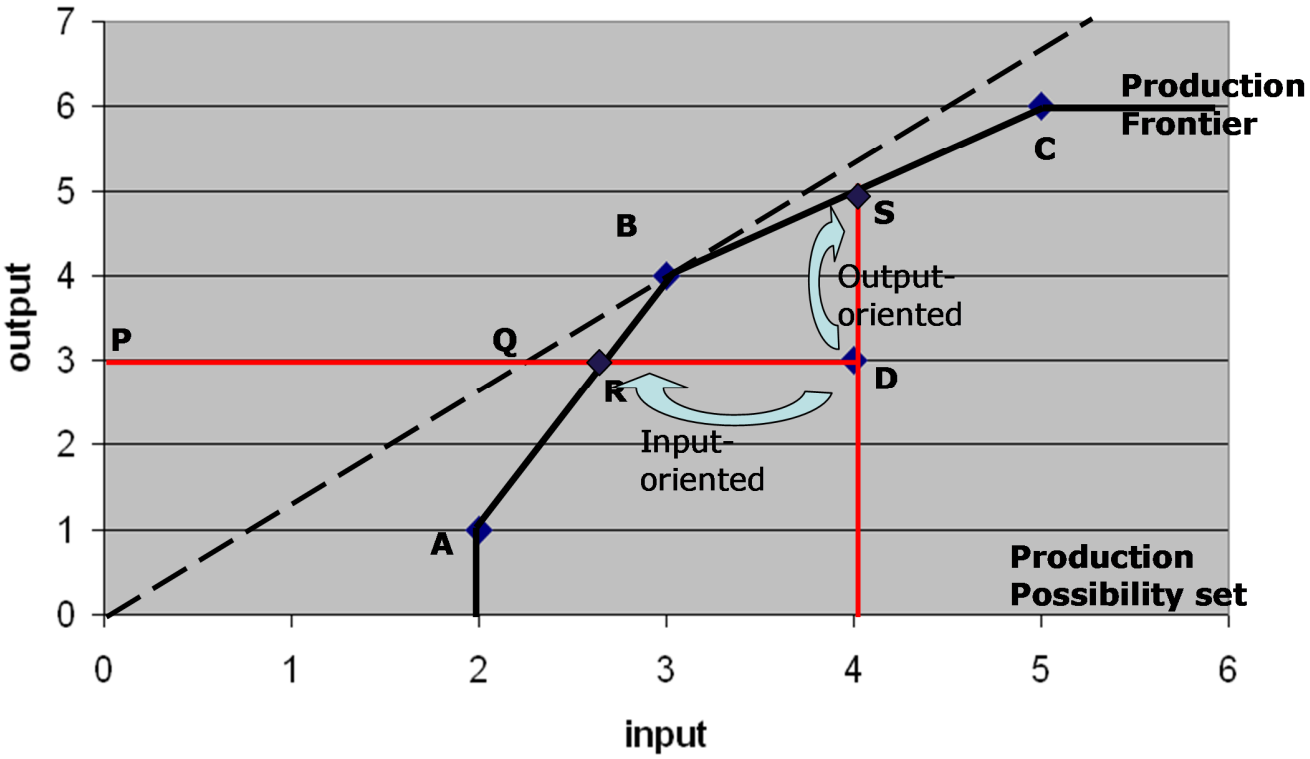


Figure 3. Efficiency Frontier for the BCC model, illustrated for a hypothetical model with one input.

In Figure 3, there are four decision making units (A, B, C and D) and three of them (A, B, and C) are efficient since they are enveloping the inefficient one (D) with the polyline connecting them. R and S are the projections of decision making unit D on the efficient frontier. R is the input-oriented projection while S is the output-oriented one. The uppermost DMUs are the most efficient ones

because the output/input ratio is maximized and hence productivities are maximized at these points. The productivity of an inefficient DMU such as D is given by the ratio PR/PD. The reference set for D is composed of B and C, which means in order to be efficient, D should set these two DMUs as benchmark. The critical issue here is the shape of the efficient frontier. It is not linear, since it is not exhibiting constant returns to scale at all points; rather it is a concave curve where it has increasing returns to scale in the first solid line segment, followed by decreasing returns to scale in the second part and at the intersection of two, there is constant returns to scale.

The model was first proposed by Banker, Charnes and Cooper (1984). The mathematical model for the input-oriented BCC Model (Cooper et al., 2006) is given below and is solved for each DMU to compute its efficiency:

$$(BCC)\max\ \theta_B \qquad (1)$$

$$s.t.\ \theta_B x_0 - [X]\lambda \geq 0\ ,\ [Y]\lambda \geq 0\ ,\ e\lambda = 1\ ,\ \lambda \geq 0$$

where $[X]=(\mathbf{x_j})$ is the matrix of input variables and $[Y]=(\mathbf{y_j})$ is the output matrix of variables, $\boldsymbol{\lambda}$ is a column vector and $\mathbf{e}$ is the raw vector of 1's. θ_B is the input oriented efficiency score for the DMU that the model attempts to find out.

In order for a DMU to be efficient, there are two conditions that should be satisfied:

I. $\theta_B = 1$
II. There should not be input excesses and output shortfalls

According to the methodological framework of Fethi and Pasiouras (in press), this chapter measures *technical efficiency* (as opposed to cost and/or profit efficiency), assumes *variable returns to scale* (as opposed to constant returns to scale), builds an *input-oriented DEA* model (as opposed to an output-oriented model), follows the *intermediation approach* for the selection of inputs and outputs (perceives banks as financial intermediaries between savers and investors), accounts for environmental variables using a *two-stage approach* with traditional DEA in the first stage and regression in the second stage. The methodological setup of this chapter is in accordance

with its goals, and the conventional practice in literature: For example, Berger and Humphrey (1997) suggest the intermediary approach when benchmarking financial institutions as a whole, while they suggest the alternative production approach for benchmarking branches of a single institution. On the other hand, the studies reviewed in Fethi and Pasiouras (2010) by far employ an input-oriented model, assuming that managers have higher control over inputs compared to outputs.

In this chapter, after obtaining efficiency scores using DEA, a fixed effects panel regression[2] is run in the second stage of the empirical analysis. The dependent variable is the efficiency scores with and without other earning assets obtained in the first step, such that the effects of different variables on efficiency and their significance can be observed. The set up for the fixed effects panel analysis is:

$$Y_{it} = \alpha + \beta X_{it} + \varepsilon_{it} \quad (2)$$

$$\varepsilon_{it} = u_i + v_{it} \quad (3)$$

$i=1,\ldots, N$ and $t=1,\ldots,T$

where Y_{it} stands for the efficiency scores, α is the constant for the regression model, X_{it} is the matrix of independent variables and ε_{it} is the random error in the regression. u_i represents the individual-specific, time-invariant effects, which are assumed to be fixed over time for each bank in this model.

[2] Before applying fixed effects panel regression, variables were checked for autocorrelation. The result of the test show that there exist no autocorrelation hence we continued with the Hausman test to compare fixed effects versus random effects regressions. According to the result of the test, there is no significant difference between two models in terms of consistency of the estimates. Therefore, we are indifferent between two models. In the literature using this two-step procedure fixed effects panel regression is used, so we provide the results of this analysis. In the appendix, the results of random effects regression will be presented as well.

This two step empirical methodology emerges to be widely used in recent studies[3]. For example, a similar study was conducted by Arestis et al. (2006) where they assessed the relationship between financial deepening and efficiency in some non-OECD countries. The authors have used a two-step procedure: After measuring the efficiency scores, they regressed them on several variables representing financial deepening. The rationale behind using this two-step procedure was explained by Arestis et al. (2006) as to prevent any measurement error that may exist in the DEA since it is a non-parametric method for efficiency calculation. Additionally, this procedure deepens the analysis by presenting effects of other variables on efficiency scores as well as the variable of concern.

4. DATA AND EMPIRICAL SETTING

In this chapter, the decision making units (DMUs) of the DEA model are the commercial banks operating in Turkey, including those owned by the Turkish state and foreign entities within the years 2001 through 2006. The data for inputs and outputs are obtained from the Banks Association of Turkey. The variables used in the data set are as follows:

Inputs:

I. Personnel expenses: Represents the cost of labor, covering wages and all associated expenses
II. Fixed assets: Stands for the cost of capital
III. Total deposits: The sum of demand and time deposits from customers and interbank deposits

Outputs:

I. Net interest income: The difference between interest income and interest expenses

[3] Also see Aysan and Ceyhan (2007), Aysan and Ceyhan (2008-a) for studies that analyze the Turkish banking sector using the same two-stage approach.

II. 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 transactions as well as other off-balance sheet activities
III. Total loans: The net value of loans to customers and other financial institutions
IV. Other earning assets: Interbank funds (sold) and investment securities (treasury and other securities)

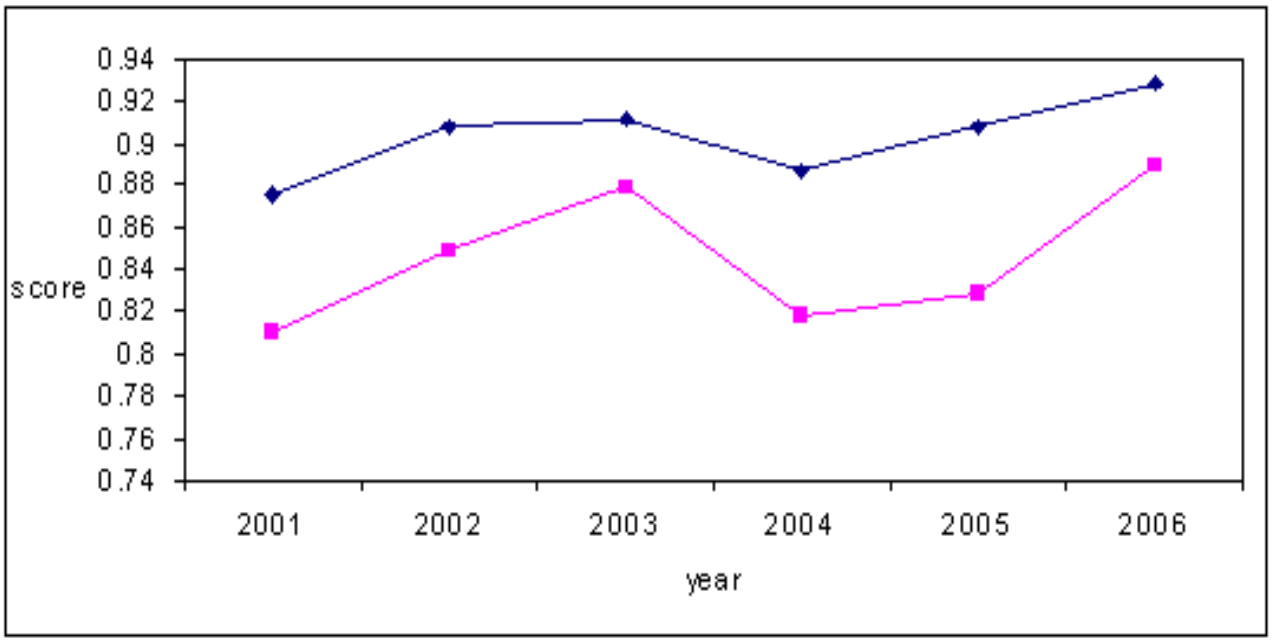
In the literature, different studies use different models where almost all variables change due to the approach applied. Since there exist no universally accepted set of inputs and outputs, it is crucial to explain why these variables are selected for DEA analysis. The reason why personnel expenses and fixed assets are chosen as inputs is obvious. Without necessary equipment, building and human resource it is not possible for a bank to operate. Therefore, their existence and functioning are vital in determining the efficiency of a bank.

Total deposits are included as well because money collected by banks from their customers is used for investments in the form of instruments like loans, securities or interbank funds. The banks operate as if they convert these inputs, like time and effort of personnel, equipment and deposits from customers into outputs like the loans to firms, to individuals, to government through treasury bills or to other banks. Hence, the loans and other earning assets are also taken as outputs.

The net interest income is the output of a bank where interest expenses and interest income are the inputs. The literature on efficiencies on banking supports the idea that off balance sheet items need to be included in the measurement in addition to balance sheet items. According to Clark and Siems (2002), excluding off balance sheet items leads to an underestimation of the efficiency scores, given that non-traditional ways of banking like the letters of credit, futures or forwards are not taken into account otherwise. Hence by considering off balance sheet items in the output set, we do not ignore banks' asset management activities. DEA is conducted with and without other earning assets to see the difference between these two efficiency scores. The computations are conducted using the DEA-Solver software (Cooper et al., 2006).

The results of DEA are presented in the Appendix where average efficiencies for all banks over the selected time frame are given (see Table A.1). The most obvious outcome in Table A.1 is that the exclusion of other earning assets in the outputs decreases the efficiency scores. There are fifteen banks that are efficient in all periods. Only one of them, Ziraat Bankası, is a state bank. Hence other state banks may take Ziraat Bankası as a benchmark to enhance their efficiency scores. Six banks out of fifteen efficient banks are foreign banks. This result shows that foreign banks have not performed systematically better as compared to their domestic counterparts. Based on the average efficiency scores, one can also conclude that more efficient banks usually come from the groups of private banks and foreign banks. This finding supports the idea that these groups of banks have invested more to improve their technology and used their resources more productively in the post crisis period. In the last column of Table A.1, percentage differences between the efficiency scores of including the other earning assets and excluding them are presented as well. The efficiency scores of Toprakbank and Turkishbank display an extreme difference (194 percent and 100 percent) between these two different calculations. Other than these two banks, the percentage differences are always positive and are at most 20 percent.

Figure 4 shows the average efficiency scores of all banks for the years 2001-2006. The time series above in Figure 4 shows the scores with the other earning assets included, whereas the time series below shows the scores with the other earning assets excluded. There is an increasing trend in both series implying that the commercial banks in Turkey improved their productivities in the restructuring period. However, excluding other earning assets in the output set causes efficiency scores to be underestimated.



Source: Authors' calculation and Banks Association of Turkey.

Figure 4. Efficiency Scores between 2001 and 2006.

Having included the other earning assets in the computations, we obtain the efficiencies for every bank over the selected years. Figure 5 shows the improvements in the efficiencies for all the 48 banks that existed for at least one year through 2001-2006, plotted using Miner3D software[4]. In the figure, *Year* is mapped to the X axis, *DMUs* are mapped to the Y axis, and *efficiency scores* are linearly mapped to colors of the glyphs (data points). The light colors denote higher efficiency scores. The darkest colors denote that the bank did not exist in that year. For example, the bank WLG existed in 2001, but did not exist through 2002-2006.

In the second part of the analysis, the efficiency scores are regressed on the following independent variables: interbank funds, bank capitalization, loan ratio, total assets/number of employees, return on assets (ROA), number of branches, and foreign/domestic and state/private dummies.

[4] See the webpage of the program for details: www.miner3d.com

The critical variable that this chapter aims to evaluate the effect of interbank funds/OEA ratio as the critical variable and its ratio in the other earning assets is included in the regression specifications. The effect of interbank funds on the efficiency is expected to be negative because high investment in interbank market is an indicator for inefficiency, confirming that the bank could not invest in more profitable assets or loans with greater returns than the interbank funds (Adenso-Diaz and Gascón, 1997). The loans are expected to yield higher returns for the banks. However, the interbank loans tend to offer lower interest rate returns and hence provide less profit opportunities for the banks.

The loan ratio and bank capitalization are expected to have positive impact on efficiencies. The loan to asset ratio indicates how much loan an asset can generate. Therefore, an increase in this ratio implies that the bank uses its assets more efficiently. The bank capitalization is gauged as the ratio of equity to total assets. As this share increases, the amount of assets transferred into equity increases. Since equity is a vital source for the survival of the bank and its operations, it is expected to have a positive relationship with efficiency. Moreover, it is expected that when the owners of the banks put more capital (equity) into their banks, the banks are expected to run more efficiently while alleviating the moral hazard problem.

The total asset to number of employees is another indicator showing the performance of an employee in asset generating activities and it is tested in (Isik and Hassan, 2002). For the period of 1988 and 1996, Isik and Hassan (2002) demonstrated its relationship with the efficiency. Hence we attempt to figure out if this relationship exists in recent years as well. If the relationship still remains, it is expected to be positive because per employee asset needs to be higher for the more efficient banks. Among profitability ratios, Return on Assets (ROA) is taken and it is the net income over total assets. As a bank performs better, it becomes more profitable through managing its assets more successfully and increasing its income. Hence there needs to be a positive relationship with ROA and efficiency scores.

The number of branches denotes the accessibility of the banks to the existing and potential customers and directly affects the amount of deposits. Thus this variable is expected to have a positive relationship with the efficiency scores. The effects of state/private and foreign/domestic

dummies on the efficiency scores are ambiguous. There are mixed evidence on the effects of different ownership structure on efficiency. However, the private commercial banks and the foreign banks in general tend to be more efficient than the state banks (Isik and Hassan, 2002).

The correlation matrix is presented in Table 3. Even though the bank capitalization and loan ratio have positive impacts on efficiency, they are negatively correlated with each other. Hence, an attempt to increase efficiency through increasing one of them is likely to cause the other variable to worsen. The same result is also valid for the assets/employee ratio since it is negatively correlated with both the bank capitalization and loan ratio while all of them have positive relationship with efficiency. Interbank to other earning assets ratio is weakly related with bank capitalization, while their correlations with efficiency are adversely related. The negative correlations between interbank/other earning assets and loan ratio are as expected since the banks have fewer assets to use for the interbank funds as the loan ratio increases.

5. EMPIRICAL RESULTS

The main contribution of this chapter is to analyze how the efficiency scores are affected by the increasing volume of interbank funds. The results of the analysis are evaluated in two parts given that the dependent variable is either the efficiency scores with other earning assets or without it.

In Table 4, the results of the regression on the efficiency with two dependent variables are presented. The coefficients and t-values (in the parenthesis) are presented in the table.

Table 1. Number of Efficient Decision Making Units

Year	Total number of banks	Number of efficient banks with OEA	Number of efficient banks without OEA
2001	42	28	23
2002	36	20	18
2003	36	25	23
2004	33	16	11
2005	33	18	15
2006	32	21	19

Source: Authors' calculation and Banks Association of Turkey.

Table 2. Descriptive Statistics

Variables	Num. of Observations	Mean	Std Dev	Min	Max
Interbank/Other Earning Assets	212	0.463	0.543	0.001	6.978
Efficiency with Other Earning Assets	212	0.902	0.164	0.150	1.000
Efficiency without Other Earning Assets	212	0.845	0.209	0.138	1.000
Bank Capitalization	212	0.175	0.168	-0.353	0.850
Loan Ratio	212	0.296	0.187	0.000	0.733
Asset/Employee	212	2508	1994	90	16879
Return on Asset	212	-0.008	0.099	-0.641	0.322
Number of Branches	212	149	268	0	1504

Source: Authors' calculation and Banks Association of Turkey.

Table 3. Correlation Matrix

	Interbank	Efficiency with OEA	Efficiency w/o OEA	Bank Capital.	Loan Ratio	Asset / Employee	ROA	No of Branches
Interbank	1.000							
Efficiency with OEA	-0.236	1.000						
Efficiency w/o OEA	-0.197	0.822	1.000					
Capitalization	0.093	0.054	0.160	1.000				
Loan Ratio	-0.174	0.124	0.244	-0.379	1.000			
Asset/ Employee	0.070	0.210	0.135	-0.028	-0.214	1.000		
ROA	-0.035	0.171	0.160	0.070	0.105	0.228	1.000	
No of Branches	-0.205	0.171	0.183	-0.171	0.059	-0.033	0.105	1.000

Source: Authors' calculation and Banks Association of Turkey.

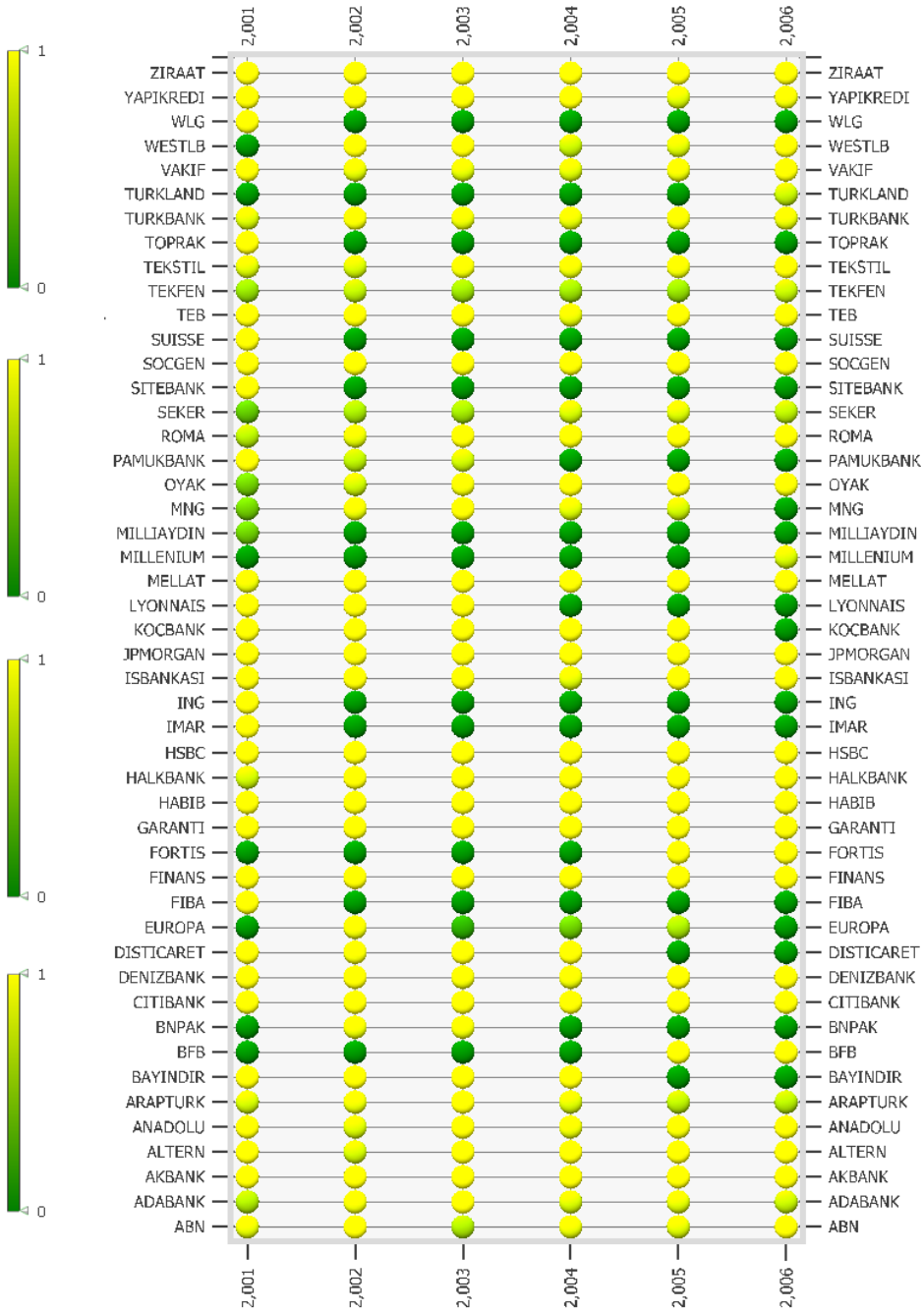


Figure 5. Change of Efficiency Scores over 2001-2006 for Turkish Banks (Other Earning Assets is included in the DEA model).

Table 4. Fixed Effects Panel Regressions

Independent Variables	Dependent variable	Dependent variable
	Efficiency with	*Efficiency without*
	Other Earning Assets	*Other Earning Assets*
Interbank/OEA	**-0.068**	**-0.049**
	(-4.44)***	**(-2.47)****
Bank Capitalization	**0.251**	**0.457**
	(2.89)***	**(4.01)*****
Loan Ratio	**0.239**	**0.432**
	(3.69)***	**(5.16)*****
Assets/Employees	**0.00001**	0.00001
	(1.74)*	(0.61)
Return on Assets	0.015	-0.149
	(0.14)	(-1.09)
Number of Branches	-0.00002	-0.00002
	(-0.12)	(-0.29)
Foreign/Domestic	-0.022	-0.007
	(-0.28)	(-0.07)
Constant	**0.804**	**0.656**
	(19.48)***	**(12.31)*****
R-square	0.736	0.729
Number of Observations	212	212

In the first fixed effect panel regression specification, the explanatory variables are regressed on the efficiency scores with other earning assets included as output. The interbank/other earning asset is significant and affects the efficiency scores adversely, as expected. The loan ratio and bank capitalization are significant in explaining efficiencies and they have a positive relationship with efficiency. This supports the view that when the banks turn their assets into more lucrative investments, their efficiency scores improve. Interestingly, the ROA and asset/employee ratio are not significant in explaining the dependent variable. Finally, number of branches and foreign domestic dummies are not significant, either.

In the second panel, the dependent variable stands for the efficiency scores without the other earning assets. The aim of this second regression specification is to uncover whether the other earning assets drastically alter the main findings. The results are not much different from the findings of the previous regression. The interbank funds, the bank capitalization and loan ratio are still significant. The interbank funds variable has a negative relationship with efficiency while the bank capitalization and loan ratio are positively correlated with the efficiency scores. Similar to earlier results, other variables are found to be insignificant in explaining the banks' efficiencies.

This chapter's findings regarding the effects of interbank funds contradict with the results of Hauner (2005), where interbank funds are found to have positive effects with a significance level of 1%. There can be several reasons for the contradictory results: Firstly, the environmental settings are not the same: Hauner (2005) investigates the banks in Germany and Austria, where we investigate the banks in Turkey. It is only expected that the banking sector in these two different settings are different. Secondly, the time frames are different: Hauner (2005) considers the period 1995-1999, whereas we consider the period 2001-2006. Thirdly, Hauner (2005) considers the ratio of interbank funds to total assets as a factor, whereas we consider the ratio to only other earning assets. One future research area is to investigate the causes of the varying results, and also collect evidence from other countries and time frames.

6. CLUSTER ANALYSIS

In section 5, the variables interbank funds, banks capitalization and loan ratio were determined to be highly significant in determining the average efficiency scores over the years 2001-2006. In this section, a cluster analysis is carried out for the year 2006 using the above three factors, and the efficiency scores for 2006 computed with and without OEA, totaling to five variables. Then the results of the cluster analysis are combined with two additional status variables, State/Private and Foreign/Domestic.

ClusterNo	AVG(2006_Interbank/OEA)	AVG(2006_BankCapitalization)	AVG(2006_LoanRatio)
1	0.19	0.10	0.55
2	0.67	0.15	0.63
3	0.62	0.13	0.35
4	0.45	0.12	0.57
5	0.67	0.12	0.12
6	0.13	0.17	0.39
7	0.11	0.12	0.33
8	0.93	0.83	0.00
9	0.73	0.59	0.01
AVG(Column	0.44690625	0.17871875	0.4091875

ClusterNo	AVG(2006_Eff_Excluding)	AVG(2006_Eff_Including)	PercOfForeign	PercOfPrivate	NoOfBanks
1	0.97	0.99	0.17	0.83	6
2	1.00	1.00	0.71	1.00	7
3	0.56	0.92	0.00	1.00	2
4	0.67	0.70	0.00	0.33	3
5	1.00	1.00	1.00	1.00	4
6	0.61	0.63	0.50	1.00	2
7	0.93	0.98	0.20	0.40	5
8	0.68	0.68	0.00	1.00	1
9	1.00	1.00	0.50	0.50	2
AVG(Column	0.88984375	0.92809375	0.34	0.79	

Figure 6. Results of Cluster Analysis for the Year 2006.

Figure 6 shows the results of cluster analysis, which was carried out using the k-means clustering algorithm (Han et al., 2005) implemented within Miner3D software. K-means partitions a set of observations into k distinct clusters such that similar observations can be identified. In this case, the observations are the banks, and the clustering is performed using the five variables mentioned above. Table A.1 lists the clusters that each of the banks that exist in 2006 belong to.

Banks in clusters 1 and 2 (first two rows in Figure 6) exhibit similar characteristics as can be seen from similar bar levels under each column. These are also the two clusters with the most elements (last column), and are almost all efficient in both DEA models (with and without OEA).

These two clusters mainly differ from each other with respect to their interbank/OEA values, as can be seen from the large difference in the bars under the column AVG(2006_Interbank/OEA). After combining data on the ownership status of banks, it is also observed that these two clusters differ significantly with respect to their Foreign/Domestic ownership. 71 percent of the banks in cluster 2 are foreign, whereas only 17 percent of banks in cluster 1 are foreign. Thus a careful analysis of clustering results revealed that among efficient banks that operate similarly (low bank capitalization, high loan ratio); domestic banks have low interbank/OEA values, whereas foreign banks have high interbank/OEA values.

Two clusters are composed of a small percentage of private banks: Cluster 4, which is composed of three banks, contains two state banks and one private bank (hence the percentage of private value of 33 percent). Cluster 7 is composed of five banks, three of them state banks, and two of them private banks (hence the percentage of private value of 40 percent). Even though these two clusters are characterized by the felt presence of state banks, their average efficiency scores differ significantly: average efficiency for cluster 4 is 0.70 in the second DEA model, whereas average efficiency for cluster 7 is 0.98. A curious investigation of the values under other tables reveals differences that can explain this significant difference. The banks in cluster 4 have a high average value of 0.45 for interbank/OEA for 2006, whereas banks in cluster 7 have a low average value of 0.11. The values under the bank capitalization column are the same. However, the values under average loan ratio column also differ significantly (0.57 vs. 0.33). The interbank/OEA values and loan ratios were proven to have negative effect on efficiency scores by the panel regression in section 5. Thus, it is reasonable that cluster 7 has a higher average efficiency compared to cluster 4.

7. CONCLUSION

Starting from the beginning of 1980s, the banking sector in Turkey was liberalized through the new banking laws and the establishments of regulatory financial agencies. The traditional way of banking where loans are the main output of the banking operations started to change in this process. Banks began to lend other banks through Interbank Money Market and to give loans to the

government through treasury bills. Therefore, this chapter aims to find out the developments in the interbank funds and its effect on the bank efficiencies for the periods 2001-2006. Turkish economy suffered from major financial crises in 2000 and 2001. In the post-crisis episode, the banking sector in Turkey has better performed its intermediatory role between borrowers and lenders. Hence, the focus is on post-crisis period to find out the effects of increasing volume of interbank funds in recent years.

After conducting Data Envelopment Analysis (DEA) to find efficiency scores, fixed effects panel regressions are carried out to uncover the role of certain selected factors on the efficiencies of the banks in Turkey. Besides showing the statistically significant factors that affect efficiency including the interbank funds, a historical summary of efficiencies of banks operating in Turkey and the results of a cluster analysis for the year 2006 are visually presented, accompanied with newly discovered insights.

The effect of interbank funds stands to be negative and statistically significant. This result supports the idea that the higher amount of investment in the interbank funds is an indicator of inefficiency. The bank capitalization and loan ratio are other significant variables and they are positively correlated with efficiency. The profitability and efficiency are not significantly associated to each other, confirming the earlier findings of Abbasoğlu et al., (2007). The asset/employee ratio, measuring the amount of asset an employee can create, and the number of branches are found to be insignificant in affecting efficiency. Finally, foreign/domestic dummy is found to be insignificant as well. Overall, this chapter uncovers the adverse effects of the interbank funds on the efficiencies while the loan ratio enhances the efficiency scores. Hence, the empirical findings of this chapter confirms the argument for an emerging market economy that the bank efficiency is enhanced through extending relatively longer term loans as opposed to extending shorter term loans to other banks.

8. APPENDIX

Table A.1. Average Efficiency Scores of DMUs (Source: Authors' calculations)

DMU Abbreviation	DMU Full Name	Cluster No (in 2006)	Excluding OEA	Including OEA	Perc. Change in Efficiency
ABN	*ABN Amro Bank*	7	0.7	0.84	0.20
ADABANK	*Adabank*	8	0.74	0.78	0.05
AKBANK	*Akbank*	1	1	1	0
ALTERN	*Alternatifbank*	2	0.94	0.95	0.01
ANADOLU	*Anadolubank*	3	0.76	0.93	0.22
ARAPTURK	*Arap Türk Bankası*	6	0.68	0.77	0.13
ROMA	*Banca di Roma*	2	0.86	0.9	0.05
EUROPA	*Bank Europa*		0.49	0.5	0.02
MELLAT	*Bank Mellat*	2	0.89	0.98	0.10
BAYINDIR	*Bayındırbank*		1	1	0
BFB	*Birleşik Fon Bankası*	9	1	1	0
BNPAK	*Bnp-Ak Dresdner Bank*		0.9	0.92	0.02
CITIBANK	*Citibank*	5	0.99	1	0.01
LYONNAIS	*Credit Lyonnais Turkey*		1	1	0
SUISSE	*Credit Suisse*		1	1	0

	First Boston				
DENIZBANK	*Denizbank*	2	0.89	0.97	0.09
DISTICARET	*Dış Ticaret Bankası*		0.88	0.98	0.11
FIBA	*Fibabank*		1	1	0
FINANS	*Finansbank*	2	1	1	0
FORTIS	*Fortisbank*	1	0.89	0.99	0.11
DMU Abbreviation	*DMU Full Name*	Cluster No (in 2006)	Excluding OEA	Including OEA	Perc. Change in Efficiency
GARANTI	*Garanti Bankası*	1	1	1	0
HABIB	*Habib Bank*	5	1	1	0
HALKBANK	*Halkbank*	7	0.8	0.95	0.19
HSBC	*HSBC*	2	1	1	0
ING	*ING Bank*		1	1	0
IMAR	*İmarbank*		1	1	0
ISBANKASI	*İşbankası*	7	0.94	0.97	0.03
JPMORGAN	*JPMorgan Chase Bank*	9	0.95	1	0.05
KOCBANK	*Koçbank*		0.99	1	0.01
MILLENIUM	*Millenium Bank*	4	0.75	0.75	0
MILLIAYDIN	Milli Aydın Bankası		0.31	0.36	0.16
MNG	MNG Bank		0.71	0.75	0.06
OYAK	Oyakbank	1	0.81	0.82	0.01
PAMUKBANK	Pamukbank		0.68	0.78	0.15
SITEBANK	Sitebank		1	1	0
SOCGEN	Societe Generale	5	0.89	1	0.12

SEKER	Şekerbank	6	0.55	0.59	0.07
TEB	TEB	1	0.97	0.97	0
TEKFEN	Tekfenbank	4	0.49	0.56	0.14
TEKSTIL	Tekstilbank	2	0.86	0.87	0.01
TOPRAK	Toprakbank		0.34	1	1.94
TURKBANK	Turkish Bank	3	0.43	0.86	1.00
TURKLAND	Turkland Bank	4	0.66	0.68	0.03
VAKIF	Vakıfbank	1	0.76	0.87	0.14
WESTLB	West LB AG	5	0.88	0.89	0.01
WLG	Westdeutsche Landesbank		1	1	0
YAPIKREDI	Yapı Kredi Bankası	7	0.93	0.95	0.02
ZIRAAT	Ziraat Bankası	7	1	1	0

Table A.2. Random Effects Panel Regressions

Independent Variables	Dependent variable	Dependent variable
	Efficiency with	*Efficiency without*
	Other Earning Assets	*Other Earning Assets*
Interbank/Other Earning Assets	-0.070	-0.052
	(-4.80)***	(-2.72)**
Bank Capitalization	0.229	0.470
	(3.22)***	(5.30)***
Independent Variables	Dependent variable	Dependent variable
Loan Ratio	0.199	0.396
	(3.46)***	(5.44)***
Assets/Employees	0.00001	0.00001
	(2.26)*	(1.47)
Return on Assets	0.009	-0.069
	(0.09)	(-0.58)

Number of Branches	-0.00004	-0.00009
	(-0.76)	(-1.23)
Foreign/Domestic	0.022	0.044
	(0.57)	(0.95)
Constant	0.804	0.612
	(20.23)***	(12.82)***
R-square	0.736	0.729
Number of Observations	212	212

* indicates significance at the 10% level, ** indicates significance at the 5% level, *** indicates significance at the 1% level.

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