

## TÜRK BANKACILIK SEKTÖRÜNDE VERİMLİLİĞİN DEĞERLENDİRİLMESİ: BİR VERİ ZARFLAMA ANALİZİ UYGULAMASI

Asst. Prof. Elif AKBEN SELÇUK\*  
Res. Asst. Duygu ÜNDEĞER SOĞUKTAŞ\*\*

### ÖZ

*Bu çalışmanın amacı 2001 sonrası Türk bankacılık sektörünün verimliliğinin incelenmesidir. Kullanılan yöntem veri zarflama analizidir ve sonuçlar 2001-2006 yılları arasında Türk bankacılık sektöründe bir verimlilik artışı olduğunu göstermiştir. Verimli bankaların oranı inceleme döneminde anlamlı derecede artarak 2001’de yüzde 50 iken, 2006’da yüzde 89’a yükselmiştir. Bu verim kazançları, daha iyi kaynak kullanımından ziyade daha yüksek ölçek verimliliği sebebiyle gerçekleşmiştir.*

**Anahtar Kelimeler:** Bankacılık sektörü, verimlilik, veri zarflama analizi.

**Jel Sınıflandırması:** C14, C51, G21

## EVALUATING THE EFFICIENCY OF TURKISH BANKING SECTOR: AN APPLICATION OF DATA ENVELOPMENT ANALYSIS

### ABSTRACT

*The objective of this study is to investigate the efficiency of Turkish banking sector after 2001. The method employed is data envelopment analysis and the results show that Turkey has experienced an increase in the relative efficiency of its banking sector between 2001 and 2006. The percentage of efficient banks significantly increased throughout the analysis period from 50 percent in 2001 to 89 percent in 2006. The efficiency gains were mainly due to the increased scale efficiency, rather than improved resource management.*

**Keywords:** Banking sector, efficiency, data envelopment analysis.

**JEL Classification:** C14, C51, G21

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\* Kadir Has Üniversitesi, İİSBF, İşletme Bölümü, elif.akben@khas.edu.tr

\*\*Boğaziçi Üniversitesi, İİBF, İşletme Bölümü, duyguundeger@gmail.com

## 1. INTRODUCTION

The Turkish economy and financial markets have undergone a fundamental liberalization process since the early 1980s. The earlier economic development strategy of import-substitution has gradually evolved into an export-oriented one. This liberalization process has two dimensions with respect to the banking sector (Denizer, 1997). The first dimension is the reduction of directed credit programs and the elimination of interest rate controls. The second dimension is the relaxation of entry barriers into the banking system to promote competition and increase efficiency. In addition to the developments in the banking sector, some regulations have been implemented to organize equity and bond markets (Denizer, 1997). The establishment of Borsa Istanbul (formerly Istanbul Stock Exchange) was one of the most remarkable results of this process. Another cornerstone of this liberalization trend was the opening of the capital account.

For Turkey, the 1990s were generally marked by high volatility and uncertainty due to the impact of volatile global markets and domestic political conditions. The effects of global markets were felt in the crises that the country experienced in 1994, 1999, 2000, and finally in 2001. In addition, the short-lived coalitions that have dominated the political arena have also contributed to the volatile nature of the economy. After 2001, the country has started up a new economic program in coordination with IMF, letting the exchange rate to float and targeting inflation directly. A series of important reforms were made, including the change of Central Bank law that provided independence to the institution. Moreover, the developments on the way to European Union and the opening up of participation negotiations have also added to the positive climate that emerged within the economy together with the political stability. The period after 2001 seems to be a start of a new era for Turkish economic liberalization process.

The objective of the present study is to investigate the efficiency of Turkish banking sector after 2001. It is hypothesized that thanks to financial liberalization and new regulations, the banks will be forced to increase their efficiencies and their performance will improve. The analysis was carried out using data envelopment analysis methodology (DEA) and the results show that Turkey has experienced an increase in the relative efficiency of its banking sector between 2001 and 2006. The percentage of efficient banks increased throughout the analysis period from 50% in 2001 to 89% in 2006. The efficiency gains were mainly due to the increased scale efficiency, rather than improved technical efficiency.

The remainder of this paper is organized as follows. Section 2 provides a review of the literature on banking sector efficiency in Turkey and other emerging markets. The data and methodology are presented in Section 3. Section 4 contains the empirical results while Section 5 summarizes the main findings of the study and concludes.

## 2. LITERATURE REVIEW

Over the past twenty years, many emerging countries tended to deregulate their banking sector to improve efficiency and several studies investigated the impact of such liberalization processes. In one such study, Bhattacharyya, Bhattacharyya and Kumbhakar (1997) found that liberalization through deregulation brought about improvements on productivity and efficiency in banking sectors of some Eastern and Central European countries and in China. Leightner and Lovell (1998) analyzed the Thai banking industry for the period between 1989 and 1994. The authors found that Thai banks gained from the liberalization attempts and ended up with increased productivity. However, overall macroeconomic growth was not accomplished. In another study, Gilbert and Wilson (1998) reported that as deregulation took place, the efficiency of Korean banks improved during the period 1980-1994.

In one of the earliest papers about Turkish banking sector efficiency, Oral and Yolalan (1990) employed data envelopment analysis (DEA) to measure the operating efficiencies of 20 branches of a major Turkish bank and showed that DEA is a useful approach for resource allocation among branches. According to the results, the most profitable branches were found to be the service-efficient ones. In a later study, Yolalan (1996) analyzed the impact of liberalization on Turkish financial sector for the years 1981-1990. The author used non-performing loans and non-interest expenses as inputs and owners' equity plus net income, fees and commissions paid, and liquid assets as outputs for the DEA analysis. According to the results, the most efficient banks were foreign ones, followed by the private banks and public banks.

In their study, Denizer, Dinç and Tarımcılar (2000), implementing the DEA method, analyzed the efficiency of the banking sector before and after the liberalization process in Turkey, as well as the scale effect on efficiency by ownership from 1970 to 1994. The authors found that there was a significant decline in efficiency after the liberalization programs and that the Turkish banking sector had a scale problem during the period under investigation. They attributed the decline in efficiency to lower macroeconomic stability in Turkey.

Later on, Işık and Hassan (2002) analyzed the productivity growth, efficiency change and technical progress in Turkish commercial banks during the deregulation of financial markets in Turkey between 1980 and 1990. The authors found that the productivity in all types of Turkish banks had improved, mainly due to efficiency increases resulting from better resource management practices. In another study, Işık, Gündüz, Kılıç and Uysal (2004) investigated how private, foreign and public banks were affected by the financial liberalization process between the years 1981 and 1990, using Malmquist total factor productivity change index. The results showed that financial liberalization was beneficial for all three types of banks. The source of the productivity gains was scale changes for private and state banks and higher technical efficiency in foreign banks.

More recently, Özkan-Günay and Tektaş (2006) used the DEA method to analyze the technical efficiency of private banks for the period between 1990 and 2001. The focus of the study was the association between bank failures and efficiency. The authors further analyzed the sensitivity of efficiency scores to the selection of output variables. The results showed a decline in the average efficiency scores and the percentage of efficient banks throughout the analysis period. The authors also found that the choice of the output variables had a significant impact on efficiency scores. Finally, the results pointed out that failing banks, i.e. the ones taken over by the Savings Deposit Insurance Fund were the most inefficient ones

This paper attempts to complement the literature on Turkish banking efficiency, a portion of which was briefly discussed above, by investigating the period after the 2001 financial crisis. The results are expected to be relevant not only for Turkey but also for other emerging markets as well.

### **3. METHODOLOGY**

In this study, data envelopment analysis (DEA) is employed. This is a non-parametric method which relies on the observation of the population to determine the relative efficiency of the observed units (Denizer et al., 2000). In non-parametric methods, linear mathematical programming techniques are used to calculate the distance between each observation and the efficient frontier. There are no assumptions regarding the independent and dependent variables, sample size can be small and there is no requirement about the form of the production function. Non-parametric methods allow the use of more than one independent and dependent variables, so they are useful in industries where there are several inputs and outputs. However, these methods do not take random error into account. The basic assumption is that there are no random errors and any deviation from the efficient frontier indicates inefficiency. Thus measurement errors are also treated as indicators of inefficiencies. As a result, these techniques are very sensitive to extreme observations and measurement errors.

In DEA, the efficiency of every decision-making unit (DMU), which uses the same multiple inputs and outputs, is assessed relative to other DMUs (Seiford and Thrall, 1990). The DEA method has been widely used to measure banking sector efficiency (Jemric and Vujcic, 2002). The method relies on the investigation of the inputs and outputs of each DMU to determine the most efficient one, which uses the least amount of inputs for a given level of output, or produces the highest output for a specified level of input. Then the efficiency or inefficiency of all other DMUs is evaluated according to this reference point (called the efficient frontier). Thus, in DEA there is no absolute efficiency but relative efficiency.

As explained by Denizer et al. (2000), DEA starts with a fractional programming formulation assuming that each  $DMU_j$  under investigation consumes an amount  $x_{ij}$  of inputs and produces an amount  $y_{rj}$  of outputs. The inputs and outputs are assumed to be non-negative and each DMU is assumed to have at least one positive input and output. The productivity of  $DMU_j$  is defined as the

ratio of the weighted outputs to the weighted inputs and is calculated based on the following formula where  $u$  and  $v$  are the weights assigned to outputs and inputs respectively:

$$h_j = \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \quad (1)$$

DEA optimally assigns the weights by maximizing Equation 1, taking the following constraints into account: First, no other DMU using the same weights should have efficiency greater than 1. The first constraint can be expressed as follows.

$$\frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1 \quad \text{for } j = 1 \dots n \quad (2)$$

The second constraint states that the derived weights are non-negative and can be expressed as follows.

$$v_i \geq 0 \text{ for } i = 1 \dots m, \text{ and } u_r \geq 0 \text{ for } r = 1 \dots s \quad (3)$$

Based on the above, the efficient units are given the efficiency index of 1 and inefficient ones have efficiency indices smaller than 1. DEA also identifies a reference set for each inefficient unit. This comparison gives insight about how inefficient units can improve their efficiency.

In DEA, efficiency can be calculated under two different assumptions: constant returns to scale or variable returns to scale. In the Charnes, Cooper and Rhodes (1978) (CCR) model, also known as the constant returns to scale model, the ratio of multiple outputs to multiple inputs is reduced into the ratio of single virtual output to a single virtual input to measure the efficiency scores. Under this model, the inefficient units are identified regardless of their scale size. On the other hand, Banker, Charnes and Cooper (1984) (BCC) model, also known as the variable returns to scale model, aims at finding the most efficient scale size for each unit and at identifying its technical efficiency by eliminating the effect of its scale.

Using these two different assumptions, one can regard the overall efficiency of a DMU provided by the CCR model as the product of a pure technical efficiency score (provided by BCC score) and a scale efficiency measure. A DMU can be considered as scale efficient when it is operating at the optimal size, while the managers' capability to employ the unit's given resources is measured by pure technical efficiency (Banker and Thrall, 1992).

Additionally, the DEA method allows the calculation of the Malmquist Total Factor Productivity Change Index, based on which efficiency changes (the movement of a unit towards the

efficient frontier) and technological changes (the shift in the production frontier for a given level of input mix of each unit) can be determined (Işık et al., 2004). An efficiency change index greater than 1 indicates efficiency increase, less than 1 indicates efficiency decrease and 1 indicates no efficiency change from time  $t$  to  $t+1$ . Similarly, a technological change index greater than 1 indicates technical progress; less than 1, technical regress; and 1, no technical change. The Malmquist total factor productivity change index is calculated as the product of efficiency change and technological change.

### **3.1. Input Output Selection**

There is no consistency in the literature about the inputs and outputs of banks. However, there are two approaches about the input-output definition of banks: intermediation approach and production approach. In intermediation approach, the bank unit acts as an intermediary to convert funds and deposits to loans and other income-generating-assets. In production approach, the bank unit uses labor, capital and material in order to produce deposits and loans. Output is measured by the number of deposit and inputs are defined as the bank's operating costs.

The production approach is preferable when assessing the cost efficiency of banks (Ferrier and Lovell, 1990); however, intermediation approach is more useful if the main objective is to assess the overall efficiency and viability of banks (Kamberoglou et al., 2004). As the objective of this study is to examine the efficiency changes of the Turkish banking sector between 2001 and 2006, the intermediation approach is employed.

Inputs are defined as total deposits, interest expenses and non-interest expenses (including provisions for loan losses and other operating expenses) and outputs are defined as short-term loans, medium-to-long-term loans, interest income and non-interest income (including net fees and commission income, dividend income, net trading income and other operating income). Interest expenses and interest income are included in order to emphasize the distribution of funds between the banks interest-earning assets and its interest-bearing liabilities. In order to emphasize the non-traditional activities of banks, non-interest income and expenses are included.

### **3.2. Sample Selection**

The overall efficiency of Turkish banking sector between the years 2001 and 2006 is examined. 20 banks which constitute 93.3% of total assets, 92.5% of total credits and 97.9% of total deposits of Turkish banking sector during 2001-2006 are included in the sample. As the DEA method is very sensitive to extreme points, we exclude the private and state-owned banks with market shares of less than 1% and exclude foreign banks which have a market share of less than 0.1%. The sample consists of three state-owned banks, eleven private banks, and six foreign banks operating in Turkey.

### 3.3. Efficiency Measurement

First of all, assuming constant returns to scale (CRS), the overall efficiency score of each bank in the sample is calculated for each year between 2001 and 2006. Then, assuming variable returns to scale (VRS), we calculate the pure technical efficiency of each bank for each year. By dividing the overall efficiency by the pure technical efficiency we obtain scale efficiency scores of each bank for each year.

Secondly, we calculate the Malmquist Total Factor Productivity Change Index for each bank in the sample for each year between 2001 and 2006.

## 4. RESULTS

Table 1 that follows shows an increase in the percentage of efficient banks in terms of all kinds of efficiency definitions. In 2001, the percentage of efficient (overall) banks was 50% and in 2006 it was increased to 89%. The increase in the percentage of efficient banks was mainly due to the increase in the percentage of scale efficient banks.

**Table 1. Percentage of efficient banks in the sample (%)**

	Overall efficiency (CRS)	Pure technical efficiency (VRS)	Scale Efficiency
2001	50	85	55
2002	70	95	70
2003	65	100	65
2004	75	90	85
2005	75	95	75
2006	89	100	89

As shown on Table 2 below, the geometric mean of efficiency scores of all banks showed that there was an increasing trend in the scores. Although pure technical efficiency scores did not increase much -from 0.97 in 2001 to 1 in 2006-, Turkish banking industry experienced an important increase in scale efficiency, meaning that banks began to operate at the optimal scale.

**Table 2. Average efficiency scores (entire sample)**

	Overall efficiency (CRS)	Pure technical efficiency (VRS)	Scale Efficiency
2001	0.88	0.97	0.90
2002	0.94	0.99	0.95
2003	0.96	1	0.96
2004	0.97	0.99	0.98
2005	0.99	1	0.99
2006	0.99	1	0.99

When we analyzed the efficiency of banks in terms of their ownership structures, we saw that foreign banks were the most efficient banks throughout the analysis period (see Table 3). Although DEA allows us to assess only the relative efficiency of banks rather than absolute efficiency, including

the foreign banks in the sample, we find a chance to get insight about the absolute efficiency of domestic banks, assuming that foreign banks, as they are internationally diversified, perform well in absolute terms. The results indicating that foreign banks performed more efficiently than their domestic counterparts are in line with our previous assumption about absolute efficiency of foreign banks. So, analyzing the DEA results, we can conclude that overall efficiency of the Turkish banking sector has increased in absolute terms. The analysis of pure technical efficiencies of state, private and foreign banks revealed that private banks increased their technical efficiencies. The foreign banks were found to be operating at the optimal scale. State banks increased their scale efficiencies and began to operate at optimal scales, while private banks became close to operating at optimal scales in the recent years of the analysis period.

**Table 3. Average efficiency scores by ownership structure**

	Overall efficiency (CRS)			Pure technical efficiency (VRS)			Scale Efficiency		
	State	Foreign	Private	State	Foreign	Private	State	Foreign	Private
2001	0.88	1	0.82	1	1	0.95	0.88	1	0.86
2002	0.94	1	0.92	1	1	0.99	0.94	1	0.92
2003	0.93	0.98	0.95	1	1	1	0.93	0.98	0.95
2004	1	0.97	0.96	1	1	0.98	1	0.97	0.97
2005	1	1	0.98	1	1	1	1	1	0.98
2006	1	1	0.98	1	1	1	1	1	0.98

The DEA-type Malmquist Index as displayed on Table 4 shows the productivity changes of DMUs from one period to the other. From 2001 to 2002, there was an improvement in the productivity of the whole banking sector, which was due to technological changes. Following the structural changes that began in 2001, banks tried to increase their productivity by making technological investments, which resulted in a shift in the efficiency frontier. For the following years, no significant increase in the technological investments and thus productivity gains were observed.

**Table 4. Malmquist Total Factor Productivity Change Index scores (entire sample)**

	Malmquist Index	Efficiency Change	Frontier Shift
2001-2002	1.10	0.93	1.18
2002-2003	0.90	0.99	0.90
2003-2004	0.99	0.99	1.01
2004-2005	0.82	0.98	0.84

As shown on Table 5 below, when the productivity changes of banks is analyzed according to ownership structures, the increase in the overall productivity of the whole banking industry was observed to be mainly due to the productivity gains of private and foreign banks.



**Table 5. Malmquist Total Factor Productivity Change Index by ownership structure**

	Malmquist Index			Efficiency Change			Frontier Shift		
	State	Foreign	Private	State	Foreign	Private	State	Foreign	Private
2001-2002	0.90	1.38	1.01	0.93	1.00	0.90	0.96	1.38	1.13
2002-2003	0.63	1.06	0.88	1.01	1.02	0.96	0.62	1.03	0.91
2003-2004	0.97	1.08	0.95	0.93	1.00	1.00	1.05	1.08	0.96
2004-2005	0.70	0.67	0.94	1.00	0.98	0.97	0.70	0.68	0.96

## 5. CONCLUSION

In this paper, Turkish banking sector's overall efficiency was analyzed during the period between 2001 and 2006, when macroeconomic stability was achieved. The results indicate that Turkey has experienced an increase in the relative efficiency of its banking sector between 2001 and 2006, and the percentage of efficient banks increased throughout the analysis period from 50% in 2001 to 89% in 2006. The efficiency gains were mainly due to the increased scale efficiency, rather than improved resource management.

When the relationship between the ownership structure of the banks and their efficiency gains was investigated, private banks were seen to show the largest amount of increase in their efficiency. The increase in private banks' efficiency was due to both increase in pure technical efficiency and scale efficiency. However, the increase in state owned banks' efficiency mainly resulted from improvements in scale efficiency.

The productivity of the whole banking sector showed a declining trend during 2001-2005 period. The reason of this decrease was mainly the technological regress rather than efficiency decrease. The productivity of private banks showed a relatively stable pattern; however state banks as well as foreign banks witnessed technological regress during the analysis period.

The major limitation of DEA method is that it does not measure absolute efficiency changes of each DMU. Rather it gives the researcher an insight about how each DMU is performing relative to other DMUs. Thus if all the DMUs are bad performers then by employing DEA we can only detect the ones that performs best in the sample of bad performers, and consider it as efficient (relative to others). Although DEA method allow us to only compare banks' efficiencies with respect to the most efficient bank in the sample and thereby only giving relative efficiency of each bank relative to other banks in the sample, by comparing Turkish private and state banks with foreign banks, to some extent we achieved to get insights about their absolute efficiencies, by assuming that foreign banks perform well in absolute terms.

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