Measuring Banking Efficiency in the Pre- and Post-Liberalization Environment: Evidence from the Turkish Banking System*

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Abstract

This paper examines the banking efficiency in a pre and post-liberalization environment by drawing on the Turkish experience. The paper also investigates the scale effect on efficiency by ownership. Our findings suggest that liberalization programs were followed by an observable decline in efficiency. Another finding of the study is that the Turkish banking system had a serious scale problem during the study period. One major reason for such system-wide efficiency decline may be the increased macroeconomic instability Turkish economy in general and financial sector in particular experienced during the study period.

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The findings, interpretations, and conclusions are entirely those of authors, and do not necessarily represent the views of the World Bank, its executive directors, or the countries they represent.
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INTRODUCTION

Over the last two decades the globalization of financial markets has gained additional momentum as a result of liberalization programs undertaken by various countries. This, in turn, enhanced the economic links between these markets and hence deepened the integration of financial institutions (Ragunathan, 1999). As a result, these financial institutions face today a fast-paced, dynamic, and competitive environment at a global scale. Within such a competitive environment, financial institutions are forced to examine their performance because their survival in the dynamic economies of 21st century will be dependent upon their productive efficiencies. Some earlier studies (Berger and Humphrey, 1991; Berger, Hancock and Humphrey, 1993; and Berger, Hunter and Timme, 1993) showed that, particularly in banking sector, inefficiencies are more important than scale and scope issues. Hence, in response, firms have been trying to adapt and to adjust themselves to improve their productive efficiencies in this changing social and economic environment (Harker and Zenios, 2000).

For the past 20 years these circumstances prompted many countries to liberalize their financial sector through deregulation in order to improve efficiency performance. Bhattacharyya, Bhattacharyya and Kumbhakar (1997) report that deregulation and liberalization had a major impact on productivity and efficiency increases in various industries and the banking sector in some Eastern and Central European countries, as well as China. Although the primary goal of liberalization and deregulation has been to improve efficiency, earlier results have been mixed, -in particular, the short-term effects of liberalization have been discouraging (Leightner and Lovell, 1998; Harker and Zenios,

2000). For example, Berg, Forsund and Johnson (1991) found that in Norway during 1980-89 the productivity of banks declined initially but eventually rose. Zaim (1995) reported efficiency gains in Turkish banks after the 1980 liberalization program. Leightner and Lovell (1998) investigated the Thai banking industry from both the bank and the government's perspective from 1989 to 1994. They found that the average Thai bank had a rapid productivity gain based on its own objectives, but that during this period productivity gains from the liberalization program could not help advancing the government objectives (overall economic growth). Korea launched a major financial liberalization program in the 1980s. Gilbert and Wilson (1998) examined Korean banking institutions between 1980 and 1994 and found that most Korean banks experienced efficiency gains during this period as government controls were lifted. On the other hand, it was found that in the U.S. (Humprey and Pulley, 1997) and in Spain[1] (Grifell-Tatje and Lovell, 1996) deregulation resulted in a decline in efficiency.

It will be prudent to keep in mind that the consequences of deregulation may differ across countries and may also depend on the sectoral conditions prior to deregulation. Furthermore, it should be noted that all of the aforementioned studies investigated the efficiency after or during the deregulation period without covering the period before liberalization/deregulation programs. This may have altered the real impact of such programs. Extending the evaluation to before and after liberalization could show the real impact of liberalization programs on efficiency, but this has not yet been demonstrated (Harker and Zenios, 2000). There have been a number of studies on liberalization programs and their impact on efficiency in industrialized countries and

[1] Later, Grifell-Tatje and Lovell, (1997) employed a different specification and reached to the opposite conclusion.

transition economies. However, a limited number of studies have been undertaken in the context of mixed developing economies where deregulation and liberalization programs have been introduced (Bhattacharyya et al, 1997).

Turkey has undergone a number of major policy changes in bank regulation over the last 20 years (Zaim, 1995; Zaim and Taskin, 1997; Denizer, 1997). The country's banking sector has been a target of heavy regulatory interventions[2] for a long time. However, since the 1980s there has been a persistent move to liberalize banking markets in order to increase competition and hence to improve the efficiency of the financial systems. The liberalization program either abolished or relaxed regulations, and the sector responded quickly to these developments. Increased competition forced the banks to reduce their costs, which resulted in the closure of unprofitable branches and the reduction of staff. This eventually increased the profitability of the banking system (Mahmud and Zaim 1997). Even after such improvements, the question of whether financial reforms improved efficiency remains to be answered. Some earlier studies (Zaim, 1995; Ertugrul and Zaim, 1996) examined the impact of financial liberalization on the efficiency of Turkish banking and found that liberalization had a positive effect on efficiency. These studies, however, were focused on certain functions of banking and were limited to few years after the liberalization program. Hence, a comparison of before

[2] Gual (1999) groups these regulatory interventions into three major categories. The first one is regulations that soften domestic competition. This category includes controls on credit, interest rates and fees, restrictions on entry and mergers and acquisitions, and controls on capital flows. The second group is regulations that limit the scope and scale of banks. This category involves restrictions on domestic branching and establishment in foreign markets, and limits to activities within conventional banking, insurance, and securities. The last group is mainly concerned with regulations that alter the external competitive position of banks. This final category deals with reserve and investment coefficients, solvency and capital adequacy regulations, deposit insurance schemes, and restrictions on ownership linkages with non-financial firms.

and after liberalization was not possible. Mercan and Yolalan (2000) provide an excellent survey of other studies of the efficiency of Turkish banks.

In this paper, we use a non-parametric mathematical programming model, DEA, for each year from 1970 to 1994 to determine whether or not the liberalization program improved the efficiency of the Turkish banks by function and by ownership. It is hypothesized that after liberalization with the increasing new entries and relaxed regulation competition will intensify, which in turn will discipline banks in resource management and force them to be more efficient. We also examine the sources of inefficiency by function and by ownership.

This study significantly differs from earlier works in two respects. First, the application of a two-stage DEA methodology to the banking sector facilitates investigation of both production and intermediation functions of the banks to determine the relationship of these two components of bank operations. It allows us to examine the banks' efficiency in separate dimensions without one biasing the other. Although these components are two discrete analyses, they complete a continuum in presenting a more comprehensive picture of the system. Secondly, the temporal focus of the study is 1970 to 1994. Using an unprecedented twenty-five year time series of data improves the chances of identifying the long-term policy implications and comparing efficiency before and after liberalization.

The organization of the paper is as follows: The next section gives a short history of recent policy and regulation changes in the Turkish banking sector. Section 3 discusses methodology and its strengths. A two-stage modeling framework is presented, which considers both roles in this section. The selected variables and reasoning behind the

selection with the modeling framework are also discussed. Section 4 presents the findings and discussion. The paper concludes with suggestions for future research.

TURKISH BANKING SECTOR REFORMS

Until the 1980s, economic policies in Turkey were inward looking, with extensive protection against foreign competition. During this period the share of state in banking, for example, reached to more than 50 percent (Zaim and Taskin, 1997; Denizer, 1997). Because of entry restrictions prior to 1980, Turkish commercial banks enjoyed an oligopolistic environment and faced almost no competition. As a result these banks were highly profitable. Such profitability may have given overconfidence to commercial banks, which in turn might have prevented a careful analysis of bank performance and managerial ability of their executives. This lack of awareness would have caught these institutions off-guard after the liberalization program (Oral and Yolalan, 1990).

As a part of a structural adjustment program to switch to an outward-oriented growth strategy, the Turkish economy in general and financial system in particular have been significantly opened up and liberalized over the last two decades. The banking-related component of these reforms had two key elements: the elimination of controls on interest rates and a significant reduction in directed credit programs, as well as the relaxation of entry barriers into the banking system in order to promote competition and increase efficiency. There were also measures to develop equity and bond markets. In 1984 Turkish residents were allowed to open foreign currency accounts in banks, thereby increasing product variety and services. This process culminated in the opening up of the

capital account in 1989, further facilitating international trade in goods and financial services.

These were important changes considering the earlier constraints on financial markets. Interest rates had been controlled since the 1940s -a policy in keeping with the state-led development strategy based on import substitution. Rates had been changed only five or six times until 1978. The interest rate control policies led banks already in the system to non-price competition through the opening of new branches. Directed credit programs absorbed almost 75 percent of loanable funds. Entry, especially after the early 1960s, was highly restrictive. This situation, coupled with the exit of a large number of banks during the 1960-80 period, resulted in a concentrated market dominated by large private and public banks with extensive branch networks. Among the 42 existing banks in 1980, only four were foreign. Accordingly, the bank-dominated financial sector was uncompetitive and inefficient prior to 1980 with a limited range of products (Denizer, 1997). Moreover, the government strictly controlled the capital account.

There were marked changes in the financial sector following the liberalization of financial prices and policies in the 1980s. The Istanbul Stock Exchange was reopened and, over time, became an integral part of the financial system. Government securities began to be auctioned in 1985 and quickly became an important portion of the stock of financial assets. The inter-bank market began to operate in 1986, allowing banks to lend and borrow from each other for overnight facilities. While these liberalization activities were taking place, Turkey did not privatize the large public banks. These banks still play a significant role in the banking sector, accounting for about 40 percent of total banking assets.

What has been remarkable about financial liberalization in Turkey has been the entry of new banks, both domestic and foreign. By 1990 there were 23 foreign banks in the system, meaning 19 new entries, which matches the number of new entries by the Turkish banks. With interest rate deregulation, which allowed banks to engage in price competition, the entry of new banks led to a significant decline in the traditional measures of concentration ratios, suggesting that competition in the sector has improved.

These visible changes indicate that there have been major movements towards the free operation of financial markets. Indeed, by 1998 the Turkish banking sector had minimal policy constraints on domestic and financial market intermediation (Denizer, Gultekin, and Gultekin, 2000). Although this is the outcome targeted by the reforms, whether the reforms achieved their key objective, namely, increasing the efficiency of the financial sector, is more difficult to assess. A casual look at the present banking sector suggests efficiency improvements have been less than expected, as operating ratios remained relatively high. As noted earlier, the few existing studies do not fully take into account the various dimensions of efficiency measures. This study aims to fill that gap in the literature.

METHODOLOGY

The two approaches used to assess productive efficiency of an entity, parametric (or econometric) and non-parametric (mathematical programming), employ different techniques to envelop a data set with different assumptions for random noise and for the structure of the production technology. These assumptions, in fact, generate the strengths

and weaknesses of both approaches. The essential differences and the sources of (dis)advantages of these approaches can be grouped under two categories: (a). The econometric approach is stochastic and attempts to distinguish the effects of noise from the effects of inefficiency; it is based on sampling theory for the interpretation of essentially statistical results. The programming approach is non-stochastic, and hence groups noise and inefficiency together and calls this combination "inefficiency." It is built on the findings and observation of population and assesses efficiency relative to other observed units. (b). The econometric approach is parametric and confounds the effects of misspecification of functional form with inefficiency. The programming model is non-parametric and population-based and hence less prone to this type of specification error (Lovell 1993).

This inquiry employs the non-parametric frontier approach[3] to estimate the relative efficiency of commercial banks in Turkey. This approach, also known as Data Envelopment Analysis (DEA), is a mathematical programming technique that measures the efficiency of a decision-making unit (DMU) relative to other similar DMUs with the simple restriction that all DMUs lie on or below the efficiency frontier (Seiford and Thrall, 1990). It was first introduced by Charnes, Cooper and Rhodes in 1978. Since then its utilization and development have grown rapidly including many banking-related applications. For a detailed review of these extensions and developments in DEA, see Charnes, Cooper, Lewin and Seiford, (1994) and Seiford, (1994, 1996).

This analysis is concerned with understanding how each DMU is performing relative to others, the causes of inefficiency, and how a DMU can improve its

[3] Bauer, Berger, Ferrier and Humphrey (1998) provide a detailed comparison of methods used in measuring the efficiency of financial institutions.

performance to become efficient. In that sense, the focus of the methodology should be on each individual DMU rather than on the averages of the whole body of DMUs. DEA calculates the relative efficiency of each DMU in relation to all the other DMUs by using the actual observed values for the inputs and outputs of each DMU. It also identifies, for inefficient DMUs, the sources and level of inefficiency for each of the inputs and outputs (Charnes, Cooper, Lewin and Seiford, 1994).

Basic DEA Models

DEA begins with a relatively simple fractional programming formulation. Assume that there are n DMUs to be evaluated. Each consumes different amounts of **i** inputs and produces **r** different outputs, i.e. DMUj consumes $\mathbf{x_{ji}}$ amounts of input to produce $\mathbf{y_{jr}}$ amounts of output. It is assumed that these inputs, $\mathbf{x_{ji}}$, and outputs, $\mathbf{y_{jr}}$, are non-negative, and each DMU has at least one positive input and output value. The productivity of a DMU can be written as:

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

In this formulation, *u* and *v* are the weights assigned to each input and output. By using mathematical programming techniques, DEA optimally assigns the weights subject to the following constraints:

The weights for each DMU are assigned subject to the constraint that no other DMU has an efficiency greater than 1 if it uses the same weights, implying that efficient DMUs will have a ratio value of 1.

The derived weights, *u* and *v* are not negative.

The objective function of DMUk is the ratio of the total weighted output divided by the total weighted input:

$$\text{Maximize } h_k = \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}} \qquad (2)$$

$$\text{subject to } \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \text{ for j=1 … n} \qquad (3)$$

$v_i \geq 0$ for i = *1….m*, and $u_r \geq 0$ for *r = 1…..s*

This is a simple presentation of basic DEA model.

Charnes, Cooper and Rhodes (1978) employed the optimization method of mathematical programming to generalize the Farrel (1957) single-output/input technical-efficiency measure to multiple-output/multiple-input case. The characteristics of the Charnes, Cooper and Rhodes (CCR) ratio model is the reduction of the multiple-output /multiple-input situation for each DMU to a single virtual output and a single virtual input ratio. This ratio provides a measure of efficiency for a given DMU, which is a function of multipliers. The objective is to find the largest sum of weighted outputs of DMU_k, while keeping the sum of its weighted inputs at the unit value, thereby forcing the ratio of the weighted output to the weighted input for any DMU to be less than one. The CCR model is also known as the constant return to scale model, and it identifies inefficient units regardless of their scale size. In the CCR models, both technical and scale inefficiency is present.

Banker, Charnes and Cooper (1984) take into account the effect of returns to scale within the group of DMUs to be analyzed. The purpose here is to point out the most

efficient scale size for each DMU and at the same time to identify its technical efficiency. To do so, the Banker, Charnes and Cooper (BCC) model introduces another restriction, convexity, to the envelopment requirements. This model requires that the reference point on the production function for DMUk will be a convex combination of the observed efficient DMUs. The BCC model, known as variable returns to scale model, gives the technical efficiency of DMUs under investigation without any scale effect.

It is possible to create and estimate models that provide input-oriented or output-oriented projections for both CCR (constant returns to scale) and BCC (variable returns to scale) envelopment. An input-oriented model attempts to maximize the proportional decrease in input variables while remaining within the envelopment space. On the other hand, an output-oriented model maximizes the proportional increase in the output variables, while remaining within the envelopment space.

The Warwick Windows DEA version 1.02 is used in this study to solve the models. CCR and BCC input oriented models have been executed for every year from 1970 to 1994 for commercial banks in Turkey. These models identify efficiency in two stages; the intermediate point is first obtained, and then the subsequent projection point is found by solving the second stage. Formulations of these models are presented in Appendix B.

Variable Selection[4]

It is commonly acknowledged that the choice of variables in efficiency studies significantly affects the results. A number of studies present results that differ due to variable selection (Favero and Pappi, 1995; Hunter and Timme, 1995). There are,

however, certain limitations on variable selection due to the reliability of the data. For example, the variables may present different information, although they carry the same label, or the same information may be reported under different labels. This variation stems from the lack of reporting standards in banking industry. On the other hand, the use of unnecessary variables clutters the analysis and makes it difficult to interpret for both parametric and non-parametric studies. The burden is on the study to tediously justify the selection process. The variable selection for this study relied mainly on classical banking theory.

Another important complication in bank efficiency studies that affects the variable selection and hence the results is the definition of a bank's function. Therefore, before discussing the application and variable selection it is useful to understand the banking process, thereby furnishing guidelines for variable selection and application processes.

The role of a commercial bank is generally defined as collecting the savings of households and other agents to finance the investment needs of firms and consumption needs of individuals. Three approaches in the banking literature discuss the activities of banks: the production approach, the intermediation approach and the modern approach (Freixas and Rochet, 1997). The first two approaches apply the traditional microeconomic theory of the firm to banking and differ only in the specification of banking activities. The third approach goes one step further and incorporates some specific activities of banking into the classical theory and hence modifies it.

In the production approach, banking activities are described as the production of services to depositors and borrowers. Traditional production factors, land, labor and capital, are used as inputs to produce desired outputs. Although this approach recognizes

[4] Golany and Roll (1989) provide an in-depth discussion of variable selection process in DEA applications.

the multi-product nature of banking activities, earlier studies ignored this aspect of banking products, partly because the techniques to deal with scale and scope issues were not well developed (Freixas and Rochet, 1997). This approach suffers from a basic problem in terms of measurement of outputs. Is it the number of accounts, the number of operations on these accounts, or the dollar amounts? The generally accepted approach is to use dollar amounts because of availability of such data.

The intermediation approach is in fact complementary to the production approach and describes the banking activities as transforming the money borrowed from depositors into the money lent to borrowers. This transformation activity originates from the different characteristics of deposits and loans. Deposits are typically divisible, liquid and riskless, while on the other hand loans are indivisible illiquid and risky. In this approach, inputs are financial capital –the deposits collected and funds borrowed from financial markets, and outputs are measured by the volume of loans and investments outstanding.

The modern approach has the novelty of integrating risk management and information processing into the classical theory of the firm. One of the most innovative parts of this approach is the introduction of the quality of banks' assets and the probability of banks' failure in the estimation of costs. It can be argued that this approach is embedded in the previous approaches (Freixas and Rochet, 1997). This third approach, perhaps, can be best represented through the ratio-based CAMEL approach. In this approach, **C**apital adequacy, **A**sset quality, **M**anagement, **E**arnings and **L**iquidity are derived from the financial tables of the bank and are used as variables in the performance analysis (Mercan and Yolalan, 2000).

Banks were analyzed as production units in some earlier studies (Ferrier and Lovell, 1990; Shaffnit, Rosen and Paradi, 1997; Zenios, Zenios, Agathocleous, Soteriou, 1999; Athanassopoulos and Giokas, 2000), while others considered them as intermediary institutions (Barr, Seiford, and Siems, 1994; Athanassopoulos and Giokas, 2000). The importance of the definition of banking function is clear in determining the input and output variables for an efficiency study. Although it is obvious that the banks carry both functionalities, for a quantitative study the choice has to be made due to a conflict in variable definitions.

In light of these considerations, this study utilizes the production and intermediation approaches complementarily in the analysis of the efficiency of Turkish commercial banks. It is assumed that banking is a simultaneously occurring two-stage process. During the production stage banks collect deposits by using their resources, labor and physical capital. Banks use their managerial and marketing skills in the intermediation stage to transform these deposits into loans and investments. This framework is employed to determine the application process as well as the selection of inputs and outputs for the analysis of efficiency.

Figure 1 Banking Process

Following the above-discussed framework, three variables were selected as inputs for production stage of the banking: total own resources of the bank, total personnel expenses, and the interests and fees paid by the bank. At this stage a bank produces two outputs: total deposits and income from charges and commissions collected. The outputs of the previous stage may be seen as inputs for the intermediation process, and hence total deposits will be input. In addition operating expenditures, excluding personnel

expenses, will be the other input in this stage. Since personnel expenses are used as an input in the previous stage in order to avoid double counting, this variable is not included into the operating expenses in the intermediation stage as an input. The outputs of this stage are total loans and banking related income (interest and commission collected, and charges and commission for banking). All input and output variables are normalized by dividing them by the number of branches.

All data used in this study come from the Banks Associations of Turkey.

Application

Within this framework, this study utilizes a two-stage DEA analysis. In the first stage, the relative efficiency of the production process of banking is assessed. In the second stage the efficiency of intermediation process of banking is examined. The underlying reason for this is that a bank may perform relatively better in collecting deposits by using less resources than its competitors, compensating its losses in the intermediation process or vice versa. The performance matrix shows that a bank may be in four different positions regarding its performance in the production and intermediation processes. It is obvious from the performance matrix that the most desirable position is the first row where a bank performs well in both the production and intermediation processes. However, these institutions are for-profit entities, -depending on the gains from the each process, a bank may intentionally choose either the second or the fourth row to accomplish some short-term objectives i.e. market share growth or introduction of a new financial product.

Figure 2 Performance Matrix

Scale Issue

Although commercial banks are homogeneous with respect to their organizational structure, goals and objectives, they vary significantly in size and production level. Even after normalizing the data, this suggests that the scale of banks plays an important role in their relative efficiency or inefficiency. As previously stated, the CCR model comprehends both technical and scale efficiency. The BCC model, introduced by Banker, Charnes and Cooper (1984), separates technical efficiency and scale efficiency. Indeed, they showed that the CCR efficiency measure can be regarded as the product of a technical efficiency measure, given by the BCC efficiency score and a scale efficiency measure (Banker and Thrall, 1992). BCC also modified the original CCR linear programming formulation by adding a convexity constraint for the production possibility set to estimate not only technical efficiency, but also returns to scale (Banker et al., 1984; Banker and Thrall, 1992).

Banker (1984) showed that the CCR measure captures not only the productive inefficiency of a DMU at its actual scale size, but also any inefficiency resulting from its actual scale size being different from the most productive scale size. A most productive scale size maximizes average productivity. In order to maximize average productivity, a DMU would have to increase its scale size if increasing returns to scale were prevailing, and decrease the scale size if decreasing returns to scale were prevailing (Banker, 1984). It follows that a technically efficient and scale efficient DMU will be in the most productive scale size.

Given that the CCR efficiency score is a product of technical and scale efficiency, and BCC measures pure technical efficiency, then the ratio of the efficiency scores $S_k = \frac{q_{k,CCR}}{q_{k,BCC}}$ yields a measure of the relative scale efficiency of bank *k*. If *S* = 1 it is said that bank *k* is operating at the most efficient scale size. If it is less than unity, this means there is scale inefficiency for bank *k*. Thus, *(*1-*S)* represents the relative scale inefficiency of a bank (Banker et al., 1984; Banker and Thrall, 1992; Banker et al., 1996). The units that are CCR efficient will also be scale efficient, since scale was already factored in the CCR model. Thus, the two are equal. The units that are BCC efficient, but inefficient based on the CCR model, have a scale inefficiency. Since they were technically efficient, all of the inefficiencies picked up by CCR are due to scale. Those units that are CCR efficient are considered most productive scale sizes, as the average productivity of each of those units is maximized.

This can serve as a useful diagnostic tool for decision makers and bank directors. Once technical and scale efficiency are isolated, the next step is to determine the share of the overall inefficiency that is attributable to technical inefficiency and scale inefficiency.

FINDINGS AND DISCUSSION

This study examines the impact of financial liberalization of 1980 on Turkish banks in terms of efficiency gains (losses) as well as sources of inefficiencies. The analysis produced four sets of efficiency scores for each year from 1970 to 1994. They are the total efficiency scores, which are generated by the CCR model and the technical efficiency scores, which are generated by the BCC models for both stages of banking

process, namely production and intermediation. These scores are presented as annual averages of banks under investigation for the whole Turkish banking system. Although averaging the scores causes loss of information, particularly the variation among individual banks, analyzing and reporting them all on an individual bank basis would require a separate study. The number of banks under investigation ranged from 29 in 1976 and 1977 to 53 in 1991 (see Appendix A Table 1). Recall that the main hypothesis of the study was that the liberalization policies would have a positive impact on banking sector efficiencies. If the liberalization had a positive impact on the overall efficiency of Turkish Banking system, it is expected that the annual average efficiency scores would increase over time.

Average Efficiency of Turkish Commercial Banking

The results of the CCR model for both production and intermediation processes of the banking system are presented in Figure 3 (see also Appendix A Table 3). From 1970 to 1994, the average relative efficiency of Turkish banking in terms of production process fluctuated wildly, from a high 80 percent to a low 47 percent. Prior to 1980, the production performance of the banking systems appeared to be relatively more stable than after liberalization, with an average efficiency ranging from 71 percent to 80 percent. After liberalization, banking efficiency increased until 1984, although it never reached its earlier performance level. The relative efficiency of Turkish banking began to fluctuate after 1985. The results for the production process of banking as shown in Figure 3 suggest that the annual average efficiency of the banking system as a whole followed a

downward trend, which also suggests that the liberalization program did not fulfill its promise in terms of efficiency gains in the production process of banking.

Figure 3: Average Efficiency of Turkish Banking (CCR)

Figure 3 also shows the results of CCR model for intermediation process. The Turkish banking system had relatively lower efficiency scores in intermediation than production, and similar to the production process, fluctuated wildly from a high of 82 percent to a low of 35 percent. This suggests that the banking system performed relatively poorly in its basic function: transforming deposits to loans. The slope of the trend line for intermediation, which is steeper than production, is another indicator of this fact. The performance of the Turkish banking system declined between 1978 1990, although there was a short recovery period from 1981 to 1985.

Despite the homogeneity of their organizational structure, goals, and objectives, banks vary significantly in size and production level. Even with normalizing, as in this study, the data may not address the scale effect on their relative efficiency or inefficiency. We know that the CCR model comprises both technical and scale efficiency together. Hence, the above results include inefficiencies resulting from sub-optimal scale size of Turkish banks. In order to determine the level of scale inefficiency and in order to identify pure technical efficiency, the BCC model, which separates technical efficiency and scale efficiency, has been applied to both the production and intermediation functions of banks.

Figure 4 Average Efficiency of Turkish Banking (BCC)

The results of the BCC model are presented in Figure 4 (see also Appendix A Table 2). As seen in this figure, after removing the scale effect, the efficiency pattern of

the Turkish banking system remained the same, but the level of efficiency increased relative to the CCR model. Similar to the CCR model, the efficiency trends for production and intermediation functions were downward suggesting no positive effect of liberalization on efficiency. These findings suggest that, during the study period, the Turkish banking system had a scale problem.

This downward trend of the efficiency of the Turkish banking system for both production and intermediation processes may not reflect the real effect of liberalization program because of earlier shocks. In order to eliminate the effects of such shocks, we examined the efficiency scores from 1981 to 1994. Figures 3 and 4 display the trends for CCR and BCC models, respectively.

Figure 5: Average Efficiency of Turkish Banking after Liberalization (CCR)

In general, the trends are still downward, with the exception of technical efficiency of intermediation function. Moreover, the slopes of the CCR efficiency scores are steeper for the post-policy adjustment period (Figure 5). These results lead one to believe that the liberalization program did not increase the efficiency of the Turkish banking system to higher levels as anticipated. However, there are some indications of progress, although isolated, in intermediation processes. The CCR scores for 1990 through 1994 indicate some progress in increasing efficiency (Figure 5). Moreover, after removing the scale effect, the downward efficiency trend levels off for the intermediation process (Figure 6). This may mean that if the Turkish banking system had operated at the optimum scale, the liberalization program would have had an even greater positive impact on the efficiency of banks.

Figure 6: Average Efficiency of Turkish Banking after Liberalization (BCC)

Following the earlier discussion, the overall scale efficiency of Turkish banking system is calculated by using the CCR to BCC ratio, $S_k = \frac{q_{k,CCR}}{q_{k,BCC}}$. The results are presented in Figure 7. Recall that the higher the value of *S*, the lower the scale problem of the system. The scale efficiency of the Turkish banking system ranged from 75 percent to 95 percent for the production process and from 64 percent to 93 percent for the intermediation process over the period examined (see Figure 7). This means that the Turkish banking system suffered from 5 percent to 25 percent efficiency loss in the production process and from 7 percent to 36 percent in the intermediation due to scale problems. Figure 7 shows that scale problem for intermediation intensifies after liberalization.

Figure 7 Scale Efficiency of Turkish Banking System

Average efficiency scores by ownership

The number of commercial banks in Turkey remained constant before 1980, at 30 (with the exception of 1976 and 1977 when it was 29). The number increased steadily after 1980 reaching 53 in 1990 (see Appendix A Table 1). All of these banks were commercial banks, but their ownership structure was different: some were state banks, some were privately owned, and others were owned by foreign financial institutions. Since the overall objectives and organizational structure of these banks were the same, and since they operated in the same environment, we included all of them in the analysis. However, it should be kept in mind that each one of these groups might have responded to the liberalization program differently. In order to examine this issue, we looked at their

efficiency scores separately, with CCR and BCC models for both production and intermediation processes (Figures 8 and 9).

The results of the CCR model for production process are presented in Figure 8 (see also Appendix A Table 4). All groups had their lowest efficiency scores in 1993 (37.5 percent, 52.7 percent and 43.8 percent for state, private and foreign owned banks, respectively). The highest score for state-owned banks is 79 percent, for private banks 88 percent, and for foreign owned banks 93.8 percent. Prior to 1980, state owned banks performed poorly, whereas privately owned banks had a relatively better and stable performance during the same period. Foreign-owned banks fluctuated, but outperformed state banks and, in some years, even private banks. The efficiency scores of all groups converge somewhat after 1980, though all fluctuate wildly. One interesting result was that, after liberalization, they all follow a similar fluctuating pattern, which indicates that banks were responding to economic changes similarly.

Figure 8 Efficiency of Turkish Banks by Ownership (CCRp)

In terms of the intermediation process, state-owned banks outperformed their private and foreign-owned counterparts until 1988, while private banks were the least efficient group until 1992. The efficiency scores for all groups in this category followed a similar downward trend, particularly after 1984 (Figure 9). The better performance of state banks in intermediation suggests that they did not utilize their own resources efficiently in production, which implies highly publicized political interference cases. The increase in the efficiencies after 1990, similar to the general efficiencies of Figures 3 and 4, should be noted.

Figure 9 Efficiency of Turkish Banks by Ownership (CCRi)

When the scale effect from the production process is removed, the efficiency scores for all groups improved as anticipated (Figure 10). Although the pattern is almost the same, the wild fluctuation, particularly after liberalization period, is relatively steady. This indicates that, regardless of ownership, all of these banks had serious scale problems. The fluctuation of efficiency scores becomes much smoother after the liberalization period, especially for the state banks. In fact, state owned banks improved their technical capacity in production process after liberalization program.

Figure 10 Efficiency of Turkish Banks by Ownership (BCCp)

Figure 11 Efficiency of Turkish Banks by Ownership (BCCi)

In terms of the intermediation process, removing the scale effect by using the BCC model produces similar outcomes: higher efficiency scores with relatively less fluctuation and almost the same pattern (Figure 11). In this category, state banks performed better than the others over the study period, although there was no clear dominance of state banks as in the CCR model. Private banks, on the other hand, remained the poorest performing group until 1992. Another important outcome of the BCC model for intermediation process is that the efficiency scores of all groups became closer to each other, suggesting that these groups had different scale efficiencies during the study period.

The scale efficiency scores of Turkish banking by ownership are presented in Figures 12 and 13 for both the production and intermediation processes. The scale efficiency of state and private banks in the production process follow a similar pattern, and their scores are relatively close to each other. Foreign-owned banks, on the other

hand, operated at a relatively better scale size, and hence have better scores most of the time.

Figure 12 Scale Efficiency of Turkish Banking System by ownership (production)

Another important finding of this analysis is that scale efficiency scores of all groups are relatively stable for the years prior to the liberalization program, but after 1980 they fluctuate dramatically, indicating serious scale problems. In terms of the intermediation process, state banks operated at a better scale level than their private and foreign-owned counterparts, and had relatively steady scale efficiency until 1987. The figures for private and foreign-owned banks vary over the same period, and their scale efficiency is similar. All groups experienced a steep decline in scale efficiency after 1987. These results confirm that Turkish banking system, particularly after the liberalization program, had a serious scale problem.

Figure 13 Scale Efficiency of Turkish Banking System by ownership (intermediation)

Percentage of efficient banks

There is a possibility that the decline of average efficiency scores may be due to a few very inefficient banks rather than an overall trend. The percentage of efficient banks and their time series trend prompt an analysis of this hypothesis. Figures 14 and 15 display this data respectively for production and intermediation processes. These results confirm the earlier findings that the policy change did not bring about the intended results, at least in terms of increasing efficiency.

Figure 14 Percentage of Efficient Banks (Production)

Figure 15 Percentage of Efficient Banks (intermediation)

Sources of Inefficiency

One of the strengths of DEA is its ability to provide information about sources of inefficiency in both the input and output sides. This information is extremely useful for managers in improving organizational performance. We have already established the fact that Turkish banking sector struggled with serious scale problems, which, in turn, negatively affected the efficiency of the industry. However, we further demonstrated that, even after the scale effect has been removed, the banking sector still suffered high technical inefficiency. This indicates an excess use of resources, output shortfalls, or some combination of the two. Figures 16 and 17 display the sources of inefficiency for production and intermediation processes without the scale effect, respectively. The upper part of the figures represents output shortfalls and the lower part represents excess use of inputs.

Figure 16 Sources of Inefficiency (BCCp)

Figure 16 shows that, on average, Turkish commercial banks used excessive amounts of resources for all their inputs over the study period. Looking at the lower portion of the Figure, one can observe that until 1980 there was a stable, although not fully efficient, utilization of all inputs. The usage of banks' own resources, occasionally was less efficient than the other two, namely interest and fees paid and personnel expenses. After the policy is introduced, however, the input usage efficiency became less stable with larger variations.

On the output side, the results show that banks performed relatively well in collecting deposits, especially until 1984. However, their non-interest income output

varied radically within a shortfall range of 1 percent to 34 percent, mostly in the higher inefficiency zone. These findings suggests that, on average, Turkish commercial banks could have reduced all of their inputs and, at the same time, they could have produced more in terms of deposits and income.

A similar trend is apparent in the intermediation process, with even greater inefficiencies on the input side. In terms of outputs, Turkish banks performed better in the collection of interest income, while displaying poor efficiency in transforming deposits into loans. Similar to the production process, Turkish banks could have performed better at both ends of the intermediation process.

Figure 17 Sources of Inefficiency (BCCi)

Further Discussion of Results

A review of the findings above demonstrates that there are three emerging patterns irrespective of models or the functional form employed, which should be interpreted within the context of the overall macroeconomic environment as well as the ownership of banks. Before discussing the emerging patterns, it must be noted at the outset that during the period under study inflation has been high and variable, averaging about 30 percent during the 1970s, 60 percent in the 1980s, and above 70 percent during the early 1990s, and a number of stabilization programs failed to control inflation. This volatile environment affected banks' asset and liability choices and had the effect of reducing financial intermediation (Denizer, Gultekin and Gultekin, 2000). In particular, commercial banks reduced their lending and share of credit as the percentage of total bank assets declined over time. The fact that a stable macroeconomic environment has

been lacking, which contributed to uncertainty and the risks banks faced, has probably reduced system-wide efficiency.

The first pattern is that during 1981-1984, the first four years of the post-liberalization period, efficiency in the banking sector has improved in all models and functional forms used. As noted by Atiyas and Ersel (1994), the liberalization measures led to the entry of new banks, and numerous brokerage houses, which resulted in intense competition in the sector. This forced banks to be more efficient, which is probably reflected in the results. However, a financial crisis took place in 1982, which caused many brokerage houses exit the system. It may be the case that the deterioration of efficiency measures after 1984 was related to banks reestablishing themselves as the dominant players in financial markets in Turkey and regaining their market power. In fact, a number of studies showed that, even after the reform program, banks still have market power in Turkey (Aydogan, 1992).

The second pattern coincides with the opening of the capital account in 1989. This has had a major impact on bank funding and investment decisions and may have affected bank efficiency. Our findings suggest that this affect have been positive. Liberalization of the capital account enabled banks to borrow abroad at cheaper rates than domestically available and lend at market rates to the public and private sectors. This may be taken as an indication of one of the benefits of financial integration at the banking firm level, and such a development has had significant impact on the overall efficiency of the Turkish economy.

The third pattern is related to the efficiency differences between public and private banks. In both the production and intermediation processes, public banks seem to

perform better or at least as well as their private and foreign counterparts, which may seem surprising. However, a number of factors probably explain this. Public banks have always enjoyed the benefits of state support and public confidence with respect to safety of deposits. The deposits of public banks increased after the 1982 crisis in particular, which may explain the efficiency jump of public banks in production process in 1982. Another noteworthy aspect of the public ownership of banks is related to credit. Due to political pressures, public banks issue loans more easily than private banks, which has the effect of increasing of their output and making them appear more efficient. However, this may not be the case on a risk-adjusted basis, as public banks carry a large amount of non-performing loans. If adjustments to their outputs were made to reflect loan losses, public banks might actually be much less efficient than private banks. The lack of detailed data on the bad loans of public banks prevents the in-depth examination of this hypothesis.

CONCLUSIONS

This study tested the hypothesis that liberalization policies in the banking sector leads to efficiency increases in the core processes of the banks. Every phase of the analysis, the total efficiency scores by functionality or ownership, the percentage of efficient banks, and the sources of inefficiency suggests that the liberalization did not provide the anticipated efficiency gains. None of the efficiency scores displayed consistent increases after the introduction of the policy. For all measures, the scores became less stable with a wide range of dispersion during the study period. Among the two functions of the banks, intermediation reacted somewhat more favorably to the new policy. The expected result that the opening up of financial markets would have

motivated management to use its resources more efficiently, which would have been reflected positively in efficiency measures did not materialize.

Another unexpected result is the lack of a difference in efficiency between the state-owned and privately owned banks. Due to their relatively smaller size and more dynamic structure, privately owned and foreign-owned banks were expected to react better to liberalization. The findings of this study generally do not support that assumption. Similar results in sources of efficiency, together with other results, may lead one to question the impact of liberalization. Nonetheless, it would be premature to draw such a conclusion without looking into the context of the policy framework and implementation. The fact that macroeconomic environment during the study period has not been stable probably affected the financial system's efficiency and our results. In this connection, macroeconomic stability may be a prerequisite for liberalization policies to lead to efficiency gains.

Furthermore, the liberalization program is a continuous process with multiple phases. As was discussed in Section 2, some of the initiatives were introduced gradually after 1980. As a matter of fact, almost all of the scores display a significant increase in the last years of the study period. One may speculatively suggest that the introduction of the capital account liberalization policy, which allows foreign currency transfer to flow easily beginning in 1989, may be the last piece of the liberalization process. The banking sector might have begun to react to the complete package in later years. Future research that extends the study period beyond 1994 may answer some of these questions.

Appendix A: Tables

Table 1. Number of Banks

1970	30
1971	30
1972	30
1973	30
1974	30
1975	30
1976	29
1977	29
1978	30
1979	30
1980	30
1981	32
1982	33
1983	36
1984	39
1985	42
1986	48
1987	49
1988	50
1989	50
1990	53
1991	50
1992	48
1993	48
1994	47

Table 3. Average Efficiency Scores of Turkish Banking

	CCRp	**BCCp**	**CCRi**	**BCCi**
1970	71.35	82.74	66.29	71.8
1971	77.48	85.8	64.62	72.81
1972	79.52	86.91	59.04	73.16
1973	78.38	83.37	69.62	77.78
1974	79.65	83.99	60.59	74.63
1975	79.83	85.83	70.12	80.45
1976	73.79	83.76	76.76	84.48
1977	76.81	85.05	79.18	85.52
1978	80.29	87.23	82.76	88.7
1979	79.35	83.5	68.47	76.15
1980	73.81	77.9	57.63	63.67
1981	69.98	86.61	47.63	60.74
1982	74.05	84.37	56.28	65.89
1983	79.86	88.55	53.03	63.35
1984	79.37	88.32	61.82	68.49
1985	61.78	78.5	64.22	74.21
1986	71.79	79.49	54.57	67.34
1987	56.51	75.33	53.35	64.7
1988	71.39	84.46	35.31	54.76
1989	72	83.05	38.85	57.23
1990	58.01	76.42	41.09	56.54
1991	62.59	73.44	36.28	55.62
1992	70.55	77.99	43.1	63.34
1993	47.49	59.07	50.81	67.7
1994	64.88	74.42	63.13	73.94

Table 4 Average Efficiency of Turkish Banking by Ownership

		CCRp			CCRi			BCCp			BCCi	
	SAEff	**PAEff**	**FAEff**	**SAEff**	**PAEff**	**FAEff**	**SAEff**	**PAEff**	**FAEff**	**SAEff**	**PAEff**	**FAEff**
1970	48.52	81.31	72.24	75.24	58.28	84.43	56.5	95.32	78.6	77.97	65.53	87.68
1971	59.33	85.82	76.29	70.42	61.28	68.05	62.99	95.01	90	74.67	69.25	85.08
1972	66.47	82.14	93.88	68.25	54.88	59.34	69.45	91.87	99.51	72.75	68.66	94.24
1973	57.38	88.02	76.98	80.61	64.34	71.4	61.25	94.16	79.02	83.28	73.33	86.85
1974	57.8	88.05	85.56	72.08	56.03	58.16	60.27	93.06	90.62	76.42	73.78	74.84
1975	57.76	87.85	87.91	81.1	64.79	72.13	62.85	94.11	94.54	85.05	78.53	79.9
1976	45.22	86.45	73.97	87.57	70.65	84.59	48.76	97.58	94.23	88.67	80.94	94.52
1977	55.47	86.88	73.24	88.51	73.16	90.42	58.19	95.88	91.69	91.97	81.24	94
1978	61.51	86.9	88.11	90.38	78.59	86.34	64.54	95.96	93.34	91.9	86.07	94.09
1979	62.27	83.79	93.5	76.43	63.3	75.82	64.59	89.11	96.08	79.62	73.76	79.93
1980	58.11	77.24	89.8	72.93	48.4	68.54	63.02	81.82	90.06	76.72	54.62	78.33
1981	48.11	75.38	82.92	63.67	40.19	48.57	69.9	95.18	83.2	68.41	56.18	64.17
1982	61.27	75.2	85.69	70.97	48	60.77	76.97	86.52	87.32	77.68	60.49	66.27
1983	79.14	77.65	84.41	70.75	47.53	48.77	89.11	90.4	84.77	75.29	61.59	56.97
1984	75.78	79.42	81.51	72.84	57.44	61.09	87.07	89.5	87.44	78.55	67.09	64.23
1985	75.99	60.68	55.21	79.31	52.33	72.58	86.42	82.33	68.51	86.35	64.36	81.33
1986	62.56	80.28	64.63	72.64	43.38	61.19	83.3	84.82	70.47	74.71	51.74	84.98
1987	48.26	53.62	64.47	70.12	42.06	61.41	80.45	73.86	75.01	77.89	55.56	71.38
1988	60.65	71.05	76.05	39.73	25	47.91	84.05	87.5	80.41	60.34	48.49	61.3
1989	67.63	73.81	71.18	39.38	33.87	45.55	84.22	87.9	75.86	61.51	56.04	57.21
1990	58.13	63.34	51.63	38.77	36.74	47.04	80.01	81.16	69.57	58.46	54.54	58.27
1991	54.28	70.32	55.89	30.59	26.64	50.54	71.21	81.01	64.71	56.18	49.42	63.25
1992	65.22	78.1	62.26	47.4	43.45	41.21	75.06	85.42	69.07	69.27	64.05	60.41
1993	37.51	52.74	43.81	36.06	55.62	49.31	64.15	65.96	48.19	65.12	70.54	64.79
1994	59.69	75.09	53.56	68.36	70.72	51.7	71.43	86.33	60.2	83.7	78.67	64.63

Table 5 Percentage of Efficient Banks in Turkey

	CCRp	**BCCp**	**CCRi**	**BCCi**	**No. of Banks**
1970	0.17	0.3	0.2	0.33	30
1971	0.3	0.5	0.13	0.3	30
1972	0.23	0.5	0.13	0.37	30
1973	0.37	0.5	0.17	0.3	30
1974	0.4	0.53	0.1	0.33	30
1975	0.37	0.47	0.17	0.3	30
1976	0.21	0.59	0.14	0.34	29
1977	0.17	0.52	0.17	0.31	29
1978	0.27	0.57	0.27	0.47	30
1979	0.27	0.47	0.17	0.23	30
1980	0.23	0.3	0.13	0.2	30
1981	0.28	0.56	0.13	0.25	32
1982	0.24	0.52	0.09	0.18	33
1983	0.33	0.5	0.11	0.22	36
1984	0.31	0.54	0.15	0.26	39
1985	0.14	0.36	0.17	0.26	42
1986	0.21	0.29	0.1	0.25	48
1987	0.1	0.24	0.08	0.16	49
1988	0.26	0.42	0.08	0.16	50
1989	0.22	0.42	0.06	0.16	50
1990	0.09	0.3	0.11	0.19	53
1991	0.12	0.28	0.12	0.2	50
1992	0.21	0.31	0.06	0.17	48
1993	0.08	0.21	0.06	0.19	48
1994	0.17	0.3	0.06	0.19	47

Table 6. Scale Efficiency of Turkish Banking

	CCRp / BCCp	CCRi / BCCi
1970	0.86	0.92
1971	0.90	0.89
1972	0.92	0.81
1973	0.94	0.90
1974	0.95	0.81
1975	0.93	0.87
1976	0.88	0.91
1977	0.90	0.93
1978	0.92	0.93
1979	0.95	0.90
1980	0.95	0.91
1981	0.81	0.78
1982	0.88	0.85
1983	0.90	0.84
1984	0.90	0.90
1985	0.79	0.87
1986	0.90	0.81
1987	0.75	0.82
1988	0.85	0.64
1989	0.87	0.68
1990	0.76	0.73
1991	0.85	0.65
1992	0.90	0.68
1993	0.80	0.75
1994	0.87	0.85

Table 7. Scale Efficiency of Turkish Banking by Ownership

	State Owned		Private		Foreign	
	CCRp/BCCp	CCRi/BCCi	CCRp/BCCp	CCRi/BCCi	CCRp/BCCp	CCRi/BCCi
1970	0.86	0.97	0.85	0.89	0.92	0.96
1971	0.94	0.94	0.90	0.88	0.85	0.80
1972	0.96	0.94	0.89	0.80	0.94	0.63
1973	0.94	0.97	0.93	0.88	0.97	0.82
1974	0.96	0.94	0.95	0.76	0.94	0.78
1975	0.92	0.95	0.93	0.83	0.93	0.90
1976	0.93	0.99	0.89	0.87	0.79	0.89
1977	0.95	0.96	0.91	0.90	0.80	0.96
1978	0.95	0.98	0.91	0.91	0.94	0.92
1979	0.96	0.96	0.94	0.86	0.97	0.95
1980	0.92	0.95	0.94	0.89	1.00	0.88
1981	0.69	0.93	0.79	0.72	1.00	0.76
1982	0.80	0.91	0.87	0.79	0.98	0.92
1983	0.89	0.94	0.86	0.77	1.00	0.86
1984	0.87	0.93	0.89	0.86	0.93	0.95
1985	0.88	0.92	0.74	0.81	0.81	0.89
1986	0.75	0.97	0.95	0.84	0.92	0.72
1987	0.60	0.90	0.73	0.76	0.86	0.86
1988	0.72	0.66	0.81	0.52	0.95	0.78
1989	0.80	0.64	0.84	0.60	0.94	0.80
1990	0.73	0.66	0.78	0.67	0.74	0.81
1991	0.76	0.54	0.87	0.54	0.86	0.80
1992	0.87	0.68	0.91	0.68	0.90	0.68
1993	0.58	0.55	0.80	0.79	0.91	0.76
1994	0.84	0.82	0.87	0.90	0.89	0.80

Table 8 Sources of Inefficiency (BCCp)

	OWNRES	INTCOMP	PEREXP	TOTDEPO	CHCOMC
1970	-0.23	-0.23	-0.19	0.11	0.34
1971	-0.27	-0.18	-0.16	0.11	0.23
1972	-0.29	-0.17	-0.15	0.09	0.28
1973	-0.25	-0.19	-0.19	0.05	0.21
1974	-0.20	-0.20	-0.19	0.05	0.28
1975	-0.18	-0.22	-0.16	0.06	0.21
1976	-0.18	-0.19	-0.18	0.02	0.19
1977	-0.19	-0.20	-0.16	0.00	0.12
1978	-0.20	-0.17	-0.14	0.00	0.23
1979	-0.29	-0.20	-0.19	0.00	0.22
1980	-0.35	-0.24	-0.25	0.02	0.34
1981	-0.18	-0.17	-0.15	0.03	0.01
1982	-0.19	-0.16	-0.17	0.01	0.24
1983	-0.18	-0.14	-0.13	0.03	0.04
1984	-0.14	-0.12	-0.14	0.00	0.15
1985	-0.27	-0.32	-0.22	0.17	0.12
1986	-0.23	-0.28	-0.24	0.04	0.05
1987	-0.27	-0.31	-0.31	0.03	0.13
1988	-0.19	-0.20	-0.18	0.10	0.16
1989	-0.24	-0.23	-0.21	0.10	0.18
1990	-0.28	-0.26	-0.25	0.11	0.20
1991	-0.29	-0.29	-0.35	0.39	0.07
1992	-0.25	-0.24	-0.23	0.33	0.15
1993	-0.45	-0.50	-0.44	0.24	0.02
1994	-0.32	-0.26	-0.31	0.02	0.25

Table 9 Sources of Inefficiency (BCCi)

	TOTDEPO	**OPEXP**	**TOTLOAN**	**INTCOMC**
1970	-0.28	-0.30	0.07	0.14
1971	-0.27	-0.29	0.15	0.08
1972	-0.27	-0.31	0.10	0.20
1973	-0.23	-0.25	0.06	0.12
1974	-0.26	-0.27	0.00	0.03
1975	-0.22	-0.23	0.11	0.13
1976	-0.19	-0.19	0.11	0.01
1977	-0.17	-0.14	0.21	0.01
1978	-0.11	-0.11	0.07	0.00
1979	-0.25	-0.24	0.23	0.00
1980	-0.36	-0.39	0.22	0.10
1981	-0.39	-0.40	0.08	0.09
1982	-0.38	-0.38	0.30	0.02
1983	-0.39	-0.38	0.33	0.02
1984	-0.32	-0.32	0.23	0.00
1985	-0.26	-0.28	0.31	0.05
1986	-0.32	-0.33	0.25	0.00
1987	-0.38	-0.37	0.23	0.25
1988	-0.46	-0.46	0.13	0.34
1989	-0.45	-0.45	0.13	0.21
1990	-0.44	-0.43	0.13	0.00
1991	-0.44	-0.44	0.20	0.00
1992	-0.51	-0.37	0.18	0.11
1993	-0.34	-0.32	0.27	0.16
1994	-0.29	-0.26	0.05	0.32

Table 10 List of the Banks Included in the Study

1	DENIZCILIK BANKASI
2	ETIBANK
3	SUMERBANK
4	T.C. ZIRAAT BANKASI
5	T. EMLAK BANKASI
6	T. HALK BANKASI
7	T. VAKIFLAR BANKASI
8	IKTISAT BANKASI (DENIZLI IKTISAT BANKASI)
9	AKBANK
10	DEMIRBANK
11	EGEBANK
12	ESKISEHIR BANKASI
13	MILLI AYDIN BANKASI
14	PAMUKBANK
15	SEKERBANK
16	TURK DIS TICARET BANKASI
17	TURK TICARET BANKASI
18	T. GARANTI BANKASI
19	T. IMAR BANKASI
20	T. IS BANKASI
21	T. TUTUNCULER BANKASI
22	YAPI VE KREDI BANKASI
23	TURK EKONOMI BANKASI
24	ADABANK
25	KOC-AMERIKAN BANK
26	TEKSTIL BANKASI
27	T. ITHALAT VE IHRACAT BANKASI
28	FINANSBANK
29	ULUSLARARASI ENDUSTRI VE TICARET BANKASI
30	OSMANLI BANKASI
31	ARAP-TURK BANKASI
32	BANK INDOSUEZ TURK A.S.
33	BNP. AK. DRESDNER BANK
34	BIRLESIK TURK KORFEZ BANKASI
35	MANUFACTURERS HANOVER BANK
36	MIDLAND BANK A.S.
37	TURK BANKASI LIMITED
38	CHEMICAL MITSUI BANK
39	BANK MELLAT
40	BANK DI ROMA S.P.A.
41	CITIBANK
42	CREDIT LYONNAIS
43	HABIB BANK LIMITED
44	HOLANTSE BANK UNI. N.V.
45	KIBRIS KREDI BANKASI LIMITED
46	SAUDI AMERICAN BANK
47	SOCIETE GENERALE
48	THE CHASE MANHATTAN BANK
49	STANDARD CHARTERED BANK

Table 11 Variable List

	Code	Variable Name
1	TOTASSET	TOTAL ASSETS
2	TOTLOAN	TOTAL LOANS
3	INVEST	PARTICIPATIONS
4	OWNRES	TOTAL OWN RESOURCES
5	TOTDEPO	TOTAL DEPOSITS
6	NETINC	NET INCOME BEFORE TAXES
7	INTCOMP	INTEREST AND COMMISION PAID
8	PEREXP	PERSONNEL EXPENSES
9	AMPROV	AMORTIZATION AND PROVISIONS
10	OTHEXP	OTHER EXPENSES AND LOSSES
11	OPEXP	OPERATING EXPENCES
12	TOTOPEX	TOTAL OPERATING EXPENCES
13	TOEXP	TOTAL EXPENSES
14	INTCOMC	INTERESTS AND COMMISIONS COLLECTED
15	CHCOMC	CHARGES AND COMMISIONS COLLECTED FOR BANKING
16	BANKINC	INCOME FROM BANKING
17	MISCPRF	MISC. PROFITS
18	TOTINC	TOTAL INCOME
19	BRANCH	NUMBER OF BRANCHES

APPENDIX B

Models utilized in this study are formulated as:

CCR First Stage

Max q

$$\text{s.t.} \quad \sum_j l_j x_{ij} + s_i^- = (1 - w_i q) x_{ij_0} \tag{4}$$

$$\sum_j l_j y_{rj} - s_i^+ = (1 - w_r q) y_{rj_0} \tag{5}$$

$$?_i \geq 0; \quad j = 1....50; \quad q \geq 0; \quad i = 1....4; \quad r = 1...3$$

where x_{ij} and y_{rj} are the i^{th} input and r^{th} output level for DMUj. l_j is the weight of DMU in the facet for the evaluated DMU. w_i and w_r are priorities. s_i and s_r are slacks corresponding to input and output respectively (≥ 0). j_0 is the DMU being assessed. For input minimization model w_i is set equal to 100percent, while w_r is set equal to 0, implying that the input reduction is targeted while keeping output unchanged. For output maximization models, the reverse is true.

CCR Second Stage

$$\text{Max} \ \sum_i F_i^- s_i^- + \sum_i F_r^+ s_r^+ \tag{6}$$

$$\text{s.t.} \quad \sum_j l_j x_{ij} + s_i^- = (1 - w_i q) x_{ij_0} \tag{7}$$

$$\sum_j l_j y_{rj} - s_i^+ = (1 - w_r q) y_{rj_0} \tag{8}$$

$$?_i \geq 0; \quad j = 1....50; \quad q \geq 0; \quad i = 1....4; \quad r = 1...3$$

where F_i^- and F_r^+ are priorities. In this application, F_i^- is $\frac{1}{\overline{X}_i}$ where $\overline{X}_i$ is the mean value of x_{ij}, and F_r^+ is $\frac{1}{\overline{Y}_r}$, where $\overline{Y}_r$ is the mean value of y_{ij}.

Under input minimization and variable returns to scale conditions, Warwick Windows DEA software solves the following BCC models:

BCC First Stage

$$\text{Max } q = \sum_r u_r y_{rj_0} + \Omega_1 - \Omega_2 \tag{9}$$

$$\text{s.t.} \quad \sum_r u_r y_{rj} - \sum_i v_i x_{ij} + \Omega_1 - \Omega_2 \le 0 \tag{10}$$

$$\sum_i v_i x_{ij_0} = 1 \tag{11}$$

$$u_r,\ v_i,\ \Omega_1,\ \Omega_2 \ge 0$$

By letting q^* be the optimal value of q in the above model, the minimum and maximum limit of the Ω range is obtained by solving the second stage.

BCC Second Stage

$$\text{Min/Max } \Omega_1 - \Omega_2 \tag{12}$$

$$\text{s.t.} \quad q^* = \sum_r u_r y_{rj_0} + \Omega_1 - \Omega_2 \tag{13}$$

$$\sum_r u_r y_{rj} - \sum_i v_i x_{ij} + \Omega_1 - \Omega_2 \le 0 \tag{14}$$

$$\sum_i v_i x_{ij_0} = 1 \tag{15}$$

$$u_r,\ v_i,\ \Omega_1,\ \Omega_2 \ge 0$$

where u_r is the weight of the r^{th} output and v_i is the weight of i^{th} input for DMUj. Ω_1 and Ω_2 are the distance from frontier facet.

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Figure 1 Banking Process

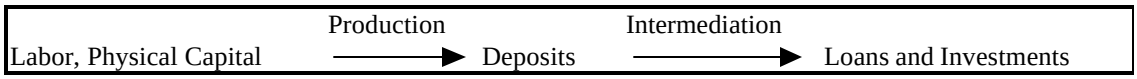

Figure 2 Performance Matrix

	Production	Intermediation
Efficiency	+	+
	+	-
	-	-
	-	+

Figure 3: Average Efficiency of Turkish Banking (CCR)

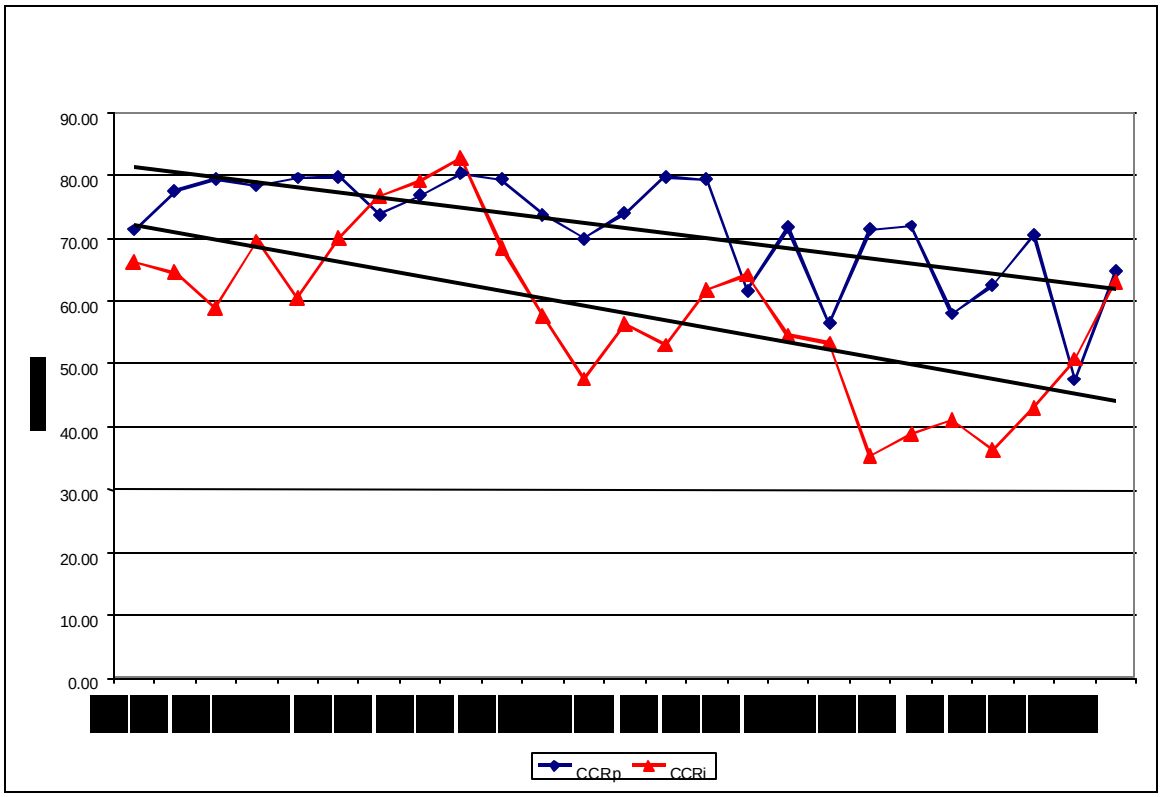

Figure 4 Average Efficiency of Turkish Banking (BCC)

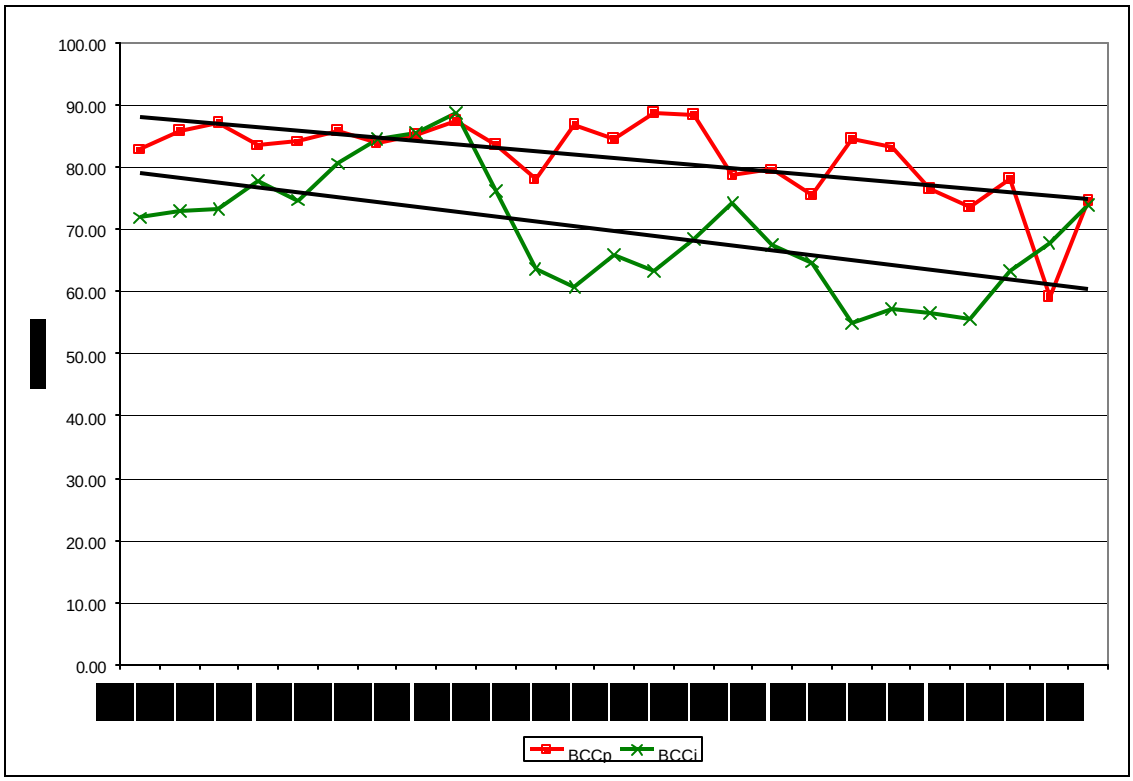

Figure 5: Average Efficiency of Turkish Banking after Liberalization (CCR)

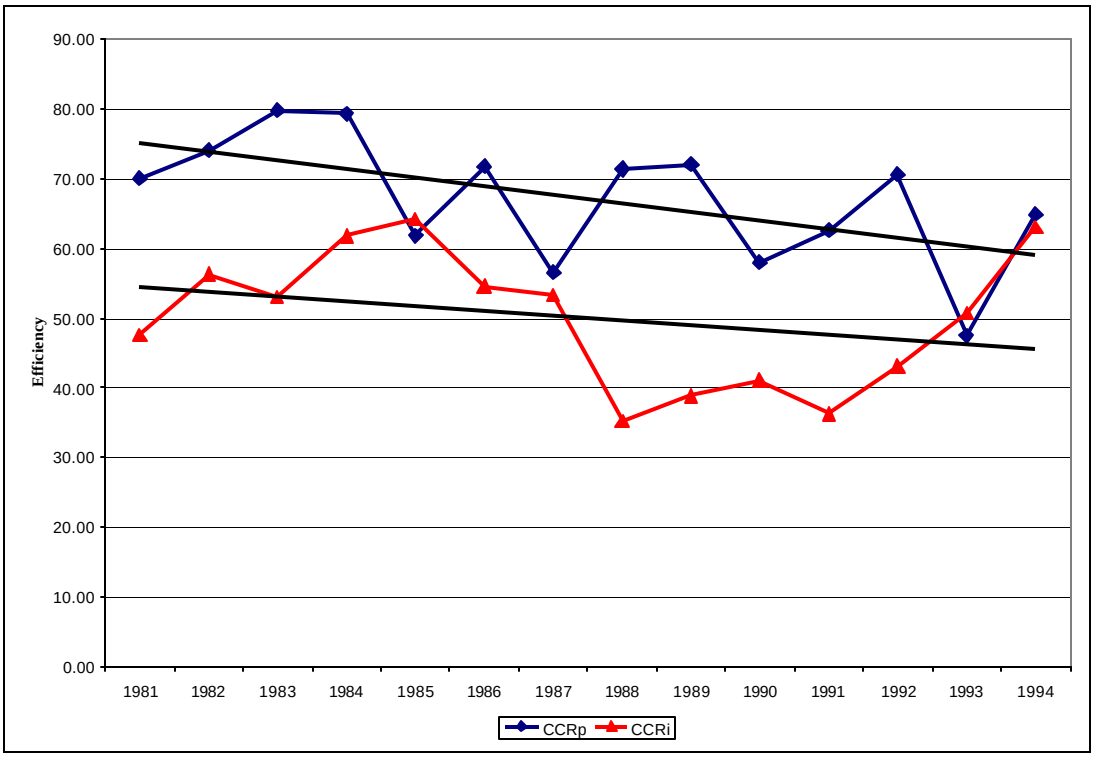

Figure 6: Average Efficiency of Turkish Banking after Liberalization (BCC)

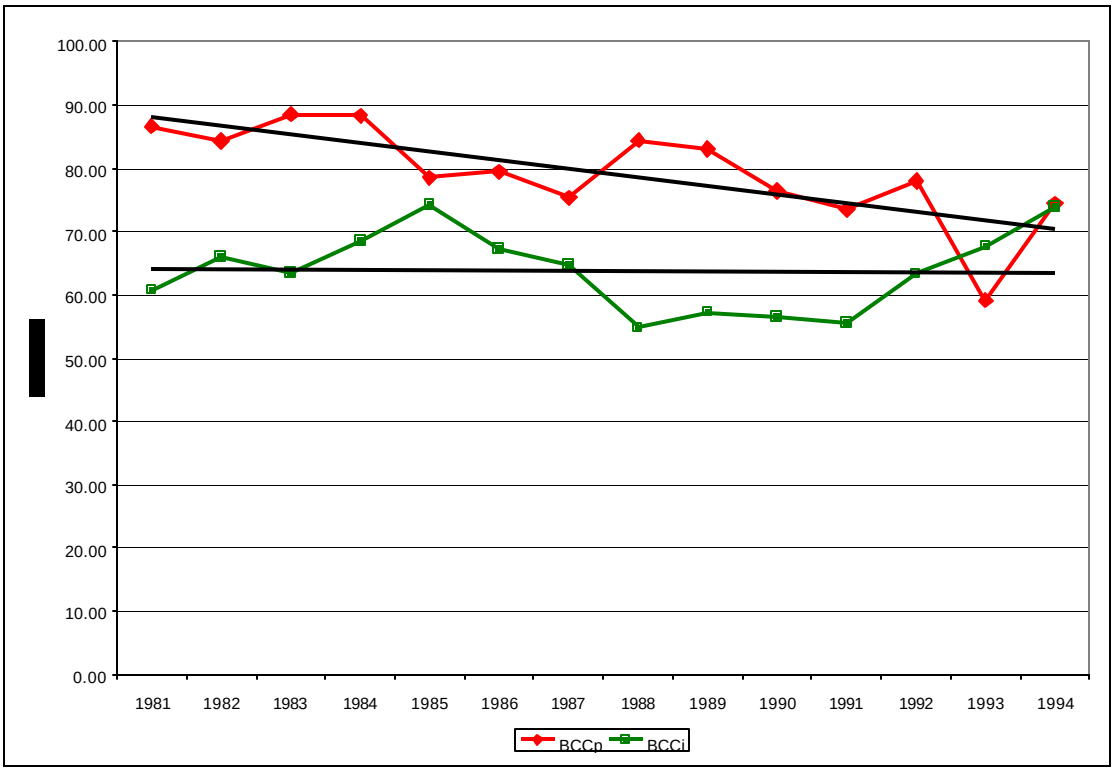

Figure 7 Scale Efficiency of Turkish Banking System

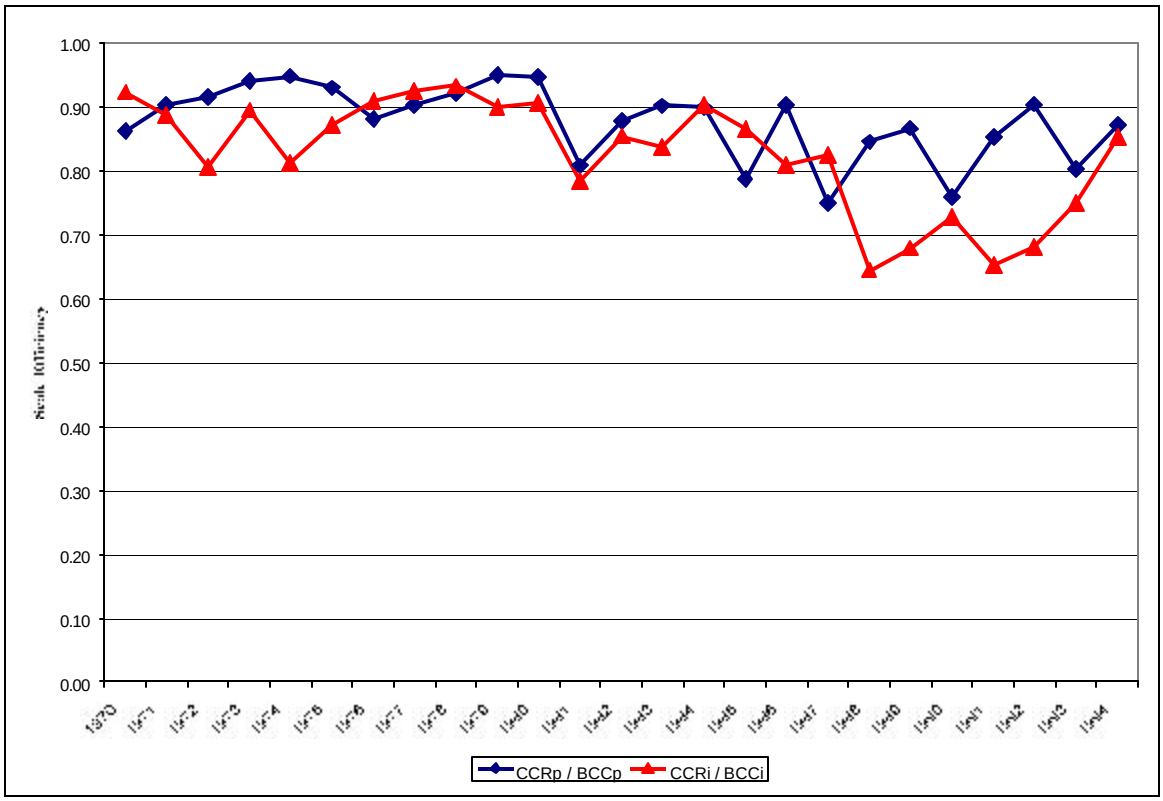

Figure 8 Efficiency of Turkish Banks by Ownership (CCRp)

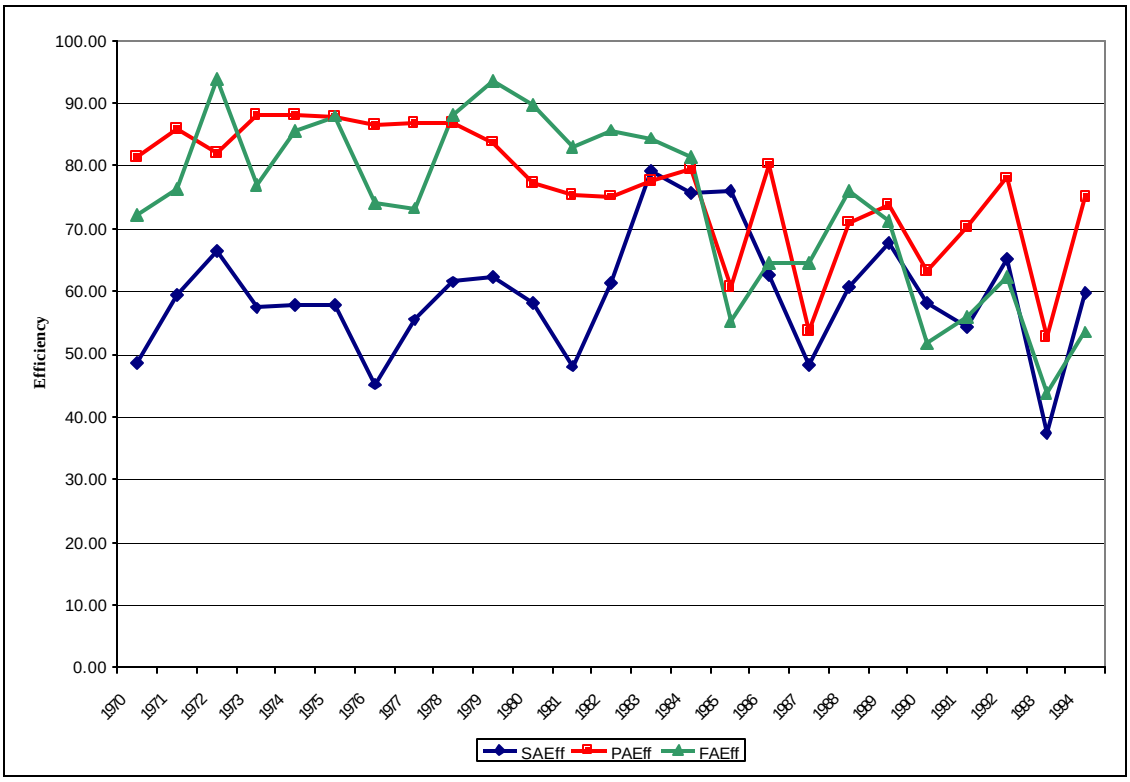

Figure 9 Efficiency of Turkish Banks by Ownership (CCRi)

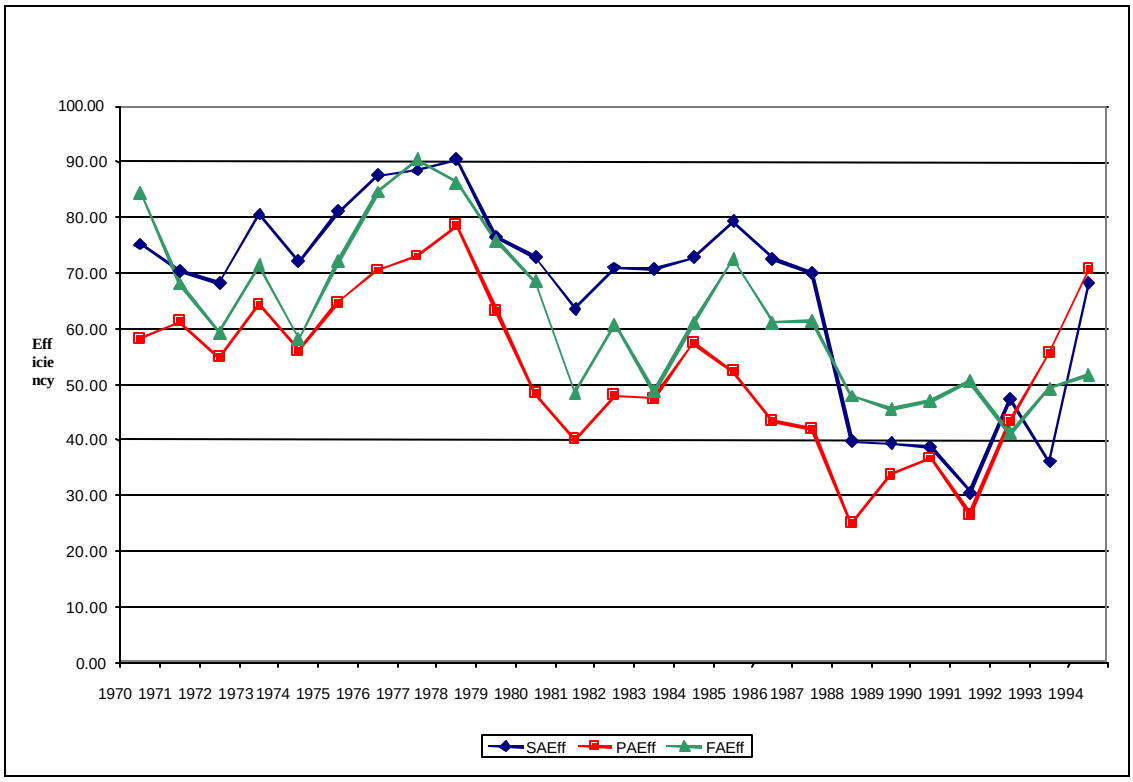

Figure 10 Efficiency of Turkish Banks by Ownership (BCCp)

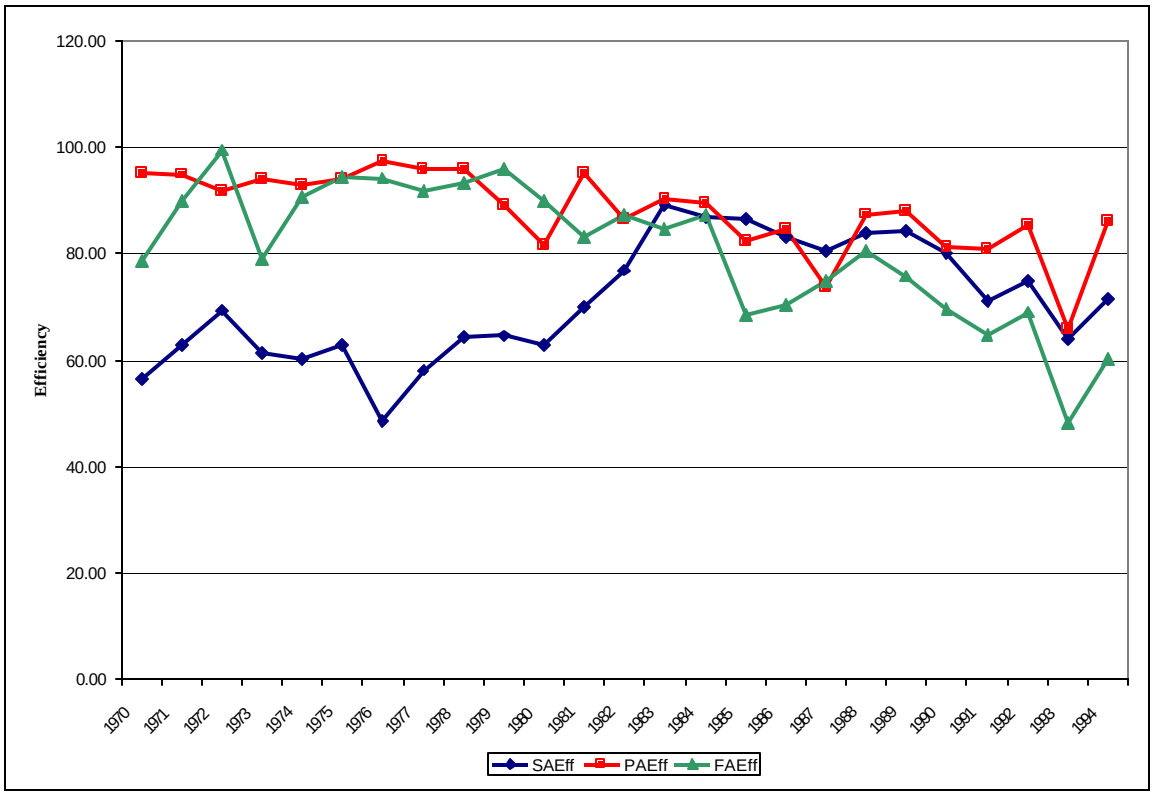

Figure 11 Efficiency of Turkish Banks by Ownership (BCCi)

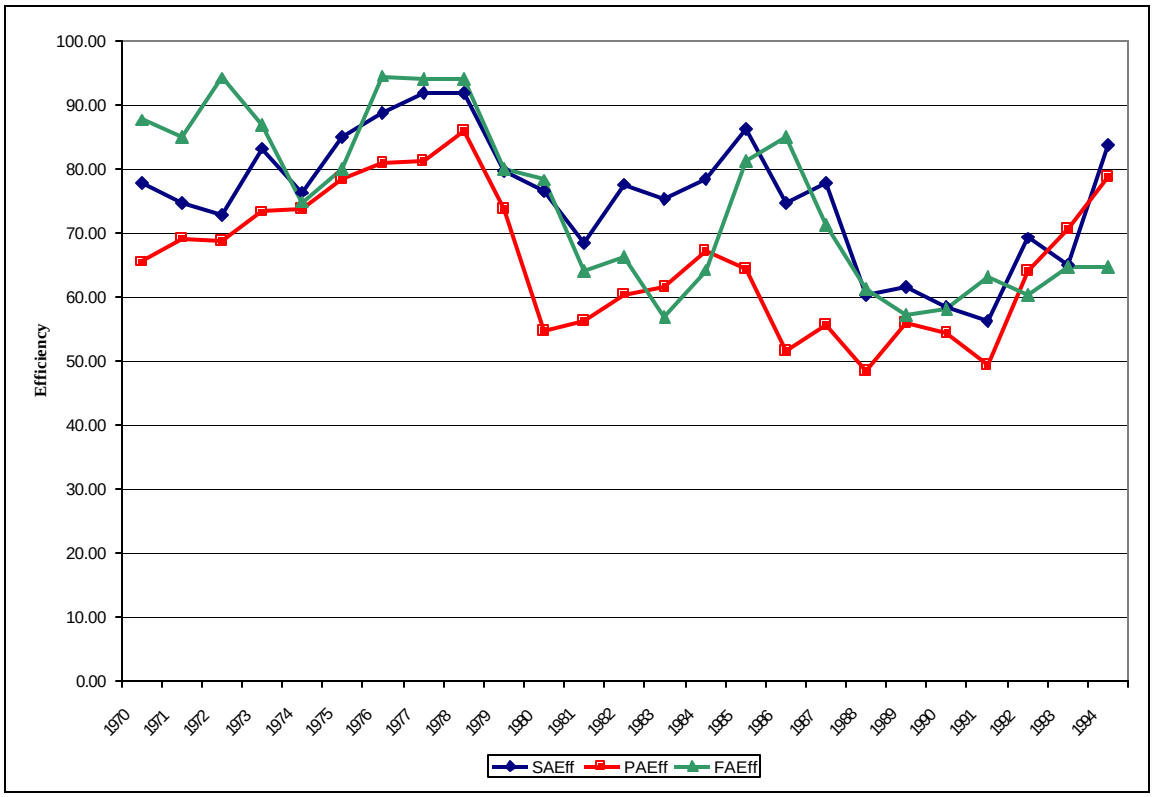

Figure 12 Scale Efficiency of Turkish Banking System by ownership (production)

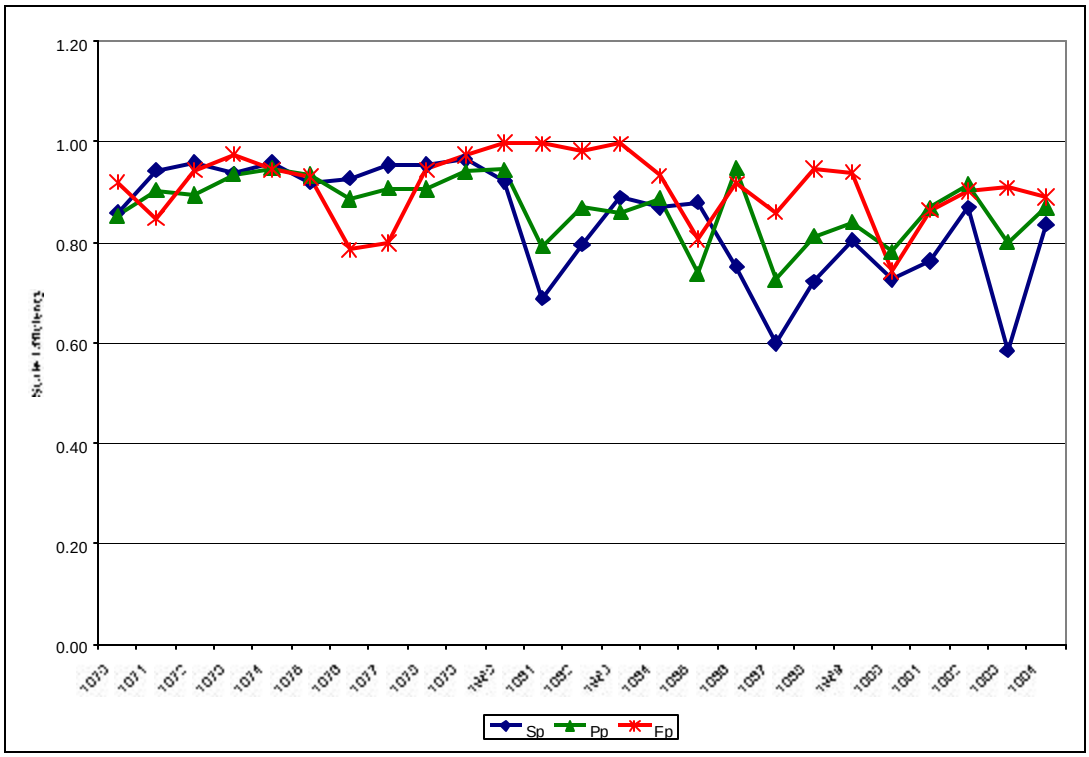

Figure 13 Scale Efficiency of Turkish Banking System by ownership (intermediation)

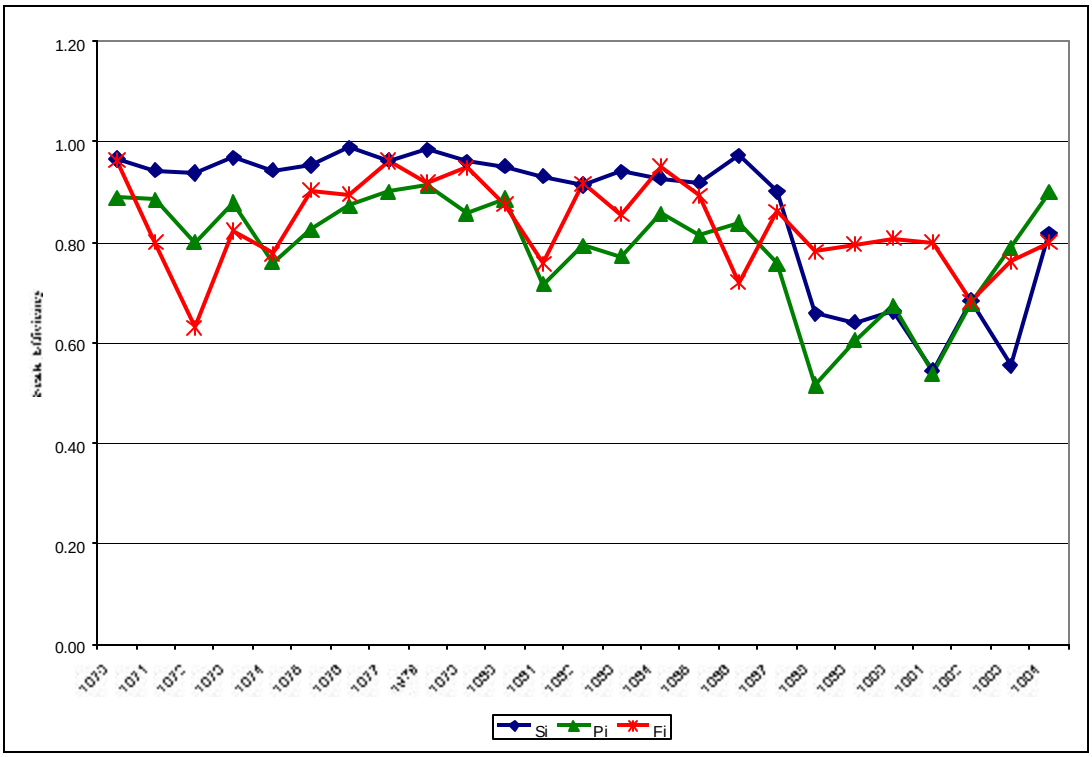

Figure 14 Percentage of Efficient Banks (Production)

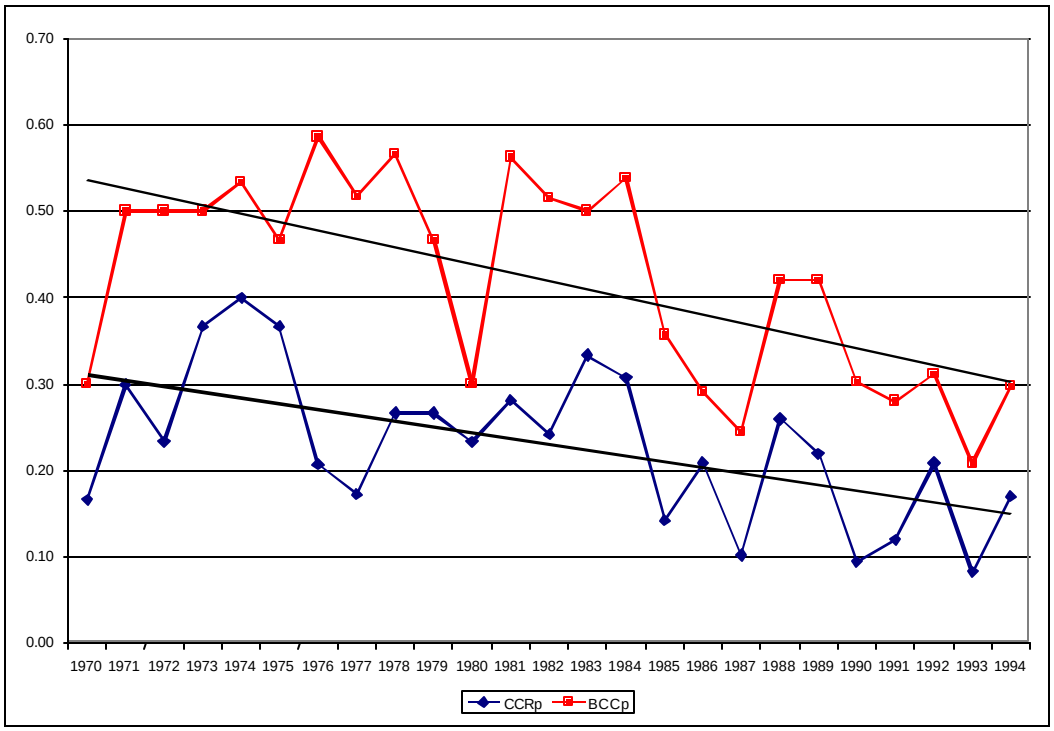

Figure 15 Percentage of Efficient Banks (intermediation)

Figure 16 Sources of Inefficiency (BCCp)

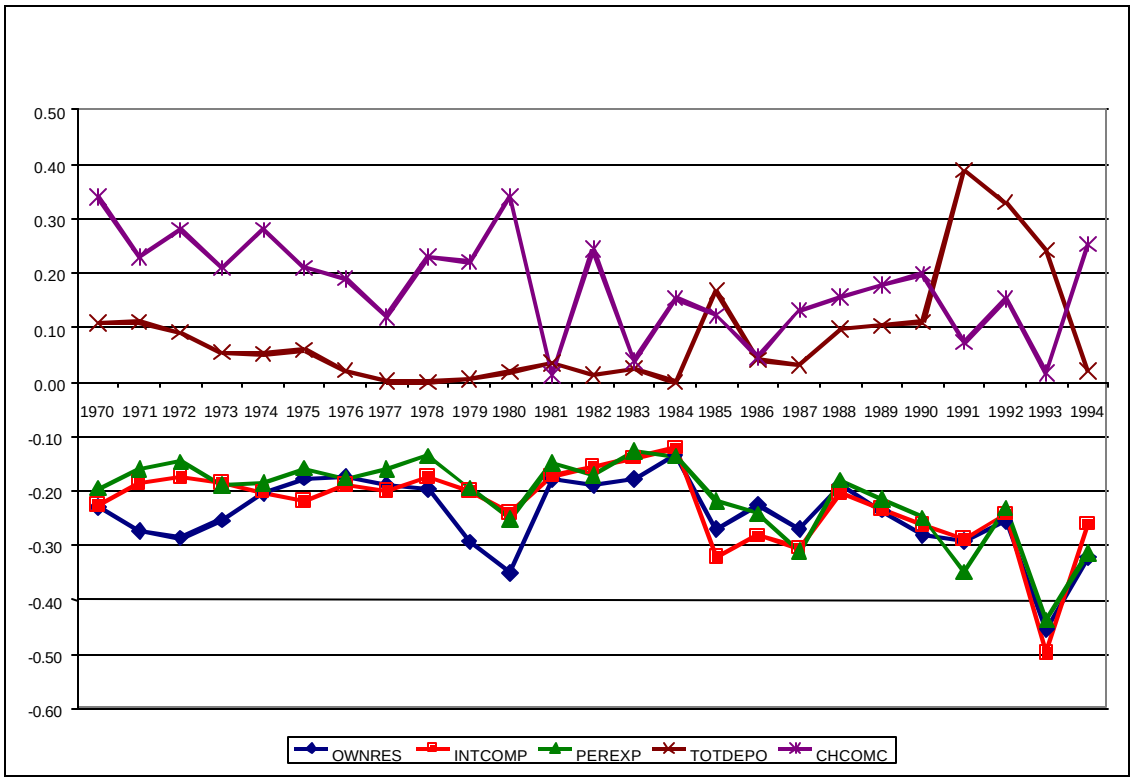

Figure 17 Sources of Inefficiency (BCCi)