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TESTING THE EFFICIENCY OF TURKISH BANKS

Ali Argun Karacabey

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ECONOMIC RESEARCH FORUM
FOR THE ARAB COUNTRIES, IRAN & TURKEY
منتدى البحوث الاقتصادية

7 Boulos Hanna St. Dokki, Cairo, Egypt
Tel: (202) 3370810 – (202) 7485553 – (202) 7602882
Fax: (202) 7616042. Email: erf@idsc.net.eg. Website: http://www.erf.org.eg

Abstract

This paper reports results from the application of Data Envelopment Analysis (DEA) on Turkish commercial banks. The aim of this paper is twofold. First, to measure the "intermediation" efficiency and profitability of Turkish banks. Second, to examine the relationship between efficiency and profitability. The results of the research generally indicate that the Turkish banking sector operates profitably despite its inefficiency from an intermediation perspective. The results also show that in an environment with low interest rates, low public borrowing requirements and severe competition, the number of bank failures is expected to increase.

1.Introduction

Berger and Humphrey (1997) state that the first task in evaluating the performance of financial institutions is to separate those that perform well from those performing poorly, which can be done by frontier analysis. There are several approaches to frontier analysis, which can be classified as to whether they employ parametric and non-parametric techniques. Ganley and Cubbin (1992, p.1) proposes that in practice there is little need to impose a parametric structure on the data when weaker non-parametric assumptions are available.

Data Envelopment Analysis (DEA), which is one of the well known non-parametric techniques, is a linear programming based method for assessing the efficiency of homogeneous organizational units. DEA was initially developed to evaluate the efficiency of the public sector by Charnes, Cooper and Rhodes (1978), however it has been used in a wide range of contexts, for example in secondary schools, in high education and mostly in banking. A comprehensive list of the banking applications can be seen in Berger and Humprey (1997).

This paper reports results from the application of DEA on Turkish commercial banks. The aim of this paper is twofold. First, to measure the "intermediation" efficiency and profitability of Turkish banks; and second to examine the relationship between efficiency and profitability. The following section briefly describes the nature of the Turkish banking sector and its unique conditions. Section 3 is about the mathematics of DEA. In this section the basic model developed by Charnes, Cooper and Rhodes (1978) and its extension that takes variable returns to scale into account are described. The results of the implementation are presented in the fourth section. Some concluding remarks are presented in the final section.

2. Turkish Banking System in Brief

The Turkish banking system is known to be one of the most profitable banking systems of the world. However, this profitability is not only the consequence of an efficient management. According to a *Euromoney* (1997) article, the reason behind this is that "government rewards them [banks] royally to get Turkish citizens to pay for its debt".

As in any market, Turkish banks are exposed to the cyclical movements of the domestic economy. For more than 20 years, high inflation, government's large budget deficits and high public borrowing requirements fostered an environment of high and variable interest rates. During this period, the government borrowed most of the funds raised in the capital markets. At the beginning of 1999 government bills and bonds in the balance sheets of the banks accounted for a further 25 percent of the total assets. In other words, banks have lent most of the funds they raised to the government, and the government encouraged the banking sector toward external borrowing, which indeed has been the basic problem of the banking sector during the financial crises. Hence during the period, the Turkish banking system operated profitably despite its incurred high costs. At the end of 1999, a three-year "disinflation program" began with a letter of intent submitted to the International Monetary Fund (IMF). Most of the changes and arrangements constituting the main components of the "stand-by agreement" signed between the government and IMF were completed at the end of 1999. The government began to raise its external debts after the stand-by agreement. With the New Year there was a sharp decrease in interest rates and rapid increase in consumer loans. For the first time, banks started to act as financial intermediaries. However, the high operating costs, increasing competitiveness and retrospective tax on the public borrowing securities that are mostly held by banks, increased the number of privately-owned banks whose administration was taken over by the Savings Deposit Insurance Fund.

It can be said that the banking sector is in a transition period that started with the letter of intent and amendments in Banking Law. The experiences of similar countries showed that an increase at the concentration of the banking sector should be expected at the end of this period, which indeed means that there will be acquisitions and mergers during the period. Although it is hard to foresee the surviving banks, it is obvious that banks operating efficiently have more chance of survival than the inefficient ones.

3. Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a non-parametric linear programming technique for assessing relative efficiency of organizational units. Lovell (1993) defines the efficiency of a unit as the comparison between observed and optimal values of its output and input. The potential of a production unit constitutes a frontier and the efficiency computations can be made relative to this frontier. However determining empirically the potential of a production unit is very difficult, if it is not impossible. DEA solves this problem by using "relative efficiency" instead of efficiency.

Relative efficiency means that a unit that is found to be efficient in a given set may be found inefficient when evaluated in another set. In practice the analyst has only a set of observations for each unit corresponding to achieved output levels for given input levels. Thus, the task is to identify the units performing well and use them to form an empirical efficient frontier. The other units' degree of inefficiency can be measured relative to this efficient frontier.

There are many different mathematical forms of the DEA model- both fractional and linear. Ganley and Cubbin (1992) states that a "fractional program can be thought of as the conceptual DEA model, while the linear program is that used in actual computation of the efficiency ratio".

The starting point of the fractional program is the calculation of the total factor productivity. Assume that an organization uses input X_k, k=1…m, to produce outputs Y_i, i=1…t. Then given a set of appropriate weights (v_i,w_k) on these variables, the total factor productivity ratio can be formed as follows:

$$\frac{\sum_1^t v_i y_i}{\sum_1^m w_k x_k} \qquad (1)$$

The weights (v_i,w_k) reduce the *t* output levels and *m* input levels into scalar numbers. The aim of every unit is to maximize its ratio. However, as output and input levels are observed values, to maximize the ratio, optimal weights must be found. If there is L units using the same inputs to produce same outputs, this total factor productivity ratio can be converted to an efficiency measure by adding a constraint reflecting the performance of other units. DEA treats the observed inputs (x_k) and outputs (y_i) in this ratio as constants and chooses values of the input and output weights to maximize the total factor efficiency of the evaluated unit relative the performance of its peers.

$$\underset{v_i w_k}{MAX} \ \frac{\sum v_i y_{ip}}{\sum w_k x_{kp}} \qquad (2)$$

Subject to

$$\frac{\sum v_i y_{ic}}{\sum w_k x_{kc}} \le 1 \qquad c = 1,\ldots,p,\ldots,L$$

$$v_i, w_k \ge \varepsilon > 0$$

This fractional form of DEA gives us positive weights which maximizes the output to input ratio for the unit being evaluated, subject to the constraint that no unit has a ratio larger than unity. This nonlinear fractional model can be easily converted into a linear DEA model by letting the denominator of the objective function equal to one:

$$\underset{v_i w_k}{MAX} \quad \sum v_i y_{ip} \qquad (3)$$

Subject to

$$\sum w_k x_{kp} = 1$$

$$\sum v_i y_{ic} - \sum w_k x_{kc} \le 0$$

$$v_i, w_k \ge \varepsilon > 0$$

To reduce the number of constraints and to make the problem manageable, the computation of the efficiency score generally uses the dual form of the model. Using λ_c's as the dual variables corresponding to the constraints in (3), S_k and S_i to the constraints $v_i \ge \varepsilon$ and $w_k \ge \varepsilon$, respectively, the dual model becomes:

$$\underset{\lambda_c}{MIN} \quad \theta_p - \varepsilon(\sum S_k + \sum S_i) \qquad (4)$$

Subject to

$$x_{kp}.\theta_p - \sum x_{kc}\lambda_c - S_k = 0 \qquad k = 1,\ldots, m$$

$$y_{ip} - \sum y_{ic}\lambda_c + S_i = 0 \qquad i = 1,\ldots, t$$

$$\lambda_c, S_k, S_i \ge 0$$

If the optimal value of S_k>0, this means that the *p* th unit can reduce the inputs without decreasing the output, and similarly if the S_i>0, the *p* th unit can increase the output without increasing the amount of the inputs. The evaluated unit is said to be efficient if and only if the efficiency ratio equals one, and the slack variables are zero; and the unit will be on the frontier. For the unit being evaluated the positive elements of the λ identify the set of dominating (peer) units located on the frontier.

This dual model developed by Charnes, Cooper and Rhodes (1978), named as CCR model, assumes constant return to scale. Coelli (1996) notes that the constant return to scale assumption is only appropriate when all units are operating at an optimal scale. Banker, Charnes and Cooper (1984) modified the DEA model by adding a new constraint to take into account the varying returns to scale.

$$\underset{\lambda_c}{MIN} \quad \theta_p - \varepsilon(\sum S_k + \sum S_i) \qquad (5)$$

Subject to

$$x_{kp}.\theta_p - \sum x_{kc}\lambda_c - S_k = 0 \qquad k = 1,\ldots, m$$

$$y_{ip} - \sum y_{ic}\lambda_c + S_i = 0 \qquad i = 1,\ldots, t$$

$$\sum \lambda_c = 1$$

$$\lambda_c, S_k, S_i \ge 0$$

Using this new BCC model results in different efficiency scores. These new scores are frequently named as pure efficiency (PTE) where as the former is known as technical efficiency (TE). Pure efficiency scores can be equal or higher than the technical efficiency scores but not lower. The difference between pure and technical efficiency is said to be "scale efficiency"(SE). The use of the CCR model when all the units are not operating at an optimal scale, results in measures of technical efficiency that are confounded by scale efficiencies. Thus, technical efficiency scores calculated by the CCR model may be decomposed into pure and scale efficiency scores. Conducting both models on the same data can help to calculate scale efficiency. If the technical efficiency and pure efficiency are the same then scale efficiency is said to be zero, if there is a difference between them which indicates that the unit has scale efficiency, then scale efficiency can be calculated as the difference between these two scores.

$$TE_{CCR} = TE_{BCC} * SE \tag{6}$$

If the scale efficiency equals unity, this means that the unit is operating at the optimal scale. If it is different from unity then the unit must increase or decrease its operating scale. However, this measure of scale efficiency does not indicate whether the unit is operating in an area of increasing or the decreasing returns to scale. This may be determined by running a DEA with non-increasing returns to scale (NIRS).

$$\underset{\lambda_c}{MIN} \quad \theta_p - \varepsilon(\sum S_k + \sum S_i) \tag{7}$$

Subject to

$$x_{kp}.\theta_p - \sum x_{kc}\lambda_c - S_k = 0 \qquad k = 1,\ldots, m$$

$$y_{ip} - \sum y_{ic}\lambda_c + S_i = 0 \qquad i = 1,\ldots, t$$

$$\sum \lambda_c \leq 1$$

$$\lambda_c, S_k, S_i \geq 0$$

If the efficiency score of the BCC model is equal the efficiency score of NIRS model, then decreasing returns to scale exist for the unit. Otherwise increasing returns to scale are said to exist.

4.Data and Empirical Results

The efficiency test was conduct on data for 44 commercial banks for the year 2000. 22 of the 44 banks used in this study are privately owned Turkish commercial banks, 4 of the 44 banks are foreign banks founded in Turkey, and the remaining are banks under the deposit insurance fund. The data was collected from the website of the Banks Association of Turkey.

The first step of the analysis was to assess the banks' intermediation efficiency. For the intermediation perspective, the bank units collect funds in the form of deposit and "intermediates" them to loans and other income earning activities (Thanassoulis, 1999). For this point of view, basic input and output are the value of the deposit accounts and the value of the loan accounts, respectively. In this study the number of personnel and the number of branches are other inputs. Summary statistics for the inputs and output is presented in table 1.

Results of the intermediation efficiency of banks based on the data are contained in table 2. These have been estimated using equation (5). This model permits that returns to scale vary; that is, the production surface may take on increasing, constant and decreasing returns as is appropriate.

8 of the 44 bank efficiency scores equal unity, meaning they are efficient. 6 of the efficient banks are privately owned Turkish commercial banks, and the remaining 2 banks are foreign banks founded in Turkey. None of the banks under the deposit insurance fund are found to be efficient. The mean technical efficiency score is 0.568. The mean technical efficiency score of privately owned Turkish commercial banks and foreign banks founded in Turkey are 0.732 and 0.886, respectively, and the average for the banks under the deposit insurance fund is 0.297, which indeed was expected to be low.

The peer groups identified in Table 2 can help to derive more specific qualitative information on how targets can be obtained. It is argued throughout the literature that attainment of boundary performance is facilitated by appeal to the peer group attainments identified by DEA. In table 1, bank 1, for instance, banks 2 and 5 are peers, which in linear combination define its target performance. Analysts can estimate the potential improvement for any unit by using lambda (λ) weights, slacks and the input/output levels of the peers. Table 3 includes essential data to calculate the targets for bank 1.

Target levels for all inputs can be calculated by employing the following equation:

$$TL_k = \sum x_c\lambda_c + S_k \tag{8}$$

Here TL_k denotes target levels for input k, x_{ck} and λ_c stands for the c th peer's level of k th input, λ is the weight and S_k for the slack. Using equation 8 and the data included in table 3, target levels for bank 1 can be estimated as 6538, 391 and 9645, respectively. Comparing these values with the observations will help management in decision-making. The observed values for bank 1 are 6933, 851 and 16133 which means that bank 1 should reduce its value of deposits from 6933 to 6538, the number of branches from 851 to 391 and the number of personnel from 16133 to 9645, in order to be an efficient bank.

In the literature it is common practice to identify the global leader by counting the frequency of appearing in peers reference set. Ganley and Cubbin (1992,p.49) notes that increasing the number of citations to a unit indicates that the number of observations in the neighborhood of that unit increases, and on the basis of traditional sampling theory, the larger the sample in a particular neighborhood, the closer is the sample frontier likely to approximate the true frontier. Bank 37 is found to be the global leader of the model. Bank 37 became a peer of another bank for 24 times where bank 5 was a peer of another bank 23 times.

The number of personnel of a bank that falls in the first quartile defined by the results of DEA is approximately 34.5, and the value of loans per personnel is 0.58 USD million. However this ratio for a bank that falls in the last quartile is 20.1 and 0.092 USD million. According to these ratios one can conclude that inefficient banks have more branches than they need and also they do not use their personnel productively.

The second step of the analysis is to assess the profitability of the banks. The results of the profitability analysis would as well help to identify the relation between efficiency and profitability. In order to investigate the profitability of Turkish banks, again equation (5) is employed, but the model uses different inputs and outputs. Personnel expenses, operating expenses, non-interest expenses and interest expenses are incorporated into the model as inputs, whereas the output set includes interest earnings and non-interest income. It is clear that inputs cover all the costs of the banks and outputs cover all the revenues of the banks. For the profitability analysis 42 banks data are used. The two banks whose data was not appropriate for the analysis are excluded from the data set. The summary statistics of the input and output data is given in table 4.

Table 5 presents the result of the profitability analysis. According to the profitability test 23 of 42 banks were found to be efficient. 16 of the 23 efficient banks are privately-owned Turkish banks, 3 of them are foreign banks founded in Turkey and 4 of them are the banks under the deposit insurance fund. The mean technical efficiency score is 0.904. Comparing with the intermediation efficiency score, the profitability score is extremely high. As indicated earlier the Turkish banking system is one of the most profitable baking sectors of the world. However, it seems that this profitability is not a consequence of the intermediation efficiency.

The mean technical efficiency scores of privately owned banks, foreign banks and the banks under the deposit insurance fund are 0.988, 0.984 and 0.755, respectively. As it was the case in the efficiency analysis, the mean score of the banks under the fund is again the lowest score, however compared to their efficiency score, their profitability is considerably high.

The peer reference sets of the profitability analysis are given in table 5. It is a hard task to identify the global leader of profitability analysis. Six of the efficient banks were cited 7 or 8 times. These are bank 2, 38, and 41 (cited 8 times); Banks 6,11, and 42 (cited 7 times).

Table 6 includes some ratios calculated for the first and the last quartiles defined by the efficiency scores. It is clear that profitable banks have high non-interest incomes and low interest expenses. On the other hand, there is not so much of a difference between the ratios of personnel expenses to total expenses, however according to intermediation efficiency analysis, banks in the fourth quartile should reduce the number of personnel.

Another topic of interest is whether achieving a high level of intermediation efficiency implies a high level of profitability as well. The correlation between intermediation efficiency scores and profitability is 64 percent, and the correlation between the rankings according to intermediation efficiency and profitability is 66 percent. A t-test can be used to test the null hypothesis that the mean of efficiency scores equals the mean of the profitability scores. The calculated t value (3.07276E-07) shows that the means are significantly different from each other. In other words there is no relation between efficiency and profitability in the Turkish banking sector.

5. Conclusion

The objective of this paper is to explore the profitability and intermediation efficiency of Turkish commercial banks. The analysis is based on a data set consisting of 44 commercial banks for the year 2000. The methodology is based on the concepts and principles of Data Envelopment Analysis (DEA), which banks use as a tool for assessing, monitoring and improving performance.

The analysis begins by calculating the intermediation efficiency of banks, which aims to test the efficiency of a bank unit collecting funds in the form of deposits and intermediating them into loans. The value of deposits, number of personnel and number of branches was incorporated as inputs, whereas the value of loans was used as the only output. Using both monetary variables and non-monetary variables together, DEA is able to integrate unlike multiple inputs and outputs to make simultaneous comparisons that would otherwise not be possible.

The results of the analysis shows that only 8 of the 44 Turkish commercial banks were operating efficiently as financial intermediaries. The mean efficiency score for the entire sample was calculated to be 0.568, while the mean efficiency score for the banks under the fund, which was expected to be low, was only 0.297.

Next, the study analyzes the profitability of the banks, where non-interest expenses, personnel costs, operating costs and interest expenses were selected as inputs and non-interest and interest incomes as outputs. The mean profitability efficiency score was calculated to be 0.904, which is considerably high in comparison to the intermediation efficiency score. In addition, the number of efficient banks increased from 8 to 23. The final purpose of the research was to identify the relationship between these two efficiency scores. The statistical t-test indicated there is no significant relationship between them.

The overall results of the study indicate that the Turkish banking sector operates profitably despite its inefficiency from an intermediation perspective. The results also show that in an environment with low interest rates, low public borrowing requirements and severe competition, the number of bank failures is expected to rise.

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Table 1: Summary Statistics of Inputs and Outputs

	Value of Loans (USD Million)	Value of Deposits (USD Million)	Number of Branches	Number of Personnel
Average	728.9595	1363.5703	112.3409	2118.2273
St. Deviation	1275.8208	1813.4022	162.3916	3013.8204
Max	4383.3856	6932.7161	851	16133
Min	0.5969	20.5310	2	89

Table 2: Intermediation Efficiency and Peers of Banks

Bank	TE*	PEERS	Bank	TE	PEERS
1	0.943	2,5	**23**	0.223	10,4,5,22
2	1.000	2	**24**	0.177	5,37
3	0.683	37,5	**25**	0.958	22,5,37
4	1.000	4	**26**	0.746	5,37
5	1.000	5	**27**	0.507	37,5,22
6	0.809	5,37	**28**	0.479	22,5,37
7	0.566	10,4,5,22	**29**	0.296	5,37,22
8	0.982	5,37	**30**	0.064	22,44
9	0.774	5,37	**31**	1.000	31
10	1.000	10	**32**	0.158	44
11	0.550	5,37	**33**	0.355	44
12	0.107	10,22,31	**34**	0.303	22,5,10
13	0.445	5,37	**35**	0.278	22,37,44
14	0.546	5,37	**36**	0.979	22,31,44
15	0.161	5,37,22	**37**	1.000	37
16	0.517	5,37	**38**	0.406	37,22,44
17	0.476	37,5	**39**	0.445	44
18	0.477	22,5,37	**40**	0.165	44
19	0.069	22,37,44	**41**	0.495	22,37,44
20	0.099	37,5,22	**42**	0.880	37,44
21	0.489	5,37,22	**43**	0.375	44
22	1.000	22	**44**	1.000	44

Notes: *Efficiency scores represent the pure technical efficiencies

Table 3:Potential Improvement for Bank 1

PEERS	λ	INPUT 1	INPUT 2	INPUT 3
2	0.850	6868	425	5784
5	0.150	4670	197	5784
Slacks (Bank 1)		0	412	5572

Table 4: Summary Statistics of Inputs and Outputs for Profitability Analysis

	Interest income	Non-interest income	Non-interest expense	Personnel cost	Operating cost	Interest expense
Average	382.850	572.103	544.473	47.218	118.412	254.849
St.Dev.	517.517	761.185	702.570	64.238	149.438	272.114
Max	2104.575	3188.925	3355.167	347.529	658.474	996.447
Min	19.467	9.192	12.311	3.360	4.708	7.519

Notes: *All the numbers in the table are USD millions

Table5: Profitability Efficiency of Banks

BANK	TE	PEERS	BANK	TE	PEERS
1	1.000	1	**23**	1.000	23
2	1.000	2	**24**	0.909	39,17,8
3	1.000	3	**25**	1.000	25
4	1.000	4	**26**	0.945	42,2,8,3,44
5	1.000	5	**27**	0.955	39,2,3,8,44
6	1.000	6	**28**	0.867	11,43,6
7	0.935	6,11,2	**29**	0.934	44,39,3,2,8
8	1.000	8	**30**	0.583	22,2,3,44,43
9	1.000	9	**31**	1.000	31
10	0.977	3,21,9,13,22,6	**32**	0.447	5,11,21,6,43
11	1.000	11	**33**	1.000	33
13	1.000	13	**34**	0.743	2,43,22,42,11
14	0.942	42,2,1,3,22	**35**	0.871	44,2,42,43,22
15	0.366	11,5,39,4,6	**36**	1.000	36
16	1.000	15	**37**	0.982	22,42,25,44
17	1.000	16	**38**	0.972	43,39,17
18	0.805	11,6,39,5	**39**	1.000	39
19	0.284	5,32,39	**41**	0.975	43,39,44
20	0.488	6,21,11,43	**42**	1.000	42
21	1.000	21	**43**	1.000	43
22	1.000	22	**44**	1.000	44

Table 6: Some Selected Ratios of the First and Last Quartiles

	Interest income/ total income	Non-interest expense/ total expense	Personnel expense/ total expense	Interest expense / total expense
First Quartile	0.4277	0.5172	0.0577	0.3115
Last Quartile	0.5095	0.3655	0.0675	0.3842