# “Bank efficiency in Turkey during the recent global crisis”


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# Bank efficiency in Turkey during the recent global crisis

## Abstract

This paper assesses the change in bank efficiency in Turkey during the recent financial crisis. Using a modified version of the standard data envelopment analysis (DEA) for a sample of 26 major Turkish banks, the authors find both substantial inefficiencies throughout the recent crisis, as well as a seeming deterioration in overall efficiency between 2007 and 2010.

**Keywords:** data envelopment analysis, banking efficiency.
**JEL Classification:** C61.

## Introduction

In an increasingly competitive business environment, many business firms must operate efficiently to survive. This explains why in recent years many researchers have devoted considerable time and effort to delineate the conditions necessary for technical efficiency of productive units. Formally, technical efficiency is defined as the production of a desired level of output with the minimum amounts of inputs. Thus, a productive unit is technically efficient if it cannot increase any output or reduce any input without reducing other outputs or increasing other inputs. In economic jargon, a technically efficient firm is simply operating on its efficient frontier. Clearly, this is an absolute concept of efficiency, independent of how efficient other competitors are. For this reason, and in the absence of extensive laboratory-like experiments, it is difficult, if not impossible, to ascertain whether a typical firm is operating efficiently in an absolute sense. On matters of technical efficiency, thus, all we can determine is whether a productive unit is efficient relative to others, that is, whether a firm is efficient in a relative sense. More specifically, instead of considering technical efficiency as an absolute concept internal to a firm, it can be treated as a relative notion for a collection of firms. Thus, a typical business entity can be considered as technically efficient relative to its competitors, provided that it can produce more outputs with fewer inputs relative to the latter.

Based on the foregoing, the data envelopment analysis (DEA), developed by Charnes et al. (1978), offers an empirical approach to the efficient frontier for a collection of firms through an assessment of their individual performances. The DEA efficient frontier is thus not derived by empirically fitting some specific mathematical function to the data for individual firms, as this presupposes that all firms are efficient to begin with. Rather, the DEA efficient frontier is derived as the locus of all outputs that are produced by the most efficient firms, or the so-called decision-making units (DMUs). In addition, and borrowing from the concept of efficiency in engineering, the DEA assigns a score of one to most efficient DMUs for any level of output, indicating a score of less than one for less efficient units.

The DEA has proved itself a particularly powerful tool for assessing operational efficiency in service organizations. For service organizations, such as commercial banks, it is often a challenging task to improve their operational efficiency without sacrificing service quality. Unlike manufacturing concerns, these organizations face a number of subjective factors that can seriously impact their service quality and customer satisfaction. Among the most important of these factors are customer needs and attitudes towards the services provided, the judgments and skills by which the services are offered, and the changing mix of the services themselves. The best service providers are characterized by both the high quality of their services as well as the efficient application of their resources. In an increasingly competitive business environment, it is thus of vital interest for many service providers to avail themselves of the existing analytical tools to assess their operational efficiency.

Since its inception, the DEA has been the subject of extensive theoretical refinements and empirical applications (see Cook and Seiford (2009) for an excellent review of the relevant literature over the past thirty years, covering over 130 citations). In the context of emerging economies, which is of special concern to the present study, although there are some applications of the DEA in the manufacturing sector (e.g., Duzkin and Duzkin (2007) for 500 Turkish industrial enterprises, and Saranga (2009) for 50 Indian auto manufacturers), most applications of DEA are centered in the services sector. And within the services sector, the financial industry has received the most attention. For example, Halkos and Salamouris (2004) using the DEA examine bank efficiency in Greece. Likewise, Sufian (2007) uses the DEA to study the trends in the efficiency of Singapore's commercial banking groups. In a simi-

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lar vein, Kao and Liu (2009) apply the so-called stochastic DEA to measure bank efficiency in Taiwan. All these studies highlight the efficacy of the DEA to pinpoint operational inefficiencies and the ways to deal with them. In particular, their results indicate the significant cost savings achievable through the adoption of the DEA.

## 1. Model

The standard DEA model is based on a linear programming formulation by Ragsdale (2007). Specifically, the efficiency an arbitrary bank $i$ ($i = 1,\ldots,k$) is defined as follows:

$$H_i = \frac{Weighted\ sum\ of\ bank\ i's\ outputs}{Weighted\ sum\ of\ bank\ i's\ inputs} = \frac{\sum_{j=1}^{n} O_{ij} W_j}{\sum_{j=1}^{m} I_{ij} V_j}. \quad (1)$$

Here $O_{ij}$ represents the output $j$ for bank $i$, $I_{ij}$ represents the input $j$ for bank $i$, $W_j$ is a nonnegative weight assigned to output $j$, $V_j$ is a nonnegative weight assigned to input $j$, $n$ is the number of outputs, and $m$ is the number of inputs. The problem in DEA is to determine values for weights $W_j$ and $V_j$ that will maximize the efficiency of bank $i$ subject to the constraint that, at these same weights, the efficiencies of all banks, including bank $i$, will be greater than 100%. Thus, we have:

Maximize: $H_i$ (2)

Subject to

$H_j \leq 1$ for $j = 1, 2,\ldots,k$. (3)

A separate optimization problem is solved for each bank to obtain the best possible weights to maximize the efficiency of that bank, subject to the similar constraints.

In addition, to be able to apply the linear programming techniques to the above optimization problem, as well as to prevent unbounded solutions, DEA requires the sum of the weighted inputs for each bank to equal one:

$$\sum_{j=1}^{m} I_{ij} V_j = 1. \quad (4)$$

More importantly, the use of linear averages involves the unrealistic assumption, not explicitly stated, that all outputs and inputs are perfect substitutes. In the context of inputs for banks, for example, the assumption asserts that bank employees and branches are perfectly substitutable, so that instead of adding to the number of its branches, a bank may as well add new employees to its existing branches. In realty, of course, while there is some degree of substitutability among outputs and inputs, this substitutability is far from perfect.

To overcome the above difficulties, Shirvani, Taj and Mirshab (2011) modified the standard DEA by using nonlinear (geometric) weighted averages of outputs and inputs in measuring the efficiency ratios. Thus measured, the log of each efficiency ratio can be expressed as a linear function of the logs of all outputs and inputs for each DMU. This means that the linear programming techniques can now be directly used to solve our optimization problems. The use of this new approach has the added advantage that it makes no restrictive assumptions about the perfectly substitutability of outputs and inputs. However, to prevent unbounded solutions, we need to add the linear constraint that the sum of all (nonnegative) weights, both for outputs and inputs, is one for each DMU. In light of the above, we can present the reformulation of our standard optimization problem as follows:

$$H_i = \frac{\prod_j O_{ji}^{Wj}}{\prod_i I_{ji}^{Vj}} \text{ for } i = 1,2,\ldots., k. \quad (5)$$

Maximize: $\log H_i = \Sigma_j W_j \log O_{ji} - \Sigma_j V_j \lg I_{ji}$. (6)

Subject to:

$\log H_j \leq 0$ for $j = 1, 2,\ldots..,k$, (7)

$$\sum_{j=1}^{n} W_j + \sum_{j=1}^{m} V_j = 1. \quad (8)$$

Having outlined the basic structures of the standard and modified DEA models, we can now proceed to apply these alternative approaches to assess bank efficiency in Turkey. This is done in the next section.

## 2. Empirical results

Our study of the changing character of bank efficiency in Turkey relies on an application of the DEA to 26 major Turkish banks for 2007 and 2010. Tables 1 and 2 list the input and output data for 2007 and 2010. To this end, we solve 26 optimization problems for our 26 banks for each year in the sample. The model assumes that more output and less input are always to be preferred from an efficiency point of view. Any output or input variable that does not conform to these rules should be transformed before applying the DEA (Ragsdale, 2007). Once the optimization problems for individual banks are solved, the best-practice banks are deemed as relatively efficient and are assigned a DEA efficiency score of 100%. The relatively inefficient (less-productive) units are then assigned efficiency ratings of less than 100%. Clearly, the lower

the efficiency rating for a unit, the less efficient that unit is. In addition, an inspection of the changing pattern of efficiency ratings over the sample period can shed considerable light on how bank efficiency in Turkey has evolved over time. In particular, we are interested to find out if the less efficient banks have been forced by competition to become more efficient with the passage of time, or whether the more efficient banks have gradually succumbed to lethargy to experience a loss of their competitive positions.

The inputs for each bank are the number of employees, the interest cost of deposits, the number of branches, and the total deposits. The outputs are the total loans and the interest income on loans. All the relevant data are presented in the Appendix. The information is from the selected non-consolidated financial tables from the Bank Association of Turkey (2009). We should add that the main purpose of this paper is to illustrate the use of the DEA methodology by referring to the Turkish banking system as a case study. No attempt is, thus, made here to offer a more comprehensive account of the Turkish banking policy and practice. Such information, however, can be found in Mercan et al. (2003), among others.

Our empirical findings concerning the bank efficiency in Turkey for the years 2007 and 2010 are presented in Tables 3 and 4. In addition, to facilitate comparison, Table 5 offers the bank efficiencies for both 2007 and 2010. An examination of the information in Table 5 will thus make it possible to determine how the level of productive efficiency at the level of individual Turkish banks has evolved during the recent global financial crisis. A number of striking features from Table 5 immediately stand out. To begin with, as the table demonstrates, for each of the years under review, only four out of a total of 26 sample banks display full (100%) efficiency. Outside the efficient banks, the efficiency is quite low, averaging only 60.3 percent for 2007 and 54.1 percent for 2010. Thus, not only banks in Turkey have still a long way to go in terms of improving their efficiencies, it seems clear that the recent global crisis, if anything, has had a negative impact on these efficiencies. Furthermore, for comparative reasons, we also assessed bank efficiency in Turkey using the standard non-logarithmic approach, and obtained results which, if anything, tend to indicate even a more dramatic deterioration in bank efficiency in Turkey during the recent crisis. Specifically, the standard results indicate a decrease in average efficiency from 65.2 percent in 2007 to only 53.9 percent in 2010.

Table 1. The 2007 data for 26 Turkish banks

| | | Outputs | | Inputs | |
|---|---|---|---|---|---|
| Banks | Total loans | Total assets-total loan | # of employees | # of branches | Total deposits |
| Ziraat | 18635 | 51185 | 20872 | 1251 | 58872 |
| Halk | 15631 | 19075 | 11484 | 590 | 26603 |
| Vakiflar | 20245 | 16336 | 8700 | 362 | 24897 |
| Akbank | 31929 | 26904 | 13513 | 716 | 35404 |
| Alternatifbank | 1608 | 632 | 868 | 40 | 1470 |
| Anadolubank | 1522 | 1091 | 1724 | 76 | 1601 |
| Sekerbank | 3118 | 2134 | 3824 | 235 | 3584 |
| Tekstil | 1797 | 707 | 1547 | 59 | 1306 |
| Turkish bank | 111 | 534 | 272 | 22 | 315 |
| Turk ekonomi | 5921 | 4258 | 5141 | 273 | 6110 |
| Garanti | 32104 | 26188 | 14517 | 588 | 33726 |
| Is | 29311 | 39852 | 19414 | 939 | 41864 |
| Yapi kredi | 24591 | 18843 | 14249 | 676 | 27747 |
| Arap turk | 111 | 197 | 175 | 3 | 74 |
| Citibank | 1684 | 1934 | 2349 | 54 | 2805 |
| Deutsche | 148 | 494 | 82 | 1 | 194 |
| Eurobank | 761 | 1610 | 549 | 36 | 994 |
| Finansbank | 12227 | 5786 | 9061 | 411 | 11177 |
| Fortis | 4768 | 3764 | 5041 | 268 | 4871 |
| Hsbc | 8061 | 3525 | 5733 | 237 | 6610 |
| Ing bank | 7506 | 3587 | 6357 | 366 | 6556 |
| Millennium | 635 | 365 | 300 | 16 | 824 |
| Turkland | 361 | 188 | 390 | 16 | 286 |
| Bank mellat | 91 | 97 | 49 | 3 | 37 |
| Societe generale | 62 | 435 | 107 | 1 | 2 |
| West LB A.G. | 35 | 721 | 43 | 1 | 487 |

Table 2. The 2010 data for 26 Turkish banks

| | | Outputs | | Inputs | |
|---|---|---|---|---|---|
| Banks | Total loans | Total assets-total loan | # of employees | # of branches | Total deposits |
| Ziraat | 32429 | 62815 | 22708 | 1399 | 78593 |
| Halk | 28140 | 20066 | 13450 | 709 | 35787 |
| Vakiflar | 28694 | 21265 | 11077 | 636 | 32908 |
| Akbank | 33699 | 38761 | 15330 | 913 | 44008 |
| Alternatifbank | 2100 | 721 | 1086 | 53 | 1649 |
| Anadolubank | 1938 | 1188 | 1834 | 86 | 1820 |
| Sekerbank | 4462 | 2921 | 3485 | 260 | 4787 |
| Tekstil | 1072 | 426 | 903 | 44 | 978 |
| Turkish bank | 254 | 377 | 273 | 21 | 389 |
| Turk ekonomi | 7478 | 4142 | 5646 | 335 | 6750 |
| Garanti | 41710 | 36925 | 16675 | 859 | 48621 |
| Is | 40501 | 45981 | 23944 | 1142 | 55735 |
| Yapi kredi | 32266 | 19139 | 14411 | 868 | 32447 |
| Arap turk | 331 | 363 | 255 | 6 | 167 |
| Citibank | 1510 | 2759 | 2116 | 37 | 2811 |
| Deutsche | 99 | 1246 | 101 | 1 | 800 |
| Eurobank | 1073 | 1765 | 875 | 54 | 1369 |
| Finansbank | 15256 | 8198 | 11734 | 503 | 15284 |
| Fortis | 5651 | 2109 | 4572 | 269 | 3914 |
| Hsbc | 6411 | 4186 | 6570 | 333 | 6496 |
| Ing bank | 8204 | 3266 | 5865 | 323 | 6514 |
| Millennium | 452 | 189 | 292 | 18 | 523 |
| Turkland | 601 | 314 | 510 | 27 | 659 |
| Bank mellat | 413 | 352 | 51 | 3 | 262 |
| Societe generale | 225 | 135 | 259 | 16 | 69 |
| West LB A.G. | 35 | 482 | 42 | 1 | 121 |

Table 3. Log (outputs) and Log (inputs) and the DEA efficiency for 26 Turkish commercial banks in 2007

| | | Outputs | | Inputs | | |
|---|---|---|---|---|---|---|
| Banks | Total loans | Total assets-total loan | # of employees | # of branches | Total deposits | Efficiency |
| Ziraat | 9.8328 | 10.8432 | 9.9462 | 7.1317 | 10.9831 | 44.9% |
| Halk | 9.6570 | 9.8561 | 9.3487 | 6.3801 | 10.1888 | 55.3% |
| Vakiflar | 9.9157 | 9.7011 | 9.0711 | 5.8916 | 10.1225 | 72.0% |
| Akbank | 10.3713 | 10.2000 | 9.5114 | 6.5737 | 10.4746 | 69.9% |
| Alternatifbank | 7.3827 | 6.4489 | 6.7662 | 3.6889 | 7.2930 | 77.9% |
| Anadolubank | 7.3278 | 6.9948 | 7.4524 | 4.3307 | 7.3784 | 53.1% |
| Sekerbank | 8.0449 | 7.6658 | 8.2491 | 5.4596 | 8.1842 | 47.8% |
| Tekstil | 7.4939 | 6.5610 | 7.3441 | 4.0775 | 7.1747 | 60.5% |
| Turkish bank | 4.7095 | 6.2804 | 5.6058 | 3.0910 | 5.7526 | 50.7% |
| Turk ekonomi | 8.6863 | 8.3566 | 8.5450 | 5.6095 | 8.7177 | 54.7% |
| Garanti | 10.3767 | 10.1731 | 9.5831 | 6.3767 | 10.4260 | 67.6% |
| Is | 10.2857 | 10.5929 | 9.8737 | 6.8448 | 10.6422 | 55.9% |
| Yapi kredi | 10.1101 | 9.8439 | 9.5644 | 6.5162 | 10.2309 | 60.4% |
| Arap turk | 4.7095 | 5.2832 | 5.1648 | 1.0986 | 4.3041 | 64.5% |
| Citibank | 7.4289 | 7.5673 | 7.7617 | 3.9890 | 7.9392 | 47.5% |
| Deutsche | 4.9972 | 6.2025 | 4.4067 | 0.0000 | 5.2679 | 100.0% |
| Eurobank | 6.6346 | 7.3840 | 6.3081 | 3.5835 | 6.9017 | 73.3% |
| Finansbank | 9.4114 | 8.6632 | 9.1117 | 6.0186 | 9.3216 | 56.0% |
| Fortis | 8.4697 | 8.2332 | 8.5254 | 5.5910 | 8.4911 | 50.2% |
| Hsbc | 8.9948 | 8.1676 | 8.6540 | 5.4681 | 8.7963 | 59.2% |
| Ing bank | 8.9235 | 8.1851 | 8.7573 | 5.9026 | 8.7881 | 54.2% |
| Millennium | 6.4536 | 5.8999 | 5.7038 | 2.7726 | 6.7142 | 90.1% |
| Turkland | 5.8889 | 5.2364 | 5.9661 | 2.7726 | 5.6560 | 61.2% |
| Bank mellat | 4.5109 | 4.5747 | 3.8918 | 1.0986 | 3.6109 | 100.0% |

Table 3 (cont.). Log (outputs) and Log (inputs) and the DEA efficiency for 26 Turkish commercial banks in 2007

| | | Outputs | | Inputs | | |
|---|---|---|---|---|---|---|
| Banks | Total loans | Total assets-total loan | # of employees | # of branches | Total deposits | Efficiency |
| Societe generale | 4.1271 | 6.0753 | 4.6728 | 0.0000 | 0.6931 | 100.0% |
| West LB A.G. | 3.5553 | 6.5806 | 3.7612 | 0.0000 | 6.1883 | 100.0% |

Table 4. Log (outputs) and Log (inputs) and the DEA efficiency for 26 Turkish commercial banks in 2010

| | | Outputs | | Inputs | | |
|---|---|---|---|---|---|---|
| Banks | Total loans | Total assets-total loan | # of employees | # of branches | Total deposits | Efficiency |
| Ziraat | 10.3868 | 11.0479 | 10.0305 | 7.2435 | 11.2720 | 44.0% |
| Halk | 10.2449 | 9.9068 | 9.5067 | 6.5639 | 10.4853 | 45.9% |
| Vakiflar | 10.2644 | 9.9648 | 9.3126 | 6.4552 | 10.4015 | 49.5% |
| Akbank | 10.4252 | 10.5652 | 9.6376 | 6.8167 | 10.6921 | 51.6% |
| Alternatifbank | 7.6497 | 6.5806 | 6.9903 | 3.9703 | 7.4079 | 64.0% |
| Anadolubank | 7.5694 | 7.0800 | 7.5143 | 4.4543 | 7.5066 | 55.5% |
| Sekerbank | 8.4034 | 7.9797 | 8.1562 | 5.5607 | 8.4737 | 51.4% |
| Tekstil | 6.9773 | 6.0544 | 6.8057 | 3.7842 | 6.8855 | 59.6% |
| Turkish bank | 5.5373 | 5.9322 | 5.6095 | 3.0445 | 5.9636 | 65.4% |
| Turk ekonomi | 8.9197 | 8.3289 | 8.6387 | 5.8141 | 8.8173 | 51.5% |
| Garanti | 10.6385 | 10.5166 | 9.7217 | 6.7558 | 10.7918 | 50.3% |
| Is | 10.6091 | 10.7360 | 10.0835 | 7.0405 | 10.9284 | 48.3% |
| Yapi kredi | 10.3818 | 9.8595 | 9.5757 | 6.7662 | 10.3874 | 47.9% |
| Arap turk | 5.8021 | 5.8944 | 5.5413 | 1.7918 | 5.1180 | 100.0% |
| Citibank | 7.3199 | 7.9226 | 7.6573 | 3.6109 | 7.9413 | 55.8% |
| Deutsche | 4.5951 | 7.1277 | 4.6151 | 0.0000 | 6.6846 | 100.0% |
| Eurobank | 6.9782 | 7.4759 | 6.7742 | 3.9890 | 7.2218 | 68.2% |
| Finansbank | 9.6327 | 9.0116 | 9.3702 | 6.2206 | 9.6346 | 46.5% |
| Fortis | 8.6396 | 7.6540 | 8.4277 | 5.5947 | 8.2723 | 57.7% |
| Hsbc | 8.7658 | 8.3395 | 8.7903 | 5.8081 | 8.7789 | 50.0% |
| Ing bank | 9.0124 | 8.0913 | 8.6768 | 5.7777 | 8.7817 | 54.0% |
| Millennium | 6.1137 | 5.2417 | 5.6768 | 2.8904 | 6.2596 | 60.7% |
| Turkland | 6.3986 | 5.7494 | 6.2344 | 3.2958 | 6.4907 | 58.3% |
| Bank mellat | 6.0234 | 5.8636 | 3.9318 | 1.0986 | 5.5683 | 100.0% |
| Societe generale | 5.4161 | 4.9053 | 5.5568 | 2.7726 | 4.2341 | 100.0% |
| West LB A.G. | 3.5553 | 6.1779 | 3.7377 | 0.0000 | 4.7958 | 100.0% |

Table 5. Efficiencies comparison (pre- and post-recession periods)

| Banks | 2007 efficiency | 2010 efficiency |
|---|---|---|
| Ziraat | 44.9% | 44.0% |
| Halk | 55.3% | 45.9% |
| Vakiflar | 72.0% | 49.5% |
| Akbank | 69.9% | 51.6% |
| Alternatifbank | 77.9% | 64.0% |
| Anadolubank | 53.1% | 55.5% |
| Sekerbank | 47.8% | 51.4% |
| Tekstil | 60.5% | 59.6% |
| Turkish bank | 50.7% | 65.4% |
| Turk ekonomi | 54.7% | 51.5% |
| Garanti | 67.6% | 50.3% |
| Is | 55.9% | 48.3% |
| Yapi kredi | 60.4% | 47.9% |
| Arap turk | 64.5% | 100.0% |
| Citibank | 47.5% | 55.8% |
| Deutsche | 100.0% | 100.0% |
| Eurobank | 73.3% | 68.2% |
| Finansbank | 56.0% | 46.5% |

Table 5 (cont.). Efficiencies comparison (pre- and post-recession periods)

| Banks | 2007 efficiency | 2010 efficiency |
|---|---|---|
| Fortis | 50.2% | 57.7% |
| Hsbc | 59.2% | 50.0% |
| Ing bank | 54.2% | 54.0% |
| Millennium | 90.1% | 60.7% |
| Turkland | 61.2% | 58.3% |
| Bank mellat | 100.0% | 100.0% |
| Societe generale | 100.0% | 100.0% |
| West LB A.G. | 100.0% | 100.0% |

## Conclusion

This paper has assessed the change in bank efficiency in Turkey during the recent financial crisis. Using a modified logarithmic version of the standard data envelopment analysis (DEA) for a sample of 26 major Turkish banks for 2007 and 2010, we find, first, the prevalence of substantial inefficiencies among the Turkish banks, and, second, a deterioration in overall bank efficiency between 2007 and 2010 as a result of the recent financial crisis. In addition, using the standard DEA approach, we obtained essentially similar results with even show a more dramatic decline in recent bank efficiency in Turkey.

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