THE EFFICIENCY OF BANKING SECTOR: THE EVIDENCE FROM AZERBAIJAN

Abstract. In this study, the Azerbaijani banking sector was researched for the post-COVID19 period. On the other hand, data envelopment analysis method and models were also learned. In this paper, we analyzed the top 10 banks of Azerbaijan in terms of assets for 2021 and as a result of the study, 4 banks are efficient and 6 banks are not. The analysis was carried out using the Data Envelopment Analysis method for the 3rd half of 2021 based on the data of the five largest banks for total assets in Azerbaijan. In this analysis, we used the CCR (Charnes Cooper Rhodes) model of the Data Envelopment Analysis method with the DEA Solver application. As a result of the analysis, 4 banks were efficiency 6 banks were found to be inefficiency and target points were identified for inefficiency banks.

Keywords: Efficiency, Efficiency Measurement Methods, Data Envelopment Analysis.

1. Introduction

The first regulations in the economies that transition to a centralized econometric market economy are in the banking sector and these economies are moving from a single bank system to a two-sector bank. After the collapse of the Soviet Socialist Republics (Soviet Union), Azerbaijan, which gained its independence in 1991, followed a similar path, putting the regulations on banking and central banking, one of the most important steps towards the free market economy, without delay. Thus, the central bank in the first sector and the commercial banks in the second sector have formed a two-sector bank system.

The banking sector, which is one of the building blocks of the country’s economy, is growing rapidly in international trade, and the prospect of a technological breakthrough in the globalizing world is steadily increasing. Therefore, the problems experienced in the banking system cause the negativities in
the economy to emerge. The performance of the banking sector is affecting all economic units in the country. Thus, it is important to measure and audit the performance of the banking sector.

In the determination of efficiency level in banks, ratio analysis or regression analysis methods are used. However, both methods have led to alternative approaches to policymakers or decision-makers in order not to be able to make benchmarking, to determine certain limitations and to determine which one is the most efficient and efficient bank.

Because of this trend, Data Envelopment Analysis Technique (DEA) has started to be used in the measurement of interbank efficiency and productivity. DEA is a mathematical programming technique designed to evaluate relative efficiency and efficiency, considering input items and output items used by banks in the same sector and is widely used in other sectors. DEA recognizes the efficiency levels of the highest performing decision-making units as a limit and can calculate which input items to reduce and which output items to increase and potential development possibilities for banking transactions so that other decision units can become effective according to this classification. What the bank managers need to do is to decide how to increase efficiency and productivity.

The most important aim of the study is to analyze the situation of the banking sector of Azerbaijan for the post-COVID19 period. And as a result of the study, it is observed that although some banks use all the opportunities they have fully efficient, some banks close the period with a loss. In this analysis, we used the CCR (Charnes Cooper Rhode) model of the Data Envelopment Analysis method with the DEA Solver application. As a result of the analysis, 4 banks were efficiency 6 banks were found to be inefficiency and target points were identified for inefficiency banks.

2. Methodology

Methods generally used in efficiency comparison in the banking sector ratio analysis and border approach analysis. In efficiency measurement with rate analysis, it is essential that the ratio of an input and of an output. In the banking sector, which is one of the main elements of the financial system, which has complex processes and has many inputs and many outputs, the method of the ratio analysis in efficiency
measurement is inadequate and the border approach is one of the most frequently used methods in terms of giving more accurate results in case of multiple input-output variables. Data envelopment analysis, which measures the relative efficiency of decision-making units, allows comparative efficiency analysis when there are multiple inputs and multiple outputs. It is an advantage to determine the efficiency limit according to the performance of the decision-making units in comparing the decision units of the DEA.

The DEA method will be used because it will analyse the efficiency of banks in terms of efficiency and examine the progress of the first 9th months in 2021. It would be useful to use DEA to determine the distance of the inefficient decision units to the efficiency boundary and to determine how much to amount of input should be reduced or how much the output should be increased to be above the efficiency limit, that is, to be effective.

In the study, the Data Envelopment Analysis will use the CCR model which adopts the assumption of a constant return on a scale and the BCC model which adopts a variable return valuation assumption. The input and output-oriented approach of the CCR and BCC models should be determined by examining the existing data structures of the DMUs. Since the use of inputs is usually the primary factor in the decision-making process, an input-driven approach has been adopted in many of the DEA studies in the banking sector. Therefore, input focused CCR and BCC models will be applied in the study.

2.1. Model of Data Envelopment Analysis.

The history of DEA, which has been widely used by both public and private sectors in recent years, has started with doctoral dissertation studies on “City and Public” at CORNEGIE Mellon University of Edwardo Rhodes. In this study, the performance of school groups participating in and participating in the attention screening test were compared.

Farrell’s single input-output technical efficiency measure in 1957 gave birth to the DEA proportional formula, known as the CCR (Charnes, Cooper, Rhodes) model, of the relative technical efficiency of 70 schools and their desire to predict multiple inputs and outputs, ignoring prices, the first article was published in the
The CCR model, developed and introduced by Charnes, Cooper, Rhodes from the DEA models, which is pronounced by the initials of their names, measures the total efficiency under the assumption of fixed return to scale.

Another DEA model, the BCC model developed by Banker, Charnes, Cooper’s work, measures only technical efficiency by comparing units in similar order under the assumption of variable return on a scale. Thus, the BCC model allows research under the assumption of variable return on the scale of the Decision-Making Unit in the case of multiple input multiple output.

The production boundaries will be different for the CCR model, which assumes a constant return assumption and the BCC model, which assumes a variable return on a scale basis. Below are the production limits for both models. Figure 2 shows a production limit and a set of production possibilities for the BCC model, while the CCR model has a production limit and a set of production possibilities.

2.2. Model of CCR

The CCR model developed by Charnes, Cooper, Rhodes, which is capitalized by initials of their names, calculates the efficiency limit in the case of constant returns to scale (CRS). The CCR relative efficiency model there is the total efficiency. Furthermore, with the restriction of the upper efficiency limit at 1.0 in DEA, the efficiency scores of all DMUs take a value between 0.0 and 1.0.

2.2.1. Input Oriented Model of CCR

In a market with n number of decision-making units, each decision-making unit uses a different number of m inputs to produce different output for the numbers. For example, DMUj, uses the i entry in the xij amount to produce the r output in yrij quantities. The input CCR model, where xij ≥ 0 and yrij ≥ 0, is used in the free technology of inputs and standard technology under CRS, where inputs are minimized, and outputs are accepted at a constant level.

Max \( z = \sum_{r=1}^{s} u_r y_{rij0} \) 
\[ \sum_{i=1}^{m} v_i x_{ij0} = I \]
The dual shape of this model is as follows;

$$\min \theta^*$$

$$\sum_{j=1}^{n} x_{ij} \lambda_j \leq \theta$$

$$x_{ij0} \geq 1, \ r = 1 \ldots, s$$

$$i = 1 \ldots, m$$

$$\lambda_j \geq 0$$

$$y_{rj} \geq y_{rj0}$$

$$j = 1 \ldots, n$$

The $\theta^*$ technical efficiency dimension for $DMU0$, the linear programming given above is the optimal solution of the problem? If $\theta^*$ is equal to 1, the current input level cannot be reduced proportionately without a reduction in output level and is stated to be at the limit for the $DMU0$. On the other hand, if $\theta^*$ is less than 1, it is stated that $DMU0$ is ineffective and falls below the limit and can reduce the input level without a decrease in output level.

### 2.2.2. Output Oriented Model of CCR

The CCR models given to the input in the previous section are set out for output, provided that this section maintains the validity of the constant returns to scale assumption. First, the output-oriented fractional programming model, $TFP0$, which is defined by the concept of total factor productivity, is given. (Aras, G., & Gencer, C. 2011)

**Model $TFP0$:**

Min.

$$F_k = \min \sum_{i=1}^{m} v_{ik} x_{ik}$$

$$u_{rk} \geq 0, \ v_{ik} \geq 0$$

$$i = 1 \ldots, m$$

$$\sum_{i=1}^{m} v_{ik} x_{ij}$$

$$\sum_{r=1}^{s} u_{rk} y_{rk} \geq 1$$

$$j = 1 \ldots, n, \ r = 1 \ldots, s$$

In the framework of the approach given to reduce fractional programming models to linear programming models, $TFP0$ is expressed as a fractional programming model and $M_0$ linear programming model.
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Model $M_0$:

Min.

$$g_k = \sum_{i=1}^{m} v_{ik}x_{ik}, \quad j = 1 \ldots, n \quad r = 1 \ldots., s$$

$$v_{ik} \geq 0 \quad i = 1 \ldots., m$$

$$- \sum_{r=1}^{s} \mu_{rk}y_{rk} + \sum_{i=1}^{m} v_{ik}x_{ij} \geq 0$$

$$\sum_{r=1}^{s} \mu_{rk}y_{rk} = 1 \quad \mu_{rk} \geq 0$$

The dual model of Model $M_0$ is $E_0$, an envelope model, and is given below.

Model $E_0$:

Max. $z_k$

$$- \sum_{j=1}^{n} u_{j}y_{rk} + v_{k}y_{rk} \leq 0$$

$$\lambda_{rk} \geq 0 \quad i = 1 \ldots., m$$

$$\sum_{j=1}^{n} y_{jk} \lambda_{jk} \leq x_{ik} \quad j = 1 \ldots, n \quad r = 1 \ldots., s$$

3. Determination of Inputs, Outputs and Decision-Making Units

According to the DEA, inputs and outputs should be defined to measure the efficiency.

### Azerbaijani Banks in 2021

<table>
<thead>
<tr>
<th>Bank Name</th>
<th>Net Profit</th>
<th>Interest income</th>
<th>Interest Expense</th>
<th>Equity</th>
<th>Total Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABB</td>
<td>197 181 79</td>
<td>323 735 00</td>
<td>68 316 000</td>
<td>1 411 223</td>
<td>9 431 896</td>
</tr>
<tr>
<td>Paşa Bank</td>
<td>69 285 000</td>
<td>194 336 00</td>
<td>40 122 000</td>
<td>559 505 00</td>
<td>6 068 042</td>
</tr>
<tr>
<td>Kapital Bank</td>
<td>135 180 00</td>
<td>347 661 00</td>
<td>49 558 000</td>
<td>600 150 00</td>
<td>5 916 038</td>
</tr>
<tr>
<td>Xalq Bank</td>
<td>14 243 460</td>
<td>69 715 000</td>
<td>23 892 000</td>
<td>444 900 21</td>
<td>2 221 242</td>
</tr>
<tr>
<td>Bank Respublika</td>
<td>12 099 960</td>
<td>69 959 000</td>
<td>29 333 000</td>
<td>94 480 630</td>
<td>1 194 327</td>
</tr>
<tr>
<td>Access Bank</td>
<td>4 010 000</td>
<td>87 102 000</td>
<td>34 369 000</td>
<td>97 808 000</td>
<td>9 010 000</td>
</tr>
<tr>
<td>Unibank</td>
<td>6 625 000</td>
<td>72 722 000</td>
<td>9 879 000</td>
<td>39 662 000</td>
<td>6 625 000</td>
</tr>
<tr>
<td>Asb Bank</td>
<td>1 716 540</td>
<td>20 920 000</td>
<td>11 226 000</td>
<td>104 124 00</td>
<td>1 716 540</td>
</tr>
<tr>
<td>Rabitə Bank</td>
<td>6 625 000</td>
<td>30 198 000</td>
<td>19 715 000</td>
<td>106 406 58</td>
<td>6 625 000</td>
</tr>
<tr>
<td>Turan Bank</td>
<td>404 000</td>
<td>20 920 000</td>
<td>19 715 000</td>
<td>86 557 000</td>
<td>404 000</td>
</tr>
</tbody>
</table>

Figure 1
In addition to this, for the banking sector defining inputs and outputs is not easy. For this process, firstly, similar studies were researched in the literature and decided to use 3 inputs and 2 outputs in this study. These inputs are Total Assets, Total Equity, and Interest Expenses. The Outputs are Interest Income and Net Profit. As you know, in 2020 there is COVID19, for this reason, in our analysis, we selected the 10 largest banks for the 9th months in 2020 for their assets.

4. Result of Analysis

The given below table illustrates result of analysis and efficiency degree of the banks. Firstly it is understood that from the table 4 banks are the efficient. These banks are ABB, Kapital bank, Xalq bank and Unibank. On the other hand, 6 banks are inefficient. These banks are taken efficiency degree less than 1. Moreover ABB, Kapital bank, Xalq bank and Unibank are constant to return to scale. Finally Pasha bank, Bank republic, Access bank, Rabita bank, ASB bank and Turan bank are increasing for return to scale.

<table>
<thead>
<tr>
<th>DMU No.</th>
<th>DMU Name</th>
<th>Input-Oriented CRS Efficiency</th>
<th>Sum of lambdas</th>
<th>RTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ABB</td>
<td>1.00000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2</td>
<td>Paşa Bank</td>
<td>0.66617</td>
<td>0.651</td>
<td>Increasing</td>
</tr>
<tr>
<td>3</td>
<td>Kapital Bank</td>
<td>1.00000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>4</td>
<td>Xalq Bank</td>
<td>1.00000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>5</td>
<td>Bank Respublika</td>
<td>0.91969</td>
<td>0.492</td>
<td>Increasing</td>
</tr>
<tr>
<td>6</td>
<td>Unibank</td>
<td>1.00000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>7</td>
<td>Access Bank</td>
<td>0.93584</td>
<td>0.835</td>
<td>Increasing</td>
</tr>
<tr>
<td>8</td>
<td>Rabita Bank</td>
<td>0.70159</td>
<td>0.171</td>
<td>Increasing</td>
</tr>
<tr>
<td>9</td>
<td>ASB Bank</td>
<td>0.36936</td>
<td>0.112</td>
<td>Increasing</td>
</tr>
<tr>
<td>10</td>
<td>Turan Bank</td>
<td>0.50554</td>
<td>0.338</td>
<td>Increasing</td>
</tr>
</tbody>
</table>

The other table is taken from result of analysis shows that, the new targets for inefficient banks.

When we examine the table it is understood that Pasha bank, Bank republic, Access bank, Rabita bank, ASB bank and Turan bank are need to decrease their assets, equity and interest expense for taking efficiency degree. The banks which
efficiency degree is 1, are example for other banks because these banks are used their assets are efficient.

Table 2

<table>
<thead>
<tr>
<th>DMU No.</th>
<th>DMU Name</th>
<th>Efficient Input Target</th>
<th>Efficient Output Target</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total Assets</td>
<td>Equity</td>
</tr>
<tr>
<td>1</td>
<td>ABB</td>
<td>9,431,896,990,00</td>
<td>1,411,223,040,00</td>
</tr>
<tr>
<td>2</td>
<td>Paşa Bank</td>
<td>3,425,749,717,00</td>
<td>372,727,053,86</td>
</tr>
<tr>
<td>3</td>
<td>Kapital Bank</td>
<td>5,916,038,000,00</td>
<td>600,150,000,00</td>
</tr>
<tr>
<td>4</td>
<td>Xalq Bank</td>
<td>2,221,242,120,00</td>
<td>444,900,210,00</td>
</tr>
<tr>
<td>5</td>
<td>Bank Respublika</td>
<td>855,164,224,81</td>
<td>86,892,690,91</td>
</tr>
<tr>
<td>6</td>
<td>Unibank</td>
<td>960,802,000,00</td>
<td>97,808,000,00</td>
</tr>
<tr>
<td>7</td>
<td>Access Bank</td>
<td>802,179,548,62</td>
<td>81,660,505,80</td>
</tr>
<tr>
<td>8</td>
<td>Rabita Bank</td>
<td>635,547,819,84</td>
<td>64,498,543,06</td>
</tr>
<tr>
<td>9</td>
<td>ASB Bank</td>
<td>320,103,491,79</td>
<td>32,496,155,31</td>
</tr>
<tr>
<td>10</td>
<td>Turan Bank</td>
<td>339,360,942,64</td>
<td>34,540,075,14</td>
</tr>
</tbody>
</table>

References:
comprehensive text with models, applications, references and DEA-solver software (Vol. 2).

New York: Springer.


