Efficiency Measurement and Ranking of Banks by Using Data Envelopment Analysis (DEA) and its Relation to Financial Aspects

1Mehdi Dehghan Neyestanaki and 2Zahra Shadkam

1Assistant Professor ,Department of Management and Accounting, Islamshahr Branch, Islamic Azad. University, Tehran, Iran.
2M.A, Department of Management and Accounting, Islamshahr Branch, Islamic Azad. University, Tehran, Iran.

ABSTRACT

The main objective if this article is to study the relationship between efficiency and ranking of the banks by using financial aspects. The present study uses the DEA technique which is a type of linear planning. DEA is used in fixed condition. It means that the effect of time change is ignored. In order to solve this problem the Window Analysis method, one of none parametric methods for efficiency measurement during the time, is used in this article. Here, the efficiency and ranking of 6 private banks of Iran is used by DEA for time periods of 2007 and 2012 using the GAMS software. Then the relationship between efficiency and ranking and financial dimensions is dealt with.

INTRODUCTION

One of the most important measurement scales of proper performance of the economic units including the banks is to measure their efficiency. There are different methods for measuring the efficiency of each economic unit the most important of which are the parametric and non-parametric methods. One of the non-parametric methods is DEA. DEA is a new method for solving an important issue of the economic experts and policy makers which called the issue of "efficiency measurement". Since the beginning of the discussion of DEA in 1978T by Charnez, Copper and Roads, a lot of articles have been written in this field all over the world. Different models are introduced for measuring the efficiency of decision making units and professors Van De Panne, Baseley and Seiford can be named as the pioneers of the field. In Iran, the main work is done by Jahanshaholou and Akirezaiee.

But in spite of so many advances in this field, the point which should be pointed here is that a few numbers of studies are done about efficiency and this is the issue which has been considered in this article. So, in this article, we use the Window Analysis in order to measure the efficiency of one of the non-parametric models of DEA.

Role of Bank system in Iran:

Nationalization of the banks after the victory of Islamic Revolution made the policy making and leading the bank system available for public section and banks could use their abilities in leading the banking and financial activities. However, the war of Iraq against Iran made a lot of problems for the economy of the country and banks which are the financial army of a country lost their role as independent financial institutes.

By approval of the law of banking without usury and clearing the activity realm of the banks in form of Islamic contracts lead to reduction of the decline in banking activities but the banking system could not play the role of an independent financial institute yet and this has a significant effect on banking system efficiency.

The fact that the banking systems have the role of leading the extra flow of money of the economic users cannot be denied and banking without usury has its own place in Iran but the state control on the banks although has maintained the public trust but affected their economic activities.

Another change that has taken place in the banking system of Iran in order to increase the efficiency is the issue of giving the license of economic activity for the private section in the field of banking in form of non-banking financial institutes and private banks can be a new beginning of changes in attracting the cooperation of the private section for investing in macro and micro plans in different economic sections. So, it can be said that
the competitive atmosphere which has been created due to the presence of private institutes and banks in banking industry of Iran would lead to the increase of efficiency of banking system in general.

**Main Activities of the Banks:**

Main activities of the banks in banking system includes collecting the distributed money, management and controlling them toward the healthy economic activities (equipping the sources) and also giving the facilities and money usage (source specification) for supporting the investment in production and also running the factories and industries for economic growth of the country.

So, the main tasks of the banks include:

- **Resource equipment:**
  Resource equipment has always been the main task of banking system through which the banks collect the extra money and give loans to the demanders to do the traditional function of intermediary for the depositors and borrower.

    According to the second chapter of the banking activities banks can do depositing in order to equip the financial sources under one of these titles:

    A) Deposits for loans
    B) Common deposits for loans
    C) Saving deposits for loans
    D) Short term investing deposits
    E) Long term investing deposits

- **Resource specification (giving bank facilities):**

Third chapter of the banking activities without usury is about the specification of financial resources as the facilities given by banks. Banking facilities can be divided into two main sections. Based on the paragraphs of article 14, banks have to pay the loans using the loan deposits and cannot use the long term investing. Other banking facilities are devoted in forms of Islamic contract.

  - Loan facilities
  - Partnership
  - Rewarding
  - Installment sales
  - Hire-purchase
  - self

**Definition of efficiency and its types:**

Generally, efficiency is a relative concept and compares a real performance and an ideal one. Efficiency is related with the performance of an economic unite in the production process and in other words is the performance of the production process components and their proper combination in order to get the highest production.

**Methods of efficiency measurement:**

Efficiency of an agency is done in two methods of parametric and non-parametric.

  a) Parametric methods

    These are the methods in which a special form of production function is considered. Then, it is one of the common methods of estimating the functions in statistics and economic. The un-known coefficients (parameters) of the function are estimated and since parameters of a function are estimated in this method, they are called parametric.

  b) Non-parametric methods

    They are against the parametric methods. One of the advantages of the non-parametric methods is that they do not consider a special form for the production function and are directly related with the data. Farrell in 1957 introduced the efficiency estimation by non-parametric method. He observed the input and output instead of estimating them and considered a limit for them and it was the factor of efficiency. It should be mentioned that Farrell suggested his opinion based on the works done by Debreu and Koopmans.

**Data Envelopment Analysis:**

Data Envelopment Analysis (DEA) is a non-parametric technique for measuring the relative efficiency of a collection of the phenomenon (organization) with precise input and outputs (Kao & Liu, 2000, p.427). In other words, it is a method for measuring the relative efficiency of multiple decision making units for producing the same outputs. This approach is a combination of mathematical models which are common in the principle of Envelopment.
The term relative is a key term in defining DEA since a DEA can be recognized as a DMU comparing with a series of other DMU data while when it is compared with a collection of DMU data it would be defined inefficient. The beginning point of using DEA is to create a compatible relation of a harmonious collection of the outputs with the harmonious collection of the inputs for each DEA.

Theoretical models of DEA are investigated in form of two basic methods of CCR and BCC.

A) The CCR model: Charnes, Copper and Roads (1978)
In this model the harmonious sum of the units are considered to measure the relative efficiency of the units and following formula is used for measurement of the technical efficiency.

\[(\text{The weighted sum of inputs}) \times (\text{The weighted sum of outputs}) = \text{efficiency}\]

This model has fixed revenue and tried to select the best weight to increase the efficiency of this unit for the input and output variables in a way that it has the higher efficiency compared to other units. This model has two nature of input and output and three fractional forms of multiplying and enveloped.

In formulation of the CCR model it is assumed that the relationship between the input and output follows the revenue to scale relation. That is, if the inputs are doubled, the outputs will be doubled. If the outputs are increased twice or less than twice, the efficiency of them would increase or decrease. In most of the organizations considering the revenue to scale is not fixed and it is proper when all the agencies act in proper level but different issues such as the competitive effect, limitations, week efficiencies and others cause the agencies to not be able to act in a proper level. So, Banker, Charnez and Copper in 1984, extended the previous model in a way that variable revenue to scale is considered too and the model was called BCC as the abbreviation of their last name.

Diachronic Evaluation:
DEA approach is used when the data are fixed. It means that the effect of time change is ignored. This can be confusing since the changes during the time can be toward the more usage of resources for producing better results. In fact DEA is a non-parametric model for measuring efficiency. Window Analysis is one of these models.

Window Analysis:
In studying the DEA and measuring the efficiency of the units, each DMU is investigated in a defined time. But it is mostly seen that during a time period the data are in time series and this is very important when we want to study the efficiency of a decision making unit. In this form, one can study the behavior of a DMU in a time period so that the behavior is changing in different times. The advantage is that the performance of a DMU in a specific time period can be compared with the performance of the same DMU in another time or with other DMUs.

Window analysis was done in 1985 by Charnez and colleagues in airplane maintaining practice of U.S.A. it is the best method of measuring the efficiency of decision making units (Alirezaiee, 2001, p.1-15).

Ranking the efficient units:
DEA measures the relative efficiency of the decision making units and give an efficiency score \((E)\) for each. If the score is lower than 1, it means that a linear combination of the units can have the same output with less inputs. It means that the efficiency score of Min is the relative reduction of inputs which results in efficiency.

Efficiency score of 1 means that the unit is efficient and it is not possible to rank more efficient units. So, DEA shows the efficiency ranking of inefficient units.

Review of literature:
Kale and Eken in 2011 measured the performance of the Turkish Bank using DEA. The aim of the study was to measure the relative efficiency and improvement capabilities of the banks and recognizing the weak and strong points of them. It is shown in this study that the size of the unit is related to the efficiency. Stephen Karanu in 2010 wrote the article "efficiency and measured the efficiency level of the Ghanaian banks" in a 10-year period from 1997 to 2006 using two models of DEA and SFA. He studied different hypotheses of the models and then used both of them were used for measuring the efficiency of the banks.

Matthews Asmid in 2012 analyzed the efficiency of some efficiency models in banks of China during 1997 to 2008 and showed the difference between the efficiency models among different subgroups using the MEA method and considered the case of common shared banks and banks with the state ownership. The experimental tests were used to find the differences in efficiencies of these two banks, Tzu Pu Chang, Lei Sun in 2010 did a study titled as "A comprehensive analysis of risking actions on bank efficiency: evidences of Asian countries". The relationship between the performance risks, credits and bank markets were studies in Thai banks based on efficiency of the branches and their efficiency was estimated through the DEA and SFA methods and there was
a significant relationship between them. Angelidis Lyroudi in 2011 in the article "efficiency in Italian banking industry" used the efficiency of 100 Italian banks during the time period of 2001 to 2002.

**Research Method:**
Research method of the present study is descriptive and correlation of studying the evidences. First, the measurement factors of bank efficiencies were recognized though studying the theoretical principles and then using the data, the relative amount of the data were determined for the banks and then DEA was used to measure the efficiency and rank the banks and finally the relationship between the efficiency and ranking was dealt with.

**Research Hypothesis:**
Main hypothesis: there is a significant relationship between the efficiency and ranking of the banks and their financial dimensions
Secondary hypotheses:
- There is a significant relationship between efficiency and ranking of the banks with the ration of personnel to the given loans
- There is a significant relationship between the efficiency and ranking of the bank with the deposits ratio
- There is a significant relationship between the efficiency and ranking of the bank with the interest and lose of the company
- There is a significant relationship between the efficiency and ranking of the bank with the total assets

**Inputs and Outputs:**
In this study, following variables have been selected from among the variables which can be used as the input for the banks and have been fixed during a fiscal year as the controlling variables of the bank as management tools:
Number of personnel, fixed assets, performance costs
The variables which can introduce the quantitative dimensions of the bank in the sections of facilities (deposits), resource specification (facilities) and services (considering the existed data) are as follows:
A) The output related to the banking activities in the equipment section which are ordered in terms of importance as:
- Common loan deposits
- Saving loan deposits
- Short term deposits
- Long term deposits
- Special short term deposits
B) In the section of resource specification, the facilities of the bank are considered in two sections of state and non-state.

**Evaluation of efficiency (during the 3-year window):**
As it is seen in the table below, all the banks have been evaluated during periods of three years and their efficiency is calculated during different years. For example, the average of the Tejarat bank efficiency in first window was 0.76451, in the second 0.825274 and in the third 0.827876 was obtained which shows that fact that Tejarat bank has been able to improve its efficiency during this time. So, here the efficiency of other banks can be interpreted the same way.

### Table 3.1: measurement of banks' efficiency during three-year window

<table>
<thead>
<tr>
<th>Bank</th>
<th>87</th>
<th>88</th>
<th>89</th>
<th>90</th>
<th>91</th>
<th>Efficiency mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saderaat Bank</td>
<td>0.503163</td>
<td>0.616394</td>
<td>0.824457</td>
<td>0.648005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mellat Bank</td>
<td>0.841739</td>
<td>0.869923</td>
<td>1</td>
<td>0.903887</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tejarat Bank</td>
<td>0.708003</td>
<td>0.764334</td>
<td>0.821193</td>
<td>0.948379</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasargad Bank</td>
<td>1</td>
<td>0.872728</td>
<td>0.915449</td>
<td>0.929392</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parsian Bank</td>
<td>0.870691</td>
<td>1</td>
<td>1</td>
<td>0.956897</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Total Mean and Final Ranking of the Banks:

In previous section, the efficiency mean of each bank in a year was calculated based on the window model. In order to have a good final mark, all the efficiency scores should be averaged and then the final ranking of the banks will be determined. The table below shows the total efficiency mean and ranking of each bank. The bank with higher mean has the higher rank.

<table>
<thead>
<tr>
<th>Final ranking</th>
<th>Efficiency mean</th>
<th>banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.974034</td>
<td>EghtesadNovin</td>
</tr>
<tr>
<td>2</td>
<td>0.967634</td>
<td>Parsian</td>
</tr>
<tr>
<td>3</td>
<td>0.96601</td>
<td>Mellat</td>
</tr>
<tr>
<td>4</td>
<td>0.880717</td>
<td>Tejarat</td>
</tr>
<tr>
<td>5</td>
<td>0.695734</td>
<td>Saderaart</td>
</tr>
</tbody>
</table>

Conclusion:

The evaluation period of the present study has been 5 years since 2008 to 2011. The present study does the analysis with window term (evaluation period) for three years. So that, all the banks have been evaluated in three years comparing with other banks and themselves and their efficiency during different years have been calculated.

Finally, the results show that the efficiency mean of EghtesadNovin in first, second and third window is 1 which indicates that this bank could have the higher efficiency among the six mentioned bank and has an increasing process.

Pasargad bank is in the second rank with the score of 0.974.34. in addition, Parsian, Mellat, Tejarat and Saderaat banks with the efficiency of 0.967634, 0.96601, 0.880717, 0.695734 are in later ranks respectively.

Next section presents the results of the secondary hypotheses:

1. The result of the first hypothesis shows that efficiency, ranking and ratio of the personnel to the given loans have significant relationship. Increasing the ratio of the personnel to the given loans has caused an increase in the ranking and lowering the efficiency of the banks. So, the banks have to reduce the ration of personnel to the given loans in order to increase the efficiency and reduce the ranking.

2. The results of the second hypothesis show that there is a significant relationship between the efficiency and ranking and the deposits ratio. The ration of deposits include:
   - Ratio of the common deposits to all the deposits
   - Ratio of the saving deposits to all the deposits
   - Ratio of the long term saving deposits to all the deposits
   - Ratio of the short term saving to all the deposits
   - Ratio of the special short term saving deposits to all the deposits

   The results show that four first ratios have significant relationship with the efficiency and ranking and fifth ration does not have significant relationship. In addition the results show that by reducing the ration of the common deposits to all deposits and the ratio of the short term deposits, the efficiency of the banks will be increased. In addition, the banks can improve their efficiency by increasing the long term deposits.

3. The results of the third hypothesis show that there is a significant relationship between efficiency, ranking and interests and loss. In other words, the banks with higher efficiency have more returns. The approval of the relationship between these variables of the bank means that increase or decrease of performance and efficiency leads to a little change in amount of the interests or loss of the organization. It is also concluded that higher figure of ranking leads to reduced benefit and greater loss and so lower ranking figure leads to improving the benefit of the bank.

4. Results of the 4th hypothesis show that there is a significant relationship between efficiency, ranking and ration of the assets to the total assets. So, banks have to try to reduce the ranking figure which is done in form of reduction of fixed assets to the total assets.

Considering the synergic feature of considering the four components at the same time, it is necessary to consider them all in policy making and strategic plans so that the competitive power becomes better based on competitive advantage. In addition, the performance of the economic agency based on the above model is measured and necessary actions should be done on the efficiency. The results of the present study indicate the meaningful relationship between efficiency and related variables which provide proper data for the bank managers in order to take proper decisions and policies.
REFERENCES