

## **Comparative study of the efficiency of private and public banks with a parametric and non-parametric approach using value added and income**

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### **ABSTRACT**

*Examining the efficiency of banks as one of the most important factors of the financial market of any country is one of the necessary measures to achieve economic growth and development. Banks, as the most important institution of the money market, have a very important role in the economy of any country, and considering their role and also the rapid reflection of policies in this sector in the entire economy, measuring the efficiency of banks is of particular importance. Accordingly, the purpose of this study is to measure the efficiency of selected private (Egtesad Novin, Pasargad, Sarmaye, Saderat, Mellat, Tejarat and Refah) and state (Meli, Tosee Saderat and Sannat and Madan) banks in the study period (2014-2016). To achieve this goal, a non-parametric approach (data coverage analysis) and a parametric approach (border production function) have been used using value added and revenue methods. The findings confirm the main hypothesis that in the period under study, private banks were more efficient than state banks and regardless of the revenue approach of data coverage analysis method, the second hypothesis of the research is also confirmed which is that the results of the parametric and nonparametric approaches are the same.*

*Keywords: Bank, Boundary Production Function, Data Envelopment Analysis, Efficiency*

## **1-Introduction**

The economic phase of today's societies has led to the diversification and expansion of the activities of banks, and banks are increasingly providing services with better, wider and cheaper status to applicants and trying to attract more customers and eliminate their competitors. In the long run, banks that fail to achieve this important goal of providing more, better and cheaper services, in other words, higher efficiency, are gradually marginalized and eliminated. Therefore, banks must constantly monitor their position in terms of various functions and put a continuous move towards more efficiency on their agenda. In this regard, measuring efficiency and productivity is the most basic step to improve the efficiency and productivity of banks. This means that it must be specified exactly in these economic units that resource constraints, population growth, diversity and expansion of needs, people's demands, as well as increasing their expectations, make it necessary for us to make better use of resources and factors. Financial markets, as one of the financing institutions for institutions and organizations for investment as well as financing the financial buyers of goods and services, play an important role in the economy. Therefore, improving their efficiency will affect all aspects of the economy. Among existing firms and institutions, the development of financial institutions and markets is crucial and inevitable for the growth of Islamic developing countries. With the passage of time and the increasing importance of the development of monetary and financial markets, especially banks, as an effective factor in supporting the economy and ultimately the development and economic prosperity of the country, evaluating the performance of banks in terms of efficiency has been more considered by governments and financial policymakers and the question always arises as to how much and how efficient banks are in an economy.

Considering the role of banks in the financial markets and consequently the economy of each country and considering the rapid reflection of the policies of this sector in the whole economy of the country, measuring the efficiency of banks and recognizing their type and level of efficiency is of particular importance. Increasing the efficiency of banks will not only increase their profitability, but also increase public welfare. In addition, with the expansion of markets and the change of face-to-face purchases into global and online ones, the role of banks as intermediaries for further sales is becoming clearer. Certainly, expanding the volume of transactions and their globalization will not be possible without considering the effective role of banks and increasing their efficiency and other financial institutions. If these institutions are able to reduce their costs more efficiently and finance institutions and economic organizations as well as final buyers of goods and services in a cheaper and more efficient way, it can be expected that economic cycles move faster and healthier, and overall welfare increases as production, consumption, and distribution increase. Thus, recognizing the effective factors in order to create suitable conditions for improving the efficiency and productivity of banks seems necessary.

## **2- Theoretical foundations of research**

Efficiency is the measure of an organization's productivity of its resources in the field of production relative to the best performance at some point in time (Pears, 1997). Performance is generally defined as the ratio of output to input. When a process consists of an input and output, the performance calculation is simple. However, when there is more than one input and output for the process, it needs a method to combine these inputs and outputs to achieve a performance measure. However, today, two methods are used to evaluate efficiency: parametric (econometrics) and non-parametric (linear programming).

### **2-1- Non-parametric approach (mathematical programming)**

One of the most important mathematical programming methods used to calculate the productivity and efficiency of economic units is the Data Envelopment Analysis (DEA) method, which is a mathematical planning model for evaluating efficiency. It is a decision-making unit (DMU) that has multiple inputs and multiple outputs.

Data envelopment analysis is based on a series of optimizations using linear programming, which is also called non-parametric method. In this method, an efficient boundary curve is created from a series of points determined by linear programming. To determine these points, two assumptions of fixed and

variable returns to scale can be used. The linear programming method, after a series of optimizations, determines whether the target decision-making unit is on the performance boundary or outside it. In this way, efficient and inefficient units are separated from each other. The DEA technique covers all data and for this reason it is called data envelopment analysis (Moinoddini, 2003).

The use of the DEA model for the relative evaluation of units requires the determination of two basic characteristics of the nature of the model and the return to the scale of the model. Efficiency on a scale represents the relationship between changes in the inputs and outputs of a system. One of the capabilities of the DEA method is the application of different patterns corresponding to returns to different scales as well as measuring returns per unit scale. In terms of returns to scale, returns to fixed scales and returns to variable scales can be considered, based on which two types of models (CCR) and BCC have been developed for data envelopment analysis. In the CCR model of data envelopment analysis method, returns per unit scale are assumed to be constant. When the efficiency is constant on a scale, each multiplier of the inputs produces the same multiplier of the outputs. So small and large units are compared. BCC pattern returns to scale Assumes a variable. When the efficiency varies with the scale, any factor of the inputs can produce the same factor of the outputs, or more or less.

by keeping the output level constant in the evaluation process, we try to minimize the inputs, it is the nature of the input model used. If in the evaluation process we try to maximize the output level by keeping the input level constant, it is the nature of the output model used (Cooper et al., 2000). In the input view of the DEA model, we seek to obtain technical inefficiencies as a ratio that must be reduced at the inputs so that the output remains unchanged and the unit is at the efficiency limit. From the output point of view, we are looking for a ratio that the outputs should increase, without any change in the inputs and the unit reaches the efficiency limit. In the CCR model, the values obtained for performance are equal in both perspectives. But in the BCC model these values are different.

The reason for choosing an input or output view for a DEA model is in the relative evaluation of the performance of units that in some cases the unit management has no control over the amount of output and its value is already known and fixed and vice versa; In some cases, the amount of input is fixed and the amount of production (output) is a decision variable, and in such cases, the output perspective is appropriate. Therefore, the choice of the nature of input and output is determined based on the degree of control of the manager over each of the inputs and outputs (Coeli et al., 1998).

## 2-2- Parametric approach

In the parametric method, the production structure can be examined using the production function or cost. Dogan's theory has shown that there is a single relationship between production functions and cost (Shepard, 1970). Thus, in applying this approach, the first step is to specify the structure of production or cost, which requires the selection of an appropriate form of function, in such a way as to best explain the structure of production or cost.

In many economic contexts, production is assumed to be at the border, meaning that production units obtain the maximum possible output from given input levels, and when estimating production functions, it is assumed that production Located at the boundary, unless there is an error component with a random distribution. While empirical evidence shows that manufacturers are not always successful at operating across borders, there is usually inefficiency. For this reason, in recent studies, attempts have been made to place production along the border by using border production functions. The cross-production function was first proposed independently by Aigner et al. (1977) and Meeusen and Ven den Broeck (1977). The main model proposed by them was a model for cross-sectional data and had a two-part perturbation component, one of which showed random effects and the other part showed inefficiency effects. This model is shown as follows:

$$Y_i = x_i \beta + (V_i - U_i) \quad i=1, \dots, N, \text{ equation 1}$$

In equation (1)  $Y_i$  is the product of the  $i$  th firm, the  $x_i$  vector  $k \times 1$  is one of the values of the inputs used by the  $i$  firm and  $\beta$  is the parameter vector.  $V_i$  are random variables that are distributed as iid,  $N(0, \sigma_v^2)$  and independent of  $U_i$ .  $U_i$  are also non-negative random variables that indicate inefficiencies in the production function and are usually distributed as iid,  $N(0, \sigma_u^2)$ .

### **3- Research background**

#### **3-1- Studies in the country**

Alvani et al. (2012) estimated the efficiency of 52 branches of Sepah Bank in Tehran province and the factors affecting it. For this purpose, they used information about the volume of facilities granted to the private sector, labor force, the volume of deposits and fixed assets for the period 2005-2006, and the time-varying inefficiency models of Batis and Coelly (1992) and inefficiency. They estimated the structural effects of Batis and Coelly (1995). According to the findings, the efficiency of the branches for the first model is 77.1% and for the second model is 64.2%. Total assets, staff education and degree of technology utilization included in the second model.

Ghanbari and Sadeghi (2014) evaluated the efficiency of different branches of Melli Bank in 2011-2012 in Arak. This was done using data envelopment analysis method. According to the findings, in 2011, 25.9% and 40.74% of the branches were efficient in the case of constant returns to scale and variable returns to scale, respectively.

Mohagheghnia et al. (2014) concluded that Iranian banks are more efficient than other Islamic banks and also among domestic banks, private banks have been more efficient than state-owned banks.

Azizi (2015) has evaluated the efficiency of 25 branches of Keshavarzi Bank of Mazandaran province using data envelopment analysis model and determining an integrated index. This has been done using three approaches: resource capture, application allocation and profitability. In the first stage, after determining the relative efficiency of each branch from the mentioned approaches, inefficient branches and the model unit of each inefficient branch are introduced under the studied approach. Then, in the second stage, based on the combination of the efficiencies obtained from the three mentioned approaches, a numerical index for each branch is obtained for the overall ranking. Based on the results, Sari branch is ranked first and Chalous branch is ranked last in terms of efficiency.

#### **3-2- Studies abroad**

Camau (2011) studied the productivity and intermediation efficiency of the banking system in Kenya. To evaluate the efficiency of intermediation, he used non-parametric method of data envelopment analysis to evaluate the productivity of Malmquist productivity index. The above models were estimated using data from 40 banks for a period of thirty years (1997-2009). According to the findings, these banks were not fully efficient during the study period; but they performed well.

Karimzadeh (2012) examined the performance of Indian commercial banks using data from the period 2000-2010. He selected the data envelopment analysis method by selecting 8 commercial banks as an example. According to the findings, considering the variable return to the scale of average economic, technical and allocation efficiencies equal to 0.991, 0.995 and 0.991, respectively, and considering the fixed return to the scale of average economic efficiencies, technical and allocative were equal to 0.936, 0.969 and 0.958, respectively. State-owned banks have also been more efficient than private banks.

Zha et al. (2013) evaluated the efficiency of Nepal commercial banks with two approaches of intermediation and profit. This was done using the data-driven data envelopment analysis method for the period 2005-2009. According to the results, the efficiency estimated by the bank intermediation method is higher than the efficiency estimated by the bank profitability method. Also, a bank that is more efficient according to the intermediation approach does not necessarily have a higher profitability.

Dadashi et al. (2013) studied the types of efficiencies for 11 Iranian banks using data envelopment analysis method and using input-oriented method under the assumptions of constant return and variable return to scale. According to the findings, it is known as the most efficient bank, assuming a constant return to the scale of Sanat Madan Bank. Also under the assumption of variable returns to the scale of modern economy banks, Parsian, Pasargad, Sina, Saderat, Mellat, Melli, Post Bank and Sanat and Madan have been efficient.

Repkova (2014) used the data envelopment analysis method to evaluate the efficiency of the Czech banking system and the combined data for the period 2003-2012. He used an input-driven approach. Considering the fixed return to the average efficiency scale, 70-78% and considering the variable return to the average efficiency scale, 84-89% was estimated. According to the findings, large banks are less efficient than other banks.

Sufian et al. (2016) measured the efficiency of the Malaysian banking sector with a two-step approach. The results show that the efficiency of the Malaysian banking sector has increased.

#### 4- Method of data analysis and research tools

Performance studies and measurement can be done using non-parametric or parametric approach. In the nonparametric approach, calculations are performed using the calculation of relevant indicators. While in the parametric approach, calculations are performed by estimating the production function or boundary cost. In this research, to evaluate the efficiency of private and public banks and compare their efficiency with each other, two parametric methods (function estimation) and non-parametric methods (mathematical programming methods) are used. Because in this case, the advantages of both parametric methods (including the possibility of performing statistical tests) and non-parametric methods (including not imposing a specific functional form on the production structure) can be used. To estimate the desired models of software DEAP and FRONTIER are used.

##### 4-1- Data envelopment analysis method

Charans, Cooper, and Rhodes (1978) were the first to develop a data envelopment analysis method. The model presented by them is an input-oriented method that is formed by assuming a constant return to scale. Banker, Charnes, and Cooper (1984) later proposed a model in which the assumption of variable returns over scale is assumed. Given that the model presented by Charnes, Cooper and Rhodes (1978) is the first model presented in this field, so first this model is described.

##### 4-2- Boundary function method

Batis and Coelly (1992) proposed a possible boundary generation function for panel data in which firm effects are considered as randomly distributed random variables that can change systematically over time. The boundary production function model can be expressed as equation (7):

$$Y_{it} = x_{it}\beta + (V_{it} - U_{it}) \quad , i=1, \dots, N, t=1, \dots, T,$$

Where  $Y_{it}$  is the product of the  $i$ -th firm at time  $t$ ,  $x_{it}$  is the vector  $k \times 1$  of the inputs used by the  $i$ -th firm at time  $t$ , and  $\beta$  is the vector of the model parameters.  $V_{it}$  are random variables that are distributed as iid,  $N(0, \sigma^2)$ , and independent of  $U_{it}$   $\{U_{it} = (U_i \exp(-\eta(t-T)))\}$ .  $U_i$  are also non-negative random variables that indicate inefficiencies in the production function and are usually distributed as iid and have a normal cut-off distribution  $\{N(\eta, 2U^2)\}$ .  $\eta$  is also a parameter that must be estimated. If  $\eta$  is considered zero, a model is obtained that the efficiency of the firm will be constant over time. In this case, the efficiency of the  $i$ -th firm at time  $t$  will be equal to  $TE_i = \exp(U_{it})$  (Coelly, 1996).

In the cross-border production function model, in the value-added approach of deposits, the dependent variable and the number of branches, number of employees, facilities will be the independent variable, and in the reverse income approach, the facility variable will be a function of explanatory variables of deposits, number of branches and number of employees.

#### 5- Analysis of results

In this section, the results of input-driven and output-driven data envelopment analysis methods are explained as follows.

##### 5-2- boundary production function method

In this section, the results of estimating the boundary production function are presented. Similar to the data envelopment analysis method, in the cross-border production function method, the findings are presented in two parts: value added approach and revenue approach.

##### 5-2-1- Value added approach

The results of estimating the boundary production function in the value added approach (types of deposits are a function of types of facilities, number of employees and number of branches) are given in Table (1). The table below shows that the above function is at an acceptable level in terms of significance and can provide a suitable foot for performing performance relations. So that all parameters except the width parameter from the origin are statistically significant.

**Table 1. Results of estimating the boundary production function (value added approach)**

t	coefficient	parameter
0/84	820/9	(Width of origin) $\beta_0$
26/2	10/5	(number of branches) $\beta_1$
2/8	0/004	(number of staff) $\beta_2$
2/4	0/007	(facilities) $\beta_3$
1/09	1550/9	$\mu$
-0/21	-0/009	$\eta$

According to the efficiency values reported in Table (2), it can be seen that in the value added approach, the Melli Bank's cross-border production function had the highest efficiency and was 98% efficient. In other words, this bank has been closer to the production limit than other banks. Private banks with 72% efficiency were more efficient and closer to the production limit than state-owned banks with 64% efficiency. Also, Sanat and Madan bank had the lowest efficiency and the longest distance from the production border.

**Table 2. Estimated efficiency of cross-production function method (value added approach)**

State and private average	Average	2016	2015	2014	2013	2012	Bank	
0/65	0/98	0/98	0/98	0/98	0/98	0/98	Melli	State banks
	0/53	0/52	0/53	0/53	0/54	0/54	Tose saderat	
	0/42	0/41	0/42	0/43	0/43	0/44	Sanat va madan	
		0/64	0/65	0/65	0/65	0/65	average	
0/72	0/53	0/53	0/53	0/54	0/54	0/54	Egtesad Novin	Private banks
	0/55	0/55	0/55	0/56	0/56	0/57	Pasarghad	
	0/49	0/49	0/49	0/50	0/50	0/51	Sarmayeh	
	0/88	0/88	0/88	0/88	0/88	0/88	Saderat	
	0/97	0/97	0/97	0/97	0/97	0/97	Mellat	
	0/83	0/83	0/83	0/83	0/83	0/83	Tejarat	
	0/81	0/81	0/81	0/81	0/81	0/81	Refah	
			0/72	0/72	0/73	0/73	0/73	

### 5-2-2- Income approach

The results of estimating the boundary production function with the revenue approach are given in Table (3), in which facilities are included as dependent variables and types of deposits, number of employees and number of branches as independent variables.

**Table 3. Results of estimating the boundary production function (revenue approach)**

t	coefficient	parameter
58948/6	60164/2	(width of origin) $\beta_0$
5/3	24/04	(number of branches) $\beta_1$
-4/4	-208/63	(number of staff) $\beta_2$
5/3	0/34	(deposits) $\beta_3$
0/10	0/24	$\mu$
1/09	0/90	$\eta$

The efficiency of the studied banks has also been calculated using the cross-border production function in the revenue approach and the results of efficiency have been reported in Table (12). According to the above table, it can be seen that private banks have been more efficient than state-owned Islamic banks, which is consistent with the results obtained from the cross-boundary production function of the value-added approach. In other words, private banks have been more successful in granting facilities by using certain amounts of deposits, number of employees and number of branches. Comparison with

Islamic State Banks According to Table (4), Saderat and Mellat Banks had the highest efficiency and Sarmayeh Banks had the lowest efficiency.

Thus, it can be seen that in the cross-border production function method, both the value-added approach and the revenue approach indicate the efficiency of private banks compared to state-owned banks.

**Table 4. Estimated efficiency of cross-production function method (revenue approach)**

State and private average	Average	2016	2015	2014	2013	2012	bank	
0/90	0/96	0/99	0/99	0/98	0/96	0/91	Melli	State banks
	0/86	0/98	0/97	0/93	0/83	0/59	Tose saderat	
	0/88	0/99	0/97	0/94	0/86	0/66	Sanat and madan	
		0/99	0/98	0/95	0/88	0/72	Average	
0/92	0/92	0/99	0/98	0/96	0/91	0/78	Egtesad novin	Private banks
	0/92	0/99	0/98	0/96	0/91	0/78	Pasarghad	
	0/84	0/98	0/96	0/92	0/81	0/54	Sarmaye	
	0/97	0/99	0/99	0/99	0/97	0/94	Saderat	
	0/97	0/99	0/99	0/99	0/97	0/94	Mellat	
	0/95	0/99	0/99	0/97	0/95	0/87	Tejarat	
	0/89	0/99	0/97	0/94	0/87	0/68	Refah	
	0/99	0/98	0/96	0/91	0/79	Average		

### Conclusions and suggestions

A look at the situation of banks shows that they are looking to increase efficiency to increase their competitiveness. For this purpose, a comprehensive study of the performance status of these units should be done first, and through this, appropriate policies should be made to improve their performance status. Based on this, the purpose of this study is to investigate the efficiency of Iranian banks in two groups (Melli, Tose Saderat and Sanat and madan) and private (Egtesad novin, Pasargad, Sarmaye, Saderat, Mellat, Tejarat and Refah).

In the present study, first, how to calculate the performance using the non-parametric approach of data envelopment analysis was considered. Then the parametric approach of the boundary production function was used. The above approaches have also been applied with value added and revenue approach. Findings from data envelopment analysis method with value added approach indicate that private banks are more efficient compared to state-owned banks, while findings from data envelopment analysis method with revenue approach show the efficiency of state-owned banks is comparable to that of private banks. References to relevant studies show that most of these studies have based their value-added approach on their analyses. Therefore, in this study, the value-added approach is based and it can be said that according to the data envelopment analysis method, private banks have been more efficient than state-owned banks. The results of the cross-production function method for both the value-added approach and the revenue approach show that private banks are more efficient than state-owned banks. Thus, according to all the results obtained and their comparison, it can be said that private banks have been more efficient compared to state-owned banks during the period. Based on this, it can be said that the main hypothesis of the present study that private banks are more efficient than state-owned banks is confirmed. Also, regardless of the revenue approach of data envelopment analysis method, it can be said that the second hypothesis of the research that the results of parametric and nonparametric approaches are the same is confirmed. It was observed that the results of comparing the efficiency of banks with the revenue approach indicate that the economic efficiency of state-owned banks is higher than private banks, while with the value-added approach, we achieve the opposite result, so the approach with the current system conditions. The banking of Iran's economy should be more proportionate and consistent, and which result is more acceptable. In the Iranian economy, due to low or negative real deposit rates (taking inflation into account), banks have a strong tendency to attract deposits and collect funds. Encourages deposits. On the other hand, due to high inflation in the economy, deposits in banks cannot be considered a profitable investment compared to other types of

investments due to bank interest rates and inflation rates. Banks make deposits collected from people. They do not necessarily invest in more profitable activities. Therefore, in the current situation of our economic banking system, the deposit is certainly an output, and the intermediary attitude with the value-added approach, which considers the deposit as an output, is more in line with the Islamic banking system. We accept that private banks were more efficient than state-owned banks during the review period. According to the results of research and communication of general policies of Article 44 of the Constitution, the privatization of financial markets should be considered and the process of privatization of other state-owned banks should be accelerated wisely. Also, due to the advantage of private banks over government in terms of technical efficiency in both revenue and value-added approaches, state-owned banks using the experience of private banks, including the proper use of new management methods, customer orientation, technology updates Information and technologies related to the banking industry, diversification of banking services and improving the efficiency of personnel with continuous training to bring themselves closer to the limit of technical efficiency.

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