

A Comparative Profitability Efficiency Study of Private and Government Banking System in Iran Applying Data Envelopment Analysis (DEA)

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ABSTRACT

This study evaluated efficiency of private and public banking system by data envelopment analysis with the assumption of a constant return to scale (CRS) and variable return to scale (VRS). The statistical study included all government banks and all private banks. The profitability ratio (earning per share, return on equity and return on investment) approach is used in efficiency analysis. The current number of common stock shares, the book value of equity and total assets as input variables and the profit after tax as output variables were chosen based on this approach. The results of hypothesis testing showed that the condition of the inputs and outputs of government banking system was not optimized with compared private banking system and their effectiveness could be increased by the correction of the factors combination. Also the condition of the inputs and outputs of commercial banks was not optimized with compared the specialized banks and their effectiveness could be increased by the correction of the factors combination. Also results showed the efficiency by applying the BCC model was more meaningful and consistent than CCR model and the optimization model of output centered was much more consistent to the aim of the banks, so BCC output centered model was used to express the efficiency score in digits; thus, the average profitability efficiency calculated for the government banking system was 58.88% and for the private banking system was 94.89% and thus the weighted average of profitability efficiency for whole banking system would be 73.28%.

KEYWORDS: Decision Making Units, constant returns to scale, variable returns to scale, the optimization models of output- oriented and input- oriented, profitability efficiency.

Classification JEL: G21, G24

1. INTRODUCTION

A Study of how to gain the maximum result from the limited resources in the nature of economics and the optimal allocation of these limited resources is the aim of this science. Efficiency in the simplest term is to maximize the result, to the scale of macro and micro economics. Thus, study about efficiency, especially at the firm-level, is one of the most important economics research studies. Banking is one of the most important sections of each economic. Because the banks, as the intermediaries of monetary funds are considered one of the fundamental parts of financial markets along with the stock exchange market and insurance industry. Banking has greater importance in the economics of Iran. Because of the inefficiency of capital market in practice, these banks are the ones that carry the burden of providing the long term financial capital. Also at the process of the financial markets releasing in order to join the global market, efficiency is a fundamental condition. For this reason evaluation of the efficiency of banks in the economics of Iran, subjected at this study.

At the present condition due to variability and extension of banks throughout the country, foundation of new financial and crediting institution, establishing of new private banks and entering of the foreign banks through free zones of trading and finally by privatization of banks in Iran has been created a suitable and modern condition in the country which must be done fundamentally, evaluating and reengineering the banking system.

For this purpose, it is necessary that each bank has been informed of its effectiveness and evaluated their efficiency or inefficiency and improved by appropriate evaluations to address inefficient units. Obviously achieving these goals with being performed better than inefficient banks, while reducing the cost of services provided and preventing waste of scarce resources, it can be expected that national interests to be provided and it may be minimized the overall level of inefficiency losses of a bank to the extent and may be performed better on the whole banking system at the country. Two major aim of this study are Estimation and comparison of the efficiency of commercial and specialized banking system in government banking section and also Estimation and comparison of the efficiency of governmental and private banking system.

The next section of this article is to take a look at the related literature Review. Section 3 describes research methodology and variable construction. In this section after defining Data Envelopment Analysis, various return

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to scales models along with the optimization models, different approaches in applying the inputs and the outputs, Sample data and research Hypotheses will be mentioned briefly and then input and output variables will be selected based on the approach used in this article. Section 4 presents results and findings demonstration .In this section the annual efficiency of Iranian banks, and then the five-year average of their efficiency from 2006 till 2010 will be calculated by Frontier Demo4 software and hypotheses will be tested and finally this demonstration is supplemented in section 5 with conclusion and some proposals.

2. REVIEW OF THE LITERATURE

Primary studies to evaluate the efficiency and performance of units were done by Koopmans and Debreu in 1951. Koopmans defined the technical efficiency and then explained it and Weber presents an index to measure the technical efficiency.

But the fundamental and practical work to recognize the efficiency was done by Farrell 1957. For the first time, he considered the evaluation of efficiency with parametric method and instead of guessing the production function, viewed the amount of inputs and outputs and considered a frontier for units that is the frontier production function which is considered as an index to measure the efficiency and in fact, it was exhibiting the performance of the best institute in the industry where the other institutes' performance are compared with them. For the first time, he divided the total efficiency (economics) of production into two subdivision of technical efficiency and allocation (price) efficiency where the technical efficiency indicates the ability of the institute at maximizing production due to the determined production factors, and the allocation efficiency shows the ability of the institute to use the optimum composition of the production factors due to their prices. Then, he represented a method to measure each one and assumed some assumptions; including single production of a product and stabilizing the return to the scale. And finally, by applying the linear programming method, he analyzed the efficiency.

From that time, most of the efficiency measurement methods are done based on the Farrell's method. Primary evaluation of single input and output was extended to multiple inputs and outputs for the purpose of completing the Farrell's method by Charnes, Cooper and Rhodes (1978). This method, by considering the first letters of their names, nominated as CCR. It was the base of the doctoral thesis of Edward Rhodes that along with their guides, Cooper and Charnes method was applied for educational improvement of American students. After that, CCR method is accomplished and BCC method is introduced by Banker, Charnes and Cooper (1984). This model is used to measure and appoint efficiency of units and also correction of inputs and outputs to upraise the amount of efficiency with regard to variable return to scale.

The foregoing researches have been the references of many efficiency analysis studies, and by improving of this field of operations research science, Data Envelope Analysis was applied. Of course, after Farrell, due to limiting assumption he considered in the production function, the econometrics method was used for evaluating the efficiency, which is known as statistical frontier analysis. In the following study some concepts are demonstrated as follows:

A Stochastic Cost Frontier Analysis is used to evaluate the efficiency of the Indian Banking System using panel data on public and private sector banks. Some of result indicate the presence of cost inefficiency in the Indian banking system and also indicate private banks are generally more cost-efficient than public banks, (Subal C. Kumbhakar and Subrata Sarkar,2004).

A comparative performance analysis was done between state-owned and privately-owned commercial banks of Turkey. The results suggest that state-owned banks are as efficient as private banks, and even more efficient at some aspects. Thus, it raises the question of "whether to privatize banks or not?" (Seyfettin Unal et al, 2007).

In other study the performance of the Indian banking sector was analyzed, and finding the determinants of productive efficiency through TOBIT model. Inputs The study shows that SBI and its group have the highest efficiency, followed by private banks, and the other nationalized banks. (Omprakash K. Gupta et al, 2008). Some researcher studied whether bank efficiency is related to bank ownership in Russia .they find that foreign banks are more efficient than domestic private banks and – surprisingly – that domestic private banks are not more efficient than domestic public banks. (Alexei Karas et al, 2008).

The efficiency of the industrial banking in Iran was evaluated. In this research, the facts and figure of 10 government banks were used ; including six commercial banks and four proficiency banks. The results gained based on the model 1 efficiency estimation – show that the industrial banking efficiency in Iran is 76/87 percent. By estimating the factor effecting the performance, efficiency of banks have the direct relation to becoming the specialized number of branches and the time , and diverse relation to the size (total assets) of the bank(Hosseini and Soury ,2008)

The efficiency of Tejarat bank in whole country was evaluated with the help of two models of CCR and BCC and then ranked the efficient units. They achieved the result that calculating the efficiency with the help of BCC is more meaningful and compatible than CCR as well as by applying the two inputs is more meaningful than one input and likewise calculating the efficiency with status of variable returns to scale have been recognized to be more suitable(Dadgar and Niknemat , 2008) . The efficiency and profitability of Japanese banks was analyzed. The results show that the performance of Japanese banks has steadily improved, but there are significant differences within the banking sector, with regional banks being less cost and revenue efficient relative to both City and Trust banks. While Japanese bank profitability is low compared to that in other

advanced countries, there is considerable potential for efficiency gains, particularly through increased cost-sharing arrangements among regional banks, consolidation of regional banks with major or other regional banks, and the creation of bank consortia to pool resources for asset and risk management(Elena Loukoianova , 2008).

The other researcher in India applied three approaches for measuring and defining outputs and inputs in the banking industry. they are intermediation approach which considers banks as financial intermediaries, user cost approach, and the value added approach and measure the efficiency through four indicators they are productivity, profitability, financial management and asset quality . The results of this study show that public sector banks are having high efficiency in terms of productivity, profitability, financial management and asset quality, whereas the private banks are having a very high inefficiency levels during the sample period in the different indicators but foreign banks are seems to more efficient than the private banks(Vijay Kumar et al , 2009).

Economical efficiency of two groups of Iranian banks governmental and private with assumption of variable returns on scale has been investigated and compared after establishing the first private bank. The both of income approach and value-added approach of the intermediary attitude are applied and the evaluation by the first approach reveal that economical efficiency of the government banks are more than privates which the reason of this result being low amount of allocated efficiency of the private banks for newly established private banks, and also the difference between the management perspective in applying of the production resources. In second approach, it is perceived that the economical efficiency of the private banks is more than government banks and the main reason is higher technical efficiency of them. As the reasons are referred in the text of study, the scholar explained that, as the second approach is much more synchronize with the Iran's banking system ,so at the end concludes that the economical efficiency of the private banks are higher than the government banks(Hossein zadeh et al ,2009) .

The amount of technical efficiency has been studied by the returns on scale of government and Iranian private banks . the results show 3 private banks (Eghtesad Novin , Kar Afarin and Saman) are in phase increasing return on scale and the Parsian bank is in constant return on scale and the governmental banks are in the phase of decreasing returns on scale . (Shabestary, 2009).

Most previous research on efficiency in banking takes a regulatory perspective. In contrast, some researchers investigate the empirical relation between efficiency and profitability in five large economies of the European Union during the period 1998-2005. The results of the conducted static and dynamic regression analyses show that profitable banks operate with higher technical efficiency than their competitors (Karl Werner and Jürgen, 2009).

private sector commercial banks in Turkey was examined. The results indicate that foreign banks have displayed greater efficiency compared to domestic banks when financial efficiency is considered alone; domestic and foreign banks have the same efficiency level when the data for general managers are considered; and the annual relative efficiency figures for the sector demonstrate vast amounts of fluctuation during periods of economic crisis, again with or without the data for general managers (Evren Ayranci , 2010).

a comparison between public, private and foreign banks efficiencies was investigated and finding that whether high profitability of the banking sector shows their high efficiency or not. The results show that the overall efficiency of the banking sector in the initial year is matched with the world banking efficiency, but in later years an unsystematic sequence is observed. Initially, foreign and private sector banks are well ahead of public sector in term of technical efficiency, but in the later part of the analysis public sector banks are the real difference. An aggressive privatization policy leads the inefficiency of private sector in comparative terms (Rehman and Raoof, 2010).

One article has endeavored to explore the relationship between Efficiency and profitability in the Indian public sector banking industry based on cross-sectional data for 27 banks. An analysis of efficiency–profitability matrix based on the efficiency scores and Return on Assets (ROA) reveals Both Andhra Bank and Corporation Bank appear as an ideal benchmark for the laggards on the efficiency and profitability dimensions of performance evaluation (Sunil Kumar, 2012).

3. Research methodology and variable construction

The purposes of the research methodology include collecting and processing the data correctly and ultimately to achieve reliable results. This section of the article focuses on expression of the DEA along with various models and approaches available and then purposes, data sample, and explaining the basic variables.

3.1. Data Envelopment Analysis:

The method of research is the comparative method using the multivariable techniques of decision making; data envelope analysis, to analyze the data (calculates and compares the relative efficiency of the banking system). Data envelope analysis is a technique to calculate the relative efficiency of a set of decision making units compared with each other with the help of one mathematical model. Efficiency implies that how much an organization uses its inputs in optimum way to producing the outputs and, in other words, “the right doing of things “meaning that with minimum inputs getting the maximum outputs.

Before any action, all input and output variables along with decision making units, must be defined and be clarified. Input variable is the one which if increases, the other factors being constant, the efficiency of unit would decrease and if decreases, the efficiency would increase and output variable is the one which if increases , the other things being equal, the efficiency would increase and vise versa . Decision making units are the ones

which receive series of inputs and after processing they will give out outputs. In data envelopment analysis technique are assumed that to evaluate the efficiency, there is n similar organizational units the decision maker wants to evaluate them.

The similar organizational units have m inputs and s outputs that the inputs of the j th DMUs denoted by X_{ij} and their outputs denoted by Y_{rj} .

It should be constructed linear programming in order to use these techniques for the purpose of evaluating the effectiveness of each decision making units. Based on these models, the relative performance of each decision making units can be compared with the other units. So, to the number of decision making units may construct LP model to solve and determine the relative efficiency (E) of decision making units. It will make n model LP. The logic of modeling is relying upon the principle in which the first decision making unit is defined as the following pattern. This reference unit of decision making will result in the optimal composition of inputs and outputs by n decision making unit that will be on the efficient frontier. This unit is the Hypothetical Composite DMU that accredits the measuring relative efficiency of real DMUs.

If the sum of weighted outputs of a decision making unit proportional to the sum of weighted inputs is equal to 1, it can be said that this unit lies on the efficient frontier and hence this unit will be efficient. But this proportion is less than 1, it can be said that this unit lies on the underneath of the efficient frontier and hence definitely it will be deficient. Mathematical Expression of the above concepts will be in the form of following model:

$$\text{Max } E_j = \frac{\sum_{r=1}^s W_r Y_{rj}}{\sum_{i=1}^m V_i X_{ij}} \quad j = 1, 2, \dots, 151 \quad (1)$$

$$\frac{\sum_{r=1}^s W_r Y_{rj}}{\sum_{i=1}^m V_i X_{ij}} \leq 1 \quad j = 1, 2, \dots, 15 \quad (2)$$

$$W_r \geq 0 \quad r = 1, 2, \dots, 15 \quad (3)$$

$$V_i \geq 0 \quad i = 1, 2, \dots, 15 \quad (4)$$

The objective function of above model represents the weighted sum of outputs per j th unit of decision making divided to the weighted sum of inputs. The main limitations of this model shows that the weighted sum of outputs per j th unit of decision making to the weighted sum of inputs j must not be more than one. The number of these restrictions is till n .

Other limitations implies the non-negative weights of r th output, W_r , and of i th input, V_i . The Number of decision variables of model would be $m \times s$. After solving the above model per W_r and V_i the relative efficiency of each decision making unit to the reference unit is specified. The E value is closer to 1, the j th DMU will be the more efficient. In other words, the efficient frontier for decision making unit is:

$$E_j = \frac{\sum_{r=1}^s W_r Y_{rj}}{\sum_{i=1}^m V_i X_{ij}} = 1 \quad j = 1, 2, \dots, 15 \quad (5)$$

If E is equal to one per j th decision unit it, can be said that the unit is located on the border and its performance is much the same as the reference.

3.2. The return to scale models

The possibility production space of all combinations of inputs and outputs is denoted by T, which the outputs can be generated by the inputs. If the inputs are multiplied by the coefficient in the model, outputs may also change the same coefficient which is known as constant return to scale (CRS). If this coefficient is smaller than one, the inputs and outputs will be contracted. If this coefficient is larger than one, the inputs and outputs will be expanded.

If the principle of constant returns to scale should not be established in a certain study, it must apply the other models that have developed the concept of the return to scale that the inputs and outputs do not increase or decrease with an equal ratio. These models allow reducing an input with a ratio and another input with other ratio and also the rate of increasing in the outputs will be different from one output to another output., but sometimes it may be studied to increasing or decreasing of the inputs and outputs simultaneously with the same ratio to be attributed to a balance of inputs and outputs to each other. So depending on cases the type of measuring a unit until the efficiency frontier, the direction of the model, can be determined. It is important to review the application requirements of the problem. The discussions can be found by changing the direction of the model on one hand and returns to scale on the other hand, can obtain various models per case study.

Returns to scale is concerned the rate of change in output to the rate of changes in the input. If a doubling of production technology inputs result in a doubling of the outputs, it will be constant returns to scale. In more accurate term if α times of inputs lead to the equal α times of outputs in one production technology, then we can say it is constant return on scale. If α times of inputs lead to the β times of outputs in one production technology qua $\alpha \leq \beta$, then we can say it is an increase return on scale (IRS). If α times of inputs lead to the β times of outputs in one production technology qua $\alpha \geq \beta$, then we can say it is a decrease return on scale (DRS).

3.3. The optimization models

In the DEA models, a theory is movement direction towards the efficient frontier which the two important models are input centered and output centered. According to the optimization model of input centered, the level of the outputs remains constant and the level of inputs will be decreased to reach the efficiency frontier.

According to the optimization model of output centered, the level of the inputs remains constant and the level of outputs will increase to reach the efficiency frontier.

3.4. Different approaches in applying the inputs and the outputs:

There are different approaches concerning measurement of the inputs and outputs in the literature and few studies of banking:

3.4.1. Production approach

In general, in this approach the banks are considered as service institutes provide different kinds of deposits and facilities by implementing their capital and labor force. In this method physical variable such as manpower, capital, raw material, space and informational systems are considered as inputs and provided services to customers such as providing the facilities and keeping diversified funds of deposits and implementing them in different investment are considered as bank outputs. This attitude was dominant until the 1980s in the banking literature.

3.4.2. Intermediate approach

In this method the banks are considered as funds collector. On the basis of these methods the banks invest the deposits collected from people in different projects by implementing their capital and human resource. Indeed the banks are considered as the financial service intermediaries institutes. In general intermediary approach includes three approaches which are as follows:

a) Theory of income: Theory of income is an abbreviated form of banking activities that focuses exclusively on the banks' rules. Inputs include deposits and other inventory (bank debts) and real sources (human resources, physical capital resources). Outputs include assets acquired such as loans and investments. In this theory customer deposits are also considered as an input. So in the intermediary approach, inputs are deposits (as the funds can be spent in the form of loans), of manpower, capital and outputs include different types of loans (total outstanding loans and partnership loans).

b) Theory of consumer cost: This theory, according to the proportion of each net financial production to bank's income, determines that each financial production is an input or an output. If financial return of one asset is more than the opportunity cost of that funds or its substitute and if financial cost of bank deposits (debts) is less than the opportunity cost, it is counted as outputs, otherwise it is counted as inputs.

c) Theory of value added: This theory is considered deposits as an output, because they form major contribution of the value added. Indeed the purpose of collecting the funds of investors causes competition among the banks for attracting the more customers. This theory is represented by Berger and Humphary (1997); and they gave attention to the funds which can be both output and input.

3.4.3. Operational approach (theory based on income)

The idea in this approach is the banks like business units for the purpose of financial revenue burden the total cost to manage their business. Based on this, total revenue (interest or non-interest) are considered bank's output and total expenditure (interest and operational expenditure) are considered bank's input.

3.4.4. Profitability approach

According to the profit approach, total performance of the company and also the management is evaluated by implementing some financial ratios.

3.4.5. Modern approach

This approach tries to complete some risk scales like intermediary expenditure (agency and broker costs) and quality of banking services. In this theory the financial tables of banks, supporting variables of capital, quality of assets, management competence, income capability, the liquidity risk, and the sensitivity of market risk are implemented in executive analysis. In all researches related to the evaluating the efficiency at the level of the bank's units by Data Envelope Analysis, some factors are very important at choosing the inputs and outputs variables. In this study some of these factors are as follow:

The first factor is bank's main aims for gaining the profit which lead to opting the special variables. To achieve such goals, in this study approach of profitability is emphasized to determine indicators for inputs and outputs.

The Second factor is the statistical limitations, the sample size and the statistical universe and mentioning the constraints in analysis of the model. One of these constraints in this study is that the total numbers of inputs and outputs must not exceed one third of the DMUs in Data Envelope Analysis (Bowlin, 1998).

3.5. Sample data

Statistical population of this study is the banking system of Iran, as decision-making units which were selected for the study. The sample size of government banking system nearly is equal to the statistical population, including the nine government banks (commercial and proficiency). Statistical sample of private banking system was selected based on elimination method. Therefore, the banks were selected which have started their activity during the study since 2006 to 2010, and also have been the private banks in these five years. So the banks either have started recently or have become private recently, were excluded from the survey population. Hence, Statistical sample of private banking system are six private banks as Decision Making Units(DMUs). Decision making units are the ones receive some inputs and produce the outputs after processing the inputs that in this study included 15 banks are shown in the table 1. As follows:

Table1. The DMUs under study

The name of banks	No. of DMU	Bank segment
Melli bank	DMU ₁	government and commercial
Sepah bank	DMU ₂	government and commercial
Refah K.bank	DMU ₃	government and commercial
Saderat bank	DMU ₄	government and commercial
Mellat bank	DMU ₅	government and commercial
Tejarat bank	DMU ₆	government and commercial
Industry and mine	DMU ₇	government and proficiency
Maskan bank	DMU ₈	government and proficiency
Export Development	DMU ₉	government and proficiency
Pasargad bank	DMU ₁₀	private
Parsian bank	DMU ₁₁	private
Sina bank	DMU ₁₂	private
Karafarin bank	DMU ₁₃	private
Eghtesad Novin bank	DMU ₁₄	private
Saman bank	DMU ₁₅	private

The time scope of this research is from 2006 to 2010 and collected the data from the financial statements at the end of the financial period. The required data has been collected from different secondary sources. Since this study is descriptive and library research, it would be analyzed the historical records and also historical documents like financial statements. The subjects related to the theoretical concepts and literature review have been collected through the library method published resources like internal and external sources and referring to the library books, papers published in magazines and journals as well as electronic papers, statistical and financial reports of banking system as well as central bank . Since this research is ex post facto research, it would use historical data of basically financial statements such as balance sheets, income statement and cash flow statements and also financial reports if necessary, which are available in all banks websites and also research & development & Islamic Studies of Tehran Stock Exchange website (<http://rdis.ir>).

3.6. Research Hypotheses

Research question can be stated as follows:

1. Is the profitability efficiency of the commercial banking system less than the profitability efficiency of specialized banking system?
2. Is the profitability efficiency of the government banking system less than the profitability efficiency of the private banking system?

On the basis of these questions working hypothesis of research can be stated as follows:

1. The condition of inputs and outputs of the government banking system is not optimal in comparison with the private banking system and hence their efficiency can be increased by correction of the combination of factors.
2. The condition of inputs and outputs of the commercial banking system is not optimal in comparison with the specialized banking system and hence their efficiency can be increased by correction of the combination of factors.

3.7. Input and output variables based on profitability approach

In this research by applying the profitability ratio approach and by considering the above objectives and the available research records which were mentioned in the earlier sections, the inputs and outputs variables of Data Envelope Analysis (DEA) will be clarified. According to the profitability ratio approach, some financial ratios are applied in order to measure the overall performance and management of the companies and thus with the help of profitability ratios, can be studied the performance efficiency of banks and also their management performance.

The Bank's profitability ratios in respect of earning per share (EPS), based on the return on assets (ROA) and based on the return on equity (ROE) will be examined.

On the basis of this approach, inputs will be as follows:

1. The number of ordinary shares in the hands of shareholders
2. The book value of equity
3. Total assets

And the output will be the profit after tax (PAT) by this approach.

Considering the mentioned contents in theoretical literature , the number of the input and outputs variables must not be exceeded than one third number of DMUs in Data Envelopment analysis (Bowlin,1998) and as calculating the efficiency by applying the two inputs have more meaningful than one inputs (Dadgar and NikNemat, 2008) .therefore the number of ordinary shares in the hands of shareholders, Equity and Total Assets are selected as two input variables and the profit after tax(PAT) is selected as outputs.

4. RESULTS AND ANALYSIS

After identifying the applied approach and variables, the research's variables were entered in the excel program and were calculated the variables required using excel capability and finally the summation of results are shown in table 1.

Table 2. The values of the inputs and outputs of decision making units on the basis of profitability ratio approach (the figures are in billion riyals)

Bank's name	Total assets	equity	Equity number	PAT
Melli bank	2474149693	212937982	112000	13641705
Maskan bank	817266422	49934516	31677	9569679
Sepah bank	1041331785	68250778	39107	925409
Refah bank	297905062	6929267	4475	1824780
Saderat bank	1030462694	111078015	84015	11507860
Mellat bank	1885602842	85864628	65500	9730225
bank of industry and min	248834875	95614218	72839	3390604
Tejarat bank	1470130617	88095956	52186	11089909
Export development bank	156176965	68998093	55392	3508459
Pasargad bank	301292308	37757253	26950	8306388
Parsian bank	766536405	51930305	31000	14262620
Sina bank	122263238	8203768	5570	1807172
Karafarin bank	129571854	11726980	6450	4456858
EN bank	343440968	19505796	10500	6134434
Saman bank	167022298	8964056	5250	2232631

Source: financial statements of total banking system based on excel computing from 2006 to 2010.

4.1. Description of models:

After calculating the inputs and outputs variables based on this approach, the all selected banks separate to government banks (commercial, specialized) and private banks and then the efficiency of banking system will be calculated for each year under study by applying the two software of DEA-Master and Frontier Analyst 4Demo . The models of DEA are used as returns to scales models (BCC, CCR) and optimization models (input centered and output centered). Then the 5-year average of efficiency for each sample banks will be calculated.

Table 3. The CCR model (model number 1 and 2)

Model 1 inputs cetered	Model 2 outputs centered
Min θ $\sum_{n=1}^n \lambda_n x_{1n} + s_1^- = \theta_p x_{1p}$ S t: $\sum_{n=1}^n \lambda_n x_{2n} + s_2^- = \theta_p x_{2p}$ $\sum_{n=1}^n \lambda_n x_{3n} + s_3^- = \theta_p x_{3p}$ $\sum_{n=1}^n \lambda_n y_{1n} - s_1^+ = y_{1p}$ $\lambda_n, s_1^-, s_2^-, s_3^-, s_1^+ \geq 0$ $n = 1, 2, \dots, 15$	Max ϕ $\sum_{n=1}^n \lambda_n x_{1n} + s_1^- = x_{1p}$ S t: $\sum_{n=1}^n \lambda_n x_{2n} + s_2^- = x_{2p}$ $\sum_{n=1}^n \lambda_n x_{3n} + s_3^- = x_{3p}$ $\sum_{n=1}^n \lambda_n y_{1n} - s_1^+ = \phi_p y_{1p}$ $\lambda_n, s_1^-, s_2^-, s_3^-, s_1^+ \geq 0$ $n = 1, 2, \dots, 15$

Based on DEA models with three inputs: x_{1n}, x_{2n}, x_{3n} ; and one output: y_{1n}

x_{1n} : The book value of Equity of DMUs of $n = 1, 2, \dots, 15$

x_{2n} : Total assets of DMUs of $n = 1, 2, \dots, 15$.

x_{3n} : the number of ordinary shares in the hands of shareholders of DMUs of $n = 1, 2, \dots, 15$.

y_{1n} : The profit after tax (PAT) of DMUs of $n = 1, 2, \dots, 15$.

λ_n : The coefficient value of reference for DMUs of $n = 1, 2, \dots, 15$.

(x_p, y_p) : The inputs and outputs variables of DMUs under study of $p = 1, 2, \dots, 15$.

In this model p th DMUs such as (x_p, y_p) are evaluated and they are called units under the study. With each change of p from 1 to n the value of inputs and outputs of DMUs are replaced to these units and then the model is performed for each units in order to evaluate the efficiency of all units. The aim of the first model is to minimize the amount of inputs with the same amount of outputs. In input centered optimization model, inputs under the study of p are constricted as much as possible by the θ_p ratio till the deficient units be drawn on the efficient frontier. In this process the deficient units convert to the efficient one by reducing the inputs. In other words sufficient amount of inputs and outputs of the unit of p would be equal to $(\theta_p x_p, y_p)$. In outputs centered optimization model, outputs under the study of p are expanded as much as possible by the ϕ_p ratio till the deficient units be drawn on the efficient frontier .The aim of this model is to maximise the amount of outputs with the same amount of inputs. In this process deficient units reach to the efficient level by increasing their outputs with no change in thier inputs .Hence the desire level of inputs and outputs of the units under the study of p would be equal to $(x_p, \theta_p y_p)$. The efficiency level of the inputs centered model is equal to θ_p and of the outputs centered is equal to

$$\phi_p = \frac{1}{\theta_p} \tag{6}$$

The CCR model has the constant return on scale. The return to the scale is related to the rate of change in the outputs to the rate of change in the inputs. In more accurate term if α times of inputs lead to the equal α times of outputs in one production technology, then we can say it is constant return on scale. If a few times of inputs do not lead to same proportional decrease or increase of outputs we will say it is variable return on scale. The difference between these models and constant return to the scale is the new limitation of

$$\sum_1^n \lambda_n = 1 \tag{7}$$

This constraint represents a convex combination of existing units and the envelopment models of variable return on scale would be according to the exhibit. As this model was invented first time by Banker, Charnes and Cooper it is known as BCC.

Table 4. BCC models (model 3 & 4)

Model 3 inputs cetered	Model 4 outputs centered
Min θ $\sum_1^n y_n x_{1n} + s_1^- = \theta_p x_{1p}$ S t: $\sum_1^n \lambda_n x_{2n} + s_2^- = \theta_p x_{2p}$ $\sum_1^n \lambda_n x_{3n} + s_3^- = \theta_p x_{3p}$ $\sum_1^n \lambda_n y_{1n} - s_1^+ = y_{1p}$ $\sum_1^n \lambda_n = 1$ $\lambda_n, s_1^-, s_2^-, s_3^-, s_1^+ \geq 0$ $n = 1, 2, \dots, 15$	Max ϕ $\sum_1^n \lambda_n x_{1n} + s_1^- = x_{1p}$ S t: $\sum_1^n \lambda_n x_{2n} + s_2^- = x_{2p}$ $\sum_1^n \lambda_n x_{3n} + s_3^- = x_{3p}$ $\sum_1^n \lambda_n y_{1n} - s_1^+ = \phi_p y_{1p}$ $\sum_1^n \lambda_n = 1$ $\lambda_n, s_1^-, s_2^-, s_3^-, s_1^+ \geq 0$ $n = 1, 2, \dots, 15$

Based on DEA models with three inputs: x_{1n}, x_{2n}, x_{3n} ; and one output: y_{1n} .

4.7. The profitability efficiency average of banking system

After specifying the models of BCC, CCR with the optimization models of input and output centered, input and output variables of DMUs in 2006 to 2010 were entered into software of the Frontier Demo4 and the efficiency score results were placed at the end in Table .5 to 9. After computing the annual efficiency according to tables .5 to 9, the 5-year average of efficiency for banking system is calculated with models of 1, 2, 3 & 4 and is presented in the tables 10, 11 and 12:

Table 5. The efficiency score for banking system in 2006(Percent)

Government banks	Input centered		Output centered	
Commercial	BCC	CCR	BCC	CCR
Melli bank	100	33.1	100	33.1
Sepah bank	10.8	10.1	19.2	10.1
Refah bank	31.7	7.3	9.9	7.3
Saderat bank	34.9	31	63.3	31
Mellat bank	11.3	9.9	26.7	9.9
Tejarat bank	25	19.2	43.7	19.2
Efficiency average	35.62	18.43	43.8	18.43
Government banks	Input centered		Output centered	
Proficiency	BCC	CCR	BCC	CCR
Industry and mine	100	100	100	100
Maskan bank	59.2	49.3	66.9	49.3
Export development	66.6	53.6	57.9	53.6
Efficiency average	75.27	67.63	74.93	67.63
Private banks	Input centered		Output centered	
Private	BCC	CCR	BCC	CCR
Pasargad bank	100	96.4	100	96.4
Parsian bank	100	82.1	100	82.1
Sina bank	100	100	100	100
Karafarin bank	100	100	100	100
ENBANK	85.1	72.3	73.9	72.3
Saman bank	90.77	70.4	70.7	70.4
Efficiency average	95.97	86.87	90.77	86.87

Based on DEA exercise with three inputs: the book value of equity, total assets and the number of common Stocks; and one output: the profit after tax (PAT) in 2006

Table 6. The efficiency score for banking system in 2007(Percent)

Government banks	Input centered		Output centered	
Commercial	BCC	CCR	BCC	CCR
Melli bank	100	29.6	100	29.6
Sepah bank	8.7	4.4	9	4.4
Refah bank	55.9	18.4	20.3	18.4
Saderat bank	26	22.4	44	22.4
Mellat bank	10.9	8.9	25.2	8.9
Tejarat bank	22.6	17.7	41.5	17.7
Efficiency average	37.35	16.9	40	16.9
Government banks	Input centered		Output centered	
Proficiency	BCC	CCR	BCC	CCR
Industry and mine	57.3	53.1	65.7	53.1
Maskan bank	100	76.4	100	76.4
Export development	100	88.5	100	88.5
Efficiency average	85.77	72.67	88.57	72.67
Private banks	Input centered		Output centered	
Private	BCC	CCR	BCC	CCR
Pasargad bank	100	100	100	100
Parsian bank	88.3	63.2	89.4	63.2
Sina bank	100	65.3	100	65.3
Karafarin bank	100	100	100	100
ENBANK	78.1	69	81.3	69
Saman bank	71.4	40.8	45	40.8
Efficiency average	89.63	73.05	85.95	73.05

Based on DEA exercise with three inputs: the book value of equity, total assets and the number of common Stocks; and one output: the profit after tax (PAT) in 2007.

Table 7. The efficiency score for banking system in 2008(Percent)

Government banks	Input centered		Output centered	
Commercial	BCC	CCR	BCC	CCR
Melli bank	28.4	20.4	96.9	20.4
Sepah bank	12.9	1.6	2.4	1.6
Refah bank	100	6.1	100	6.1
Saderat bank	16.9	16.8	29.3	16.8
Mellat bank	36.2	33.5	59.5	33.5
Tejarat bank	56.2	51.1	96	51.1
Efficiency average	41.77	21.58	64.02	21.58
Government banks	Input centered		Output centered	
Proficiency	BCC	CCR	BCC	CCR
Industry and mine	51.2	39.5	40	39.5
Maskan bank	100	90.7	100	90.7
Export development	70.4	48.4	48.7	48.4
Efficiency average	73.87	59.53	62.9	59.53
Private banks	Input centered		Output centered	
Private	BCC	CCR	BCC	CCR
Pasargad bank	100	98.7	100	98.7
Parsian bank	100	87.3	100	87.3
Sina bank	100	43.1	100	43.1
Karafarin bank	100	100	100	100
ENBANK	92.5	88.9	93.1	88.9
Saman bank	100	91.4	100	91.4
Efficiency average	98.75	84.9	98.85	84.9

Based on DEA exercise with three inputs: the book value of equity, total assets and the number of common Stocks; and one output: the profit after tax (PAT) in 2008.

Table 8. The efficiency score for banking system in 2009 (Percent)

Government banks	Input centered		Output centered	
Commercial	BCC	CCR	BCC	CCR
Melli bank	14.9	11.3	45.6	11.3
Sepah bank	18	2.1	3.8	2.1
Refah bank	100	100	100	100
Saderat bank	100	52.2	100	52.2
Mellat bank	49.3	25.3	71.7	25.3
Tejarat bank	53.3	29.9	77.7	29.9
Efficiency average	55.92	36.8	66.47	36.8
Government banks	Input centered		Output centered	
Proficiency	BCC	CCR	BCC	CCR
Industry and mine	54.9	30.2	36.1	30.2
Maskan bank	40.1	34.1	58.8	34.1
Export development	100	100	100	100
Efficiency average	65	54.77	64.97	54.77
Private banks	Input centered		Output centered	
Private	BCC	CCR	BCC	CCR
Pasargad bank	100	71.4	100	71.4
Parsian bank	100	59.6	100	59.6
Sina bank	100	53.5	100	53.5
Karafarin bank	100	100	100	100
ENBANK	86.1	70.1	93.5	70.1
Saman bank	100	41.6	100	41.6
Efficiency average	97.68	66.03	98.92	66.03

Based on DEA exercise with three inputs: the book value of equity, total assets and the number of common Stocks; and one output: the profit after tax (PAT) in 2009.

Table 9. The efficiency score for banking system in 2010(Percent)

Government banks	Input centered		Output centered	
Commercial	BCC	CCR	BCC	CCR
Melli bank	9.9	9.8	43	9.8
Sepah bank	21	1.8	2.7	1.8
Refah bank	100	16.8	100	16.8
Saderat bank	70.9	36.1	97.2	36.1
Mellat bank	71.2	47	96.1	47
Tejarat bank	54	38.3	76.8	38.3
Efficiency average	54.5	24.97	69.3	24.97
Government banks	Input centered		Output centered	
Proficiency	BCC	CCR	BCC	CCR
Industry and mine	43.3	13.4	19.2	13.4
Maskan bank	23.7	15.2	21.9	15.2
Export development	73.4	28.6	32.8	28.6
Efficiency average	46.8	19.07	24.63	19.07
Private banks	Input centered		Output centered	
Private	BCC	CCR	BCC	CCR
Pasargad bank	100	67.6	100	67.6
Parsian bank	100	65.3	100	65.3
Sina bank	100	61.8	100	61.8
Karafarin bank	100	100	100	100
ENBANK	100	85.8	100	85.8
Saman bank	100	68.3	100	68.3
Efficiency average	100	74.8	100	74.8

Based on DEA exercise with three inputs: the book value of equity, total assets and the number of common Stocks; and one output: the profit after tax (PAT) in 2010.

Table 10. The efficiency average based on the model 1&2 (CCR)(Percent)

Banks category	2006	2007	2008	2009	2010	average
Commercial	18.43	16.9	21.58	36.8	24.97	23.74
Proficiency	67.63	72.67	59.53	54.77	19.07	54.73
Government	34.83	35.49	43.23	42.79	23	34.07
Private	86.87	73.05	84.9	66.03	74.8	77.13

Based on the efficiency scores in tables from 5 to 9

Table 11. The efficiency average of banking system based on the model 3 (BCC)(Percent)

Banks category	2006	2007	2008	2009	2010	average
Commercial	35.62	37.35	41.77	55.92	54.5	45.03
Proficiency	75.27	85.77	73.87	65.00	46.8	69.34
Government	48.84	53.49	52.47	58.95	51.93	53.13
Private	95.97	89.63	98.75	97.68	100	96.41

Based on the efficiency scores in tables from 5 to 9

Table 12. The efficiency average of banking system based on the model 4 (BCC)(Percent)

Banks category	2006	2007	2008	2009	2010	average
Commercial	43.8	40	64.02	66.47	69.3	56.72
Proficiency	74.93	88.57	62.9	64.97	24.63	63.2
Government	54.17	56.19	63.64	65.97	54.41	58.88
Private	90.77	85.95	98.85	98.92	100	94.89

Based on the efficiency scores in tables from 5 to 9.

4.8. Testing of hypothesis

4.8.1. The first hypothesis

The result of the table.10 shows with the constant return on the scale assumption the five –year average of efficiency for government banks is 34.07% and for private banks is 77.13 %.

The result of the table.11 indicates assuming the variable returns to scale (the optimization model of input centered) the five –year average of efficiency for public banks is 53.15 % and for private banks is 96.41%.

The result of the table.12 shows that by assuming the variable returns to scale (the optimization model of output centered) the five –year average of efficiency for the government banks is 58.88 % and for private banks is 94.89 %.

So calculating the efficiency based on four models implies that the status of inputs and outputs of government banking system to compare with the private banking system is not optimized and their efficiency can be increased by modification of the factors combination.

4.8.2. The second hypothesis:

The result of the table.10 shows that by the assuming the constant return to the scale, the five–year average of efficiency for proficiency banks is 54.73% and for commercial banks is 23.74%.

The result of the table.11 indicates that by assuming the variable return to the scale (the optimization model of input centered) the five –year average of efficiency for proficiency banks is 69.34% and for commercial banks is 45.03%.

The result of the table.12 shows that by assuming the variable return to the scale (the optimization model of output centered) the five–year average of efficiency for proficiency banks is 63.2 % and for commercial banks is 56.72 %.

So calculation of the efficiency based on these four models reveals that the status of the inputs and outputs of commercial banks compared with proficiency banks is not optimum and their efficiency can be increased by adjustment in the combination of factor,.

5. Conclusion

As we find in the first hypothesis, assuming the constant return to the scale (CRS), the five–year average of efficiency for government banks is 34.07% and for private banks is 77.13 %. Assuming the variable returns to the scale (VRS) and the optimization model of input centered, the five–year average of efficiency for government banks is 53.13% and for private banks is 96.41 %. Assuming the variable returns to the scale (VRS) and optimization model of output centered, the five–year average of efficiency for government banks is 58.88% and for private banks is 94.89 %.Hence all the above calculation results of the efficiency indicates that the five – year average of profitability efficiency for the government banks is less than the same for the private banks .So the status of the inputs and the outputs of the government banking system to compare with the private banking system is not optimum and their efficiency could be increased by adjustment to the combination of factors .Also we can calculate the weighted average of profitability efficiency(WAPE) for whole banking system including all government and private banks as shown in table 13:

Table 13. The weighted average of profitability efficiency (WAPE) for whole banking system

Banks segment	CRS	VRS	
		input entered	output centered
Government	34.07	53.13	58.88
Private	77.13	96.41	94.89
WAPE	51.29	70.44	73.28

Note: The weighted average of profitability efficiency (WAPE) is calculated based on the weight of the state banks equals to $w_s = 9$ and the weight of the private banks equals to $w_p = 6$.

In the second hypothesis, assuming the constant returns to scale(CRS) , the five–year average of efficiency for proficiency banks is 92.8% and for commercial banks is 62.63% .Assuming the variable returns to the scale (VRS) and the optimization model of input centered, five-year average of efficiency for proficiency banks is 99.24% and for commercial banks is calculated 91.85% . Assuming the variable returns to scale (VRS) and optimization model of output centered, five-year average of efficiency for proficiency banks is 99.36% and for commercial banks is 91.06%.Hence all the above computing results implies that the five –year average of profitability efficiency for the commercial banks is less than the same for the proficiency banks. So the status of inputs and outputs of the commercial banks to compare with the proficiency banks in state banking system is not optimum and would be increased their efficiency by correction of the factors combination.

Table 14. The average of profitability efficiency for government banks

Banks segment	CRS	VRS	
		input entered	output centered
Commercial	62.63	91.85	91.06
Proficiency	92.8	99.24	99.36

Thus the hypothesis were confirmed and the deduction of this research revealed that the status of the inputs and the outputs of the commercial banks to compare with the proficiency banks are not optimum and their efficiency can be increased by revision in the combination of factors .The findings of this study are similar to the studies’ results of the Hosseini and Sour, Hadian and Azimi, Shabestary and even Hosseinzadeh Bhareyni et al.

Therefore it is essential to provide opportunity for presence of the private banks as the satisfactory performance of the private banks and even by notification of provision of the article 44 of constitution of privatization of the government banks. So there must be provided the arena of competition between the two groups of banks in order to reaching efficiency in the banking system sector of the country which lead to the improvement of the quality level and also the economic efficiency. Also as the result of higher efficiency of the proficiency banks compared with commercial banks, it is expected a revise in structure of commercial banking system.

In order to explain the efficiency in digits we will use the BCC model of the output centered for the following reasons:

1. as the calculation of efficiency by applying the BCC model is more meaningful and compatible than CCR and hence the evaluating of the efficiency with assuming the variable returns to scale is recognized more suitable, which is similar to the research’s result of Dadgar and Niknemat,
2. Since the model of output centered is much more consistent to the aim of the banks than the model of input centered to enhance their profit after tax (PAT).

Thus the average of profitability efficiency (APE) calculated for the government banking system is 58.88% and for the private banking system is 94.89% and as it was shown in table.13 the weighted average of profitability efficiency(WAPE) for whole banking system would be 73.28%.

Definitely by presence of immense private banks in coming years, after implementing the general policies of the article 44 of the constitute notification from the supreme leader of Islamic Republic of Iran, will delineate the new prospective for both government and private banks. As the results of the present study indicate, the growth in efficiency of banking system after achieving the goals of privatization in banking industry is predictable (due to higher efficiency of the private banks compared with government banks).

- 1- In order to acceleration in the privatization process, the entire government banks may be obliged to submit the 80 percent of their shares.
- 2- Restructuring the organization in commercial banking industrial in order to become more specialized for the purpose of optimum usage of the resources and increasing the efficiency.
- 3- The efficiency of the government banks can enhance by revision in inputs and outputs combination.
- 4- The efficiency of the commercial banks can enhance by revision in inputs and outputs combination.
- 5- The managers of the banks should improve their performance and must clarify their goal points and optimum amounts by comparing of their own performance with the reference banks.
- 6- Create and launch internal performance assessment units of banks in order to constantly evaluate the efficiency and determination of the level of deficiency of branches and try to eliminate them.
- 7- All banks can use the DEA-Master software program in order to grading the branches and even issuing the certificate of efficiency for each branch till the deficient branch try to enhance their efficiency.
- 8- Create and launch the performance assessment units of efficiency in central bank for the constant evaluation of the efficiency of banks and determine the level of deficiency of banks and encourage competition between the banks to reduce their deficiency.

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