CALCULATION THE EFFICIENCY OF REFAH BANK USING DATA ENVELOPMENT ANALYSIS (DEA)ME

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Abstract

The main objective of this study is to calculate the technical, allocative and economic efficiencies of Refah bank branches using data envelopment analysis method. To do this, the efficiency situations of nine branches of this bank, located in North Khorasan province, have been studied during fiscal years of 2009-2011 based on two assumptions of fixed return and variable return compared to the scale. In total, the results show that the three-year average of technical, allocative and economic efficiencies in the fixed return case than to the scale, respectively, have been as 0.847, 0.922 and 0.775, and in the case of variable return than to the scale respectively as 0.929, 0.930 and 0.865. Also in 2009-2011 years, respectively, 33%, 33% and 44% of the branches are efficient in both fixed and variable returns than to the scale.

Keywords: Technical efficiency, Allocative efficiency, Economic efficiency, Data envelopment analysis.

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1. Introduction

Due to the influential role of banks in economic activities, evaluation of their performance efficiency as parts that their structures are as a large organization with several branches, will be important. In this system, the branches are responsible for executive duties so that during some operations produce some goods and special services using specific inputs and components, meanwhile the organization's task includes monitoring and controlling the branches. The health and efficiency of the banking system has been always considered by the relevant authorities, since as much as influential that healthy and efficient banks can be in the economic growth and development, their unhealthiness and poor performance can also cause financial and economical crises. Since the most important mission of the banks and banking system is to gather the community's funds and optimal allocation of them to productive economic activities, reviewing the performance of banks in increasing the volume of facilities granted with a certain level of deposits and inputs used, is one of the main criteria in evaluation the proper performance of any bank in this area. Meanwhile, using some tools to determine the effectiveness level of the branches, such as data envelopment analysis method is considered as one of the main methods of banks assessment. In fact, the existence of high-performance in every country's banking industry indicates the lower banking fees, higher interest rates and providing higher quality services that ultimately leads to reduced investment costs in the country. The current study intends to estimate the level of technical efficiency, allocative efficiency and economic efficiency in Refah Bank by providing an appropriate model and using the obtained information from the Supervisory Section of the Refah Bank in North Khorasan Province, and finally provide proper solutions to reduce the inefficiencies.

The reasons for the need to review the performance and efficiency of the Refah Bank branches on the North Khorasan province are as:

1.The Refah Bank can achieve appropriate criteria to allocate the funds and resources between branches under his stewardship by investigating the effectiveness of its branches.

2. Literature review

2.1.The concept of efficiency

Efficiency, in its general sense, means the degree or quality of to achieve the desirable goals set (Farrell et al., 1985); or, efficiency is a situation in which the resources have been optimally allocated that is the same efficiency in economy. In other words, a situation can be called optimal in economy or can be claimed it has efficiency, in which none of the economic activities cannot be increased unless by reducing levels of other activities. For example, if (n) products and services are produced in the economy, there should not be possible to increase the product level in any of these (n) products, unless the production level in at least one of them is reduced. Only in this case it can be ruled that all resources available in the economy have been allocated efficiently for products producing in various fields.

2.2.Types of efficiency

Efficiency is divided originally into four types according to its types. But, Farrell has introduced only three of them that its two types are used to measure the efficiency of enterprises and the other type is used for industry. The two types used for enterprises include:

1.Technical efficiency: Technical efficiency represents the ability level of an enterprise or firm to maximize the production rate considering the resources and production factors .

2.Allocative efficiency (cost efficiency): This type of efficiency reflects an enterprise ability to use data in optimal proportions given the production technology and their associated prices .

The third type of efficiency used in industry is:

3.Structural efficiency: The structural efficiency of an industry is obtained from the weighted average efficiency (outputs weighted total divided by data weighted sum) of that industry's companies.

In addition to these three types, there is also a fourth type of efficiency as follows:

4.Scale efficacy: The scale efficiency of a unit is obtained from the proportion of the "observed efficacy" of that unit to the "efficacy in optimal scale". The purpose of this efficiency is production in optimal scale.

Two components of technical efficiency and allocative efficiency provide together an efficiency measure called economic efficiency.

Economic efficiency or overall efficiency = Allocative efficiency × Technical efficiency

If there is scale efficiency, the overall efficiency will be defined as follows:

Economic efficiency or overall efficiency = Allocative efficiency × Management efficiency × Scale efficiency

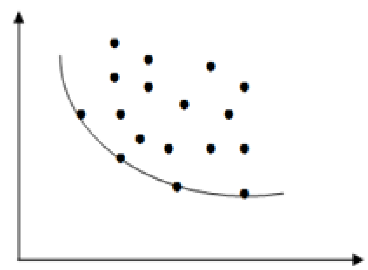
Also in economy, the efficiency can be studied in two fields of production and consumption. These two types are:

1.Efficiency in consumption (efficiency in exchange): This kind of efficiency indicates the condition of optimal allocation of goods for consumption among the consumers.

2.Efficiency in production: Allocation of productive resources for production of various goods is optimized and efficient when it is not possible to increase the production of any of the products unless one of the products' producing will be reduced.

In continue, to have a better understanding of these concepts and various types efficiencies, we will use the Farrell's frontier production function curve. For the first time, Farrell explained how to obtain the identical production function through geometric method as that if each of the spots marked on the chart (1) represents a use combination of production factors, including X_1 and X_2 to produce a the product Y in various enterprises, a convex function is obtained by connecting the points closer to axes and the origin of the coordinate that there would be no point below it. The obtained curve is called as efficient identical production function. If more than two production factors (X_1 and X_2) are needed to produce the Y product, geometrical drawing of the identical production function curve geometrically will be so difficult. In these circumstances, each productive firm is considered as a point in space according to its types and amount of production factors that the dimensions of this space are determined by the number of these production factors and the point coordinates, and by the amount of using each of the production factors; then, selecting a manufacturing firm as a studied firm and with the help of linear programming, the position of this manufacturing firm (point) is measured than to other firms (other points in the space). This action should be repeated equal to the number of firms (points), and therefore, we will have linear programming models equal to the number of firms.

Figure 1: Identical goods production curve



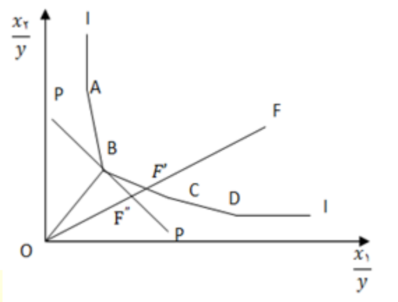
2.3.Chart evaluation of efficiency

Requisite for efficient chart review is reviewing of output -oriented and the input -oriented methods. In technical efficiency that is related to the technological structure and is a relative concept, comparison is between firms in their way and type of using of the technology. In this efficiency type, two concepts can be noted. Based on the existing definitions, an enterprise has a higher technical efficiency that can produce more product than to other enterprises with a given and constant data set. In this definition, since the discussion centered on the production rate change, hence, it is called output-oriented efficiency. According to another definition, an enterprise is efficient when with respect to a fixed level of product uses one or more production factors without increasing in amount of other factors, in comparison with other firms. This method of efficiency measurement is called input-oriented method. Based on two mentioned methods, the efficiency curves are as follows:

A. Efficiency diagram based on input-oriented measure

Introducing the types and methods of efficiency measurement through practical method is performed based on Farrell method. Farrell suggested that the comparison of an enterprise performance with the performance of the best available enterprises in that industry is more favorable. Based on this method, a set of (n) firms with two inputs and one output is considered.

Chart 2: Farrell frontier efficiency curve



In diagram 2, the Farrell boundary in the case of two inputs and one output has been shown for five firms, including A, B, C, D and F. The diagram is expressed at constant return than to the scale. As it can be seen in the chart, the F firm is inefficient, since there is another unit, called F' on the boundary that produces the sane product (unit product) with less inputs than the F firm's inputs. The F firm can tend toward the F' firm by reducing a combination of its first and second inputs. The technical efficiency of F firm is defined as $\frac{OF'}{OF}$fraction and its technical inefficiencies as 1-$\frac{OF'}{OF}$; meaning: $\frac{FF'}{OF}$. If any information related to the price of each data is available, the PP line, the same identical cost curve, can be drawn. The identical cost curve equation is as the following:

$$P_1X_1 + P_2X_2 = Y \quad (1)$$

whereas, P_1 and P_2, respectively, are the prices of the first and second inputs, and X_1 and X_2, respectively, are the first and second inputs, and Y is the output. The above equation can be written as follows:

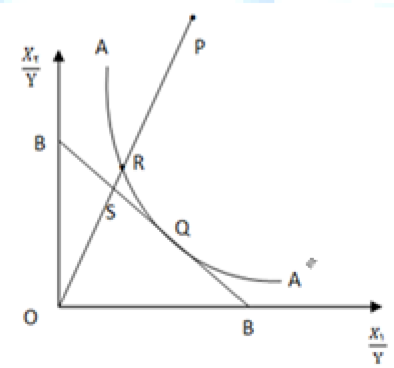
$$P_2X_2 = Y - P_1X_1 \Rightarrow X_2 = \frac{Y}{P_2} - \frac{P_1}{P_2} X_1 \quad (2)$$

As it can be seen in the above equation, the slope of this line is the ratio between two prices. The B firm has the lowest cost than other firms that are on the production curve, because it has located on the contact point of this line and the curve. In other words, the F firm needs to produce at B instead of the F' point by reducing its costs to become efficient regarding its allocation process. The allocative efficiency of the F unit is defined as the $\frac{OF''}{OF'}$ fraction and its allocative inefficiencies are defined as $1-\frac{OF''}{OF'}$, which means: $\frac{F''F'}{OF'}$

Economic efficiency is obtained from technical efficiency multiplying allocative efficiency. Economic efficiency of the F firm is defined as $\frac{OF''}{OF}$ fraction, and the economic inefficiency is defined as $1-\frac{OF''}{OF}$, which means $\frac{F''F}{OF}$.

In addition to the above examples, the input-oriented measure or the minimization of production factors can be showed as chart with assumed constant return than to scale and with two production factors (X_1, X_2) and one product (Y).

Diagram 3: Describing the types of efficiency with assuming the constant return than to the scale



The information about the identical-amount producing curve (AA ') makes the measurement of technical efficiency possible. If we consider a firm located at P point that uses the given values of X_1 and X_2 to produce one unit of Y, the value of technical inefficiency of this firm is being shown by the RP distance, which indicates the amount of production factors that can be reduced by keeping constant the product level. This value is also shown by the $\frac{RP}{OP}$ ratio and indicates the percentage by which the production factors can be reduced with the same production level in the past. The technical efficiency as a formula is equal to the following:

$$TE_i = 1 - \frac{RP}{OP} = \frac{OR}{OP}$$

If the f raction equals to 1, it means the technical efficiency of that firm is complete. For example, the efficiency of R point is equal to one, since this point is located on the efficiency or same-value production curve. The allocative efficiency of the P firm is equal to:

$$Alocative\ efficiency = AE_i = \frac{OS}{OR}$$

Whereas, the SR represents the cost rate that can be reduced with the condition of fixed product. This cost reduction will be done if the production is performed at Q point and not at R point.

The economic efficiency (EE) value is defined as follows:

$$Economic\ efficiency = EE_i = \frac{OS}{OP}$$

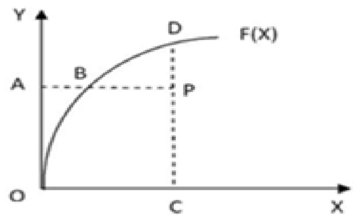
The SP distance also indicates the economic inefficiency.

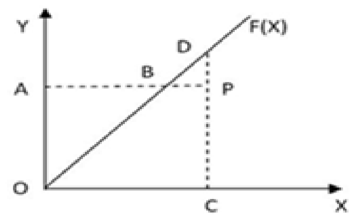
B. Efficiency diagram based on the output-oriented measure

The difference between efficiency measurements based on maximizing the product or minimizing the production factors is shown by the following graphs, which include a product and a production factor. In diagram (4 - a), the F (x) frontier production function has been plotted with diminishing return than to the scale. The P represents an inefficient firm. The technical efficiency of this firm is as $\frac{AB}{AP}$ based on minimizing the production factors and as $\frac{CP}{CD}$ based on maximizing the product. Therefore, the methods of minimizing the production factors and maximizing the product have the same answers only in terms of constant returns than to the scale. In this sample with constant return than to the, we will have: $\frac{AB}{AP} = \frac{CP}{CD}$, which means the equality of efficiencies calculated by both methods shown in the diagram (4 - b). Thus, in studies, ensuring of the base type is necessary for that industry or the studied firms.

Figure 4: Comparison of measurements based on minimizing the production factors pr maximization of the product

Diagram (4 - a) **Diagram (4 - b)**



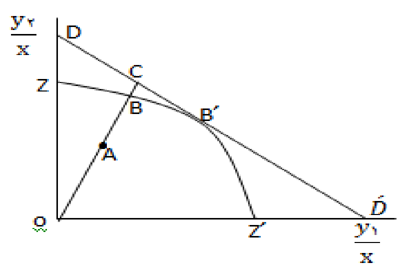


In addition, output-oriented measures or maximizing the product can be considered with respect to that the production includes two outputs (Y_1 and Y_2) and one input (X) and showed as a chart. If we assume again that the return than to the scale is constant, we will be able to draw the production as a unit production facilities curve in two dimensions. The example of this case can be seen in the diagram 5, in which the ZZ' is the unit production facilities curve and the A point refers to an inefficient firm. It should be noted that the inefficient "A" point is placed below the curve in this case, since the ZZ' shows the upper bound of the production possibilities curve. The Farrell's output-oriented efficiency measure will be provides as follows:

$$TE_0 = \frac{OA}{OB}$$

TE_0 is the technical efficiency, and the same value that through which the outputs can be increased without requiring additional inputs.

Figure 5: Technical and allocative efficiencies based on maximizing the product



If have the price information, we can draw the identical income line of DD'. Thus, the allocative efficiency would be as:

$$AE_0 = \frac{OB}{OC}$$

The AE_0 is allocative efficiency, which has an increasing interpretation for the revenue and is similar to the decreasing interpretation for the allocative inefficiency cost in the case of input-oriented approach. Moreover, the economic efficiency (EE_0) can be achieved as follows:

EE_0 = (OA/OC) = (OA/OB) × (OB/OC) = $TE_0 \times AE_0$

All of these efficiency components are between zero and one, and the efficiencies are also measured by lines plotted from the origin to the mentioned points and are independent of measurement units.

2.4.Efficiency measurement methods

The detection of efficiency depends on the definition and comparison with a desirable standard that such a desirable standard can be determined using different methods. There are two major methods to determine the efficiency of bank units, including: Ratio analysis method and frontier analysis method.

Ratio analysis method is considered as one of the oldest methods for measuring efficiency performance in bank units' category. In this method, a series of financial indicators of banks (such as ROI, ROA, capital adequacy ratio, etc.) are calculated and these ratios will be compared with standardized indicators of the banking industry, and then based on this, the efficiency or inefficiency of those banks will be evaluated. But, in the frontier analysis method, the banks initially create efficiency frontier by estimating the frontier production functions, and the banks act in this frontier will be considered as efficient units, and the banks located outside the frontier are recognized as the inefficient units. The frontier analysis method consists of two main methods, including parametric and nonparametric methods, which are also divided into several types.

Parametric methods types: They include stochastic frontier methods, thick frontier method and free distribution method. The types of nonparametric methods include observations method, step method, linear average method, limit point connecting method and data coverage analysis method.

3.Research hypotheses

1. How much is the technical efficiency in each of the branches of Refah Bank in North Khorasan province?

2.Are the inputs and outputs values the same in all the branches of Refah Bank in North Khorasan province?

3.How much are the allocative and economic efficiencies in each of the branches of Refah Bank in North Khorasan province?

4.Research objectives

Our four main objectives in this study include:

1.Determining the technical efficiency value in separation for each of the branches of Refah Bank

2.Ranking of the branches of Refah Bank in Northern Khorasan province during the study period based on fixed and variable returns compared to the scale

3.Determining allocative and economic efficiencies of each of the branches of Refah Bank

5.Background research

Among the first research, some of the significant studies can be mentioned "as the following: Benston studies (1965), Greenbam studies (1967), Bell and Murphy studies (1968), Berger, Hanvick and Humphrey studies (1987), Clark studies (1984), Giligan, Smiraveck and Marshall studies (1984), Goolari and Zardkoohi studies (1987).

- The first documented and systematic efficiency issues began by Koopman and Debru reviews and studies. Koopman defined and explained the technical efficiency and Debru provided an indicator for measuring the technical efficiency.

- The fundamental and applied work for the detection efficiency was conducted by Farrell in 1975. His studies identified new approaches in two directions: how to define the efficiency and how to calculate the efficiency. The basic premise is that we have to leave the hypothesis of optimal allocation of input and output and allow the inefficient operations to be done. Inefficiency as the distance of an organization from an accepted frontier production function is adopted as a criterion. The basis of this radial contraction / expansion measurement connects the observed point of inefficiency to the reference points (not seen) in the production frontier. If the actual production point of an organization places on the frontier line, that organization is quite efficient. If it is above the frontier, thus, it is inefficient (with actual production to potential production ratio that expresses a given organization's efficiency level).

- Farrell's suggestion includes two components: technical efficiency and allocative efficiency. These two criteria provide together a single efficiency criterion (Fiorentino et al., 2006, p. 4).

- With the completion of Farrell's method in 1978, Charnz, Cooper and Rhodes developed the initial analysis from a single input and single output pattern to a multiple inputs and multi-outputs model, which was named as the CCR method according to the first letters of their names. Later, in 1984, Banker, Charnz and Cooper introduced the BCC model by completion the CCR method. These papers became the basis of many efficiency analysis studies, and with the progress of this branch of science in operations research, the DEA method was used.

- Sherman and Gold (1985) conducted the first study on banking units using the data envelopment analysis method on 14 branches of savings banks of in U.S. The results on production efficiency indicated that just six branches had 100% efficiencies (i.e. 42% of samples), and the causes of other branches' inefficiencies were mentioned as weak management, branch size, number of employees and operating costs.

- ✓ Casio and Malinuks (2000) analyzed the efficiencies of 540 European commercial and specialized banks within the 1993-1997 years. The results of performed estimates showed that in the period of the studies, the average efficiency of banks in England was higher than other countries.

- ✓ Yodistira (2003) was seeking for new evidence on the efficiency of Islamic banks in his article by using the DEA method. He selected 18 Islamic banks among 12 countries for the period of 1997-2000 and measured their technical efficiency and their scale.

- ✓ Honer (2004) reviewed and compared the cost and scale efficiency among the banks in Germany and Austria. The average efficiency of Austrian banks has been as 42% and of German banks has been as 66%. He also concluded that factors such as being a specialized bank, the risk or return volatilities on assets, the type of bank ownership, the percentage of bank debts associated with bank staff education levels have been effective on the bank efficiency.

- ✓ Chen and others (2004), in an article, evaluated the cost efficiency, technical efficiency and allocative efficiency of 43 Chinese banks in the period of 1993 to 2000. The results showed that banks with large governmental ownership and the smaller banks were more efficient than the banks with average governmental ownership.

- ✓ Tangavlo and Findelli (2009), in an article, studied the influencing factors on banks efficiencies in Southeast Asian countries, namely, Indonesia, Malaysia, Philippines, Thailand, Singapore and using the DEA method that the survey covered nearly 600 banks from 1924 to 2008. The article results indicated that banking regulations and monitoring to improve the efficiencies of the banks and stability in financial markets in Southeast Asia is so important and crucial.

- Dash and Charles (2009), in their article titled as "Review the technical efficiency of banks in India", have emphasized on the importance of review of the banks efficiencies in order to increase the economic growth, and have reviewed the technical efficiencies of banks in India, for the period years of 2003-2008, considering their classification into governmental, private and foreign banks. For this purpose, they have used the DEA method to measure the efficiency in 49 banks as the study samples. The results suggested that the foreign banks were slightly more effective than private and governmental banks, and there is no major difference between the efficiencies of private banks and governmental banks in India.

- Margit and Melnar (2010), using the SFA method, examined the efficiency of banks in Hungary, in the domain of 25 members of Europe Union. The results showed that in Hungary, the banking efficiency is not high either in European scale or at regional scale. The competition can be the most important stimulus for gaining efficiency.

- Kerill and Nenoskai (2011) reviewed the efficiencies of Bulgarian banks and their indicators during the years of 1999-2007. They estimated the rates of technical efficiency, allocative efficiency and cost efficiency using a nonparametric method, and then linked them to a series of bank-specific factors, institutional factors and related items to the Europe Union, in which the results showed that the foreign banks have been more efficient than the domestic private banks.

- Using the DEA method inside Iran has begun from the Ph.D. thesis of Mr. Alirezaei, M. In Iran, this method has been much used in measurement of efficiency rates in industries such as banking, insurance, comparison of the universities efficiencies, power companies, etc. An apparent example has been the use of DEA method by Alirezaei to evaluate the performance efficiency of the insurance companies' branches, determining the comprehensive insurance penetration index and performance evaluation of steam, gas and water power plants, and determination of their technical efficiencies.

- The following conducted studies regarding efficiency before 2002 can be mentioned in Iran: Borhani (1999), Akhlaghi, Hadi. (1999), Alizadeh Saneh, Noloofar. (2000), Langroodi Talachi, Hussein. (2001) and Abedi, Pejman. (2001).

- The researches from 2002 onwards are as follows:

- Amiri, Hadi. and Raees Safari, Mojtaba. (2002) reviewed the efficiency of commercial banks in Iran and the factors affecting them, and calculated the inefficiency index in banks of Saderat and Sepah.

- Sameti, Morteza. And Rezvani, Mohammad Ali. (2002) evaluated the efficiencies of 36 major public universities using the DEA method.

- Haghighat, Jafar. and Nasiri, Naser. (2004) conducted a research on evaluating the technical efficiency of 172 Keshavrzi Bank branches in four districts of the country, including provinces of East Azarbaijan, West Azarbaijan and Ardabil using the DEA method.

- Hadian, Ibrahim. and Azimi Hosseini, Anita. (2005) examined the efficiency status of 10 banks in the country for the period years of 1998-2000.

- Gilak Hakim Abadi, Mohammad Taghi., Esnaashari, Abulghasem. and Ahmedpoor, Hadi. (2006) have studied the efficiencies of 141branches of the Sederat bank using the assumption of fixed and variable return than to the scale and applying the DEA method.

- Dadgar, Yadollah. and Nick Neamat, Zahra. (2007) reviewed the efficiencies of 38 Tejarat Bank supervisions using two BCC and CCR methods.

- Ebrahimi, Saeed. Et al. (2007) evaluated the efficiency rate of nine state banks in Isfahan province in the period of 2006-2007 using the DEA method.

- ✓ Khotaee, Mahmood and Yousefi Haji Abad (2008) assessed the technical efficiency of 33 branches of the Maskan Bank in the city of Tehran during years of 2003 – 2005 using the DEA method.

- ✓ Amir Yousefi, Khalid. and Hafezi, Bahar. (2008), in their article, presented a summary of the conducted report on the measurement of efficiency in the network of state-owned banks in Isfahan province for cross-sectional data of 2004. The method used was DEA one and they have considered two assumptions of fixed and variable returns than to the scale in the two input-oriented and output-oriented approaches.

- ✓ Dr. Hossein Zadeh Bahraini, Dr. Naji and Chamanehgir, Fereshteh. (2009) reviewed and compared the economic efficiencies of two groups of public and private banks by considering the assumption of variable returns than to the scale and with two attitudes, including intermediate attitude with income approach and intermediate attitude with value-added approach.

6.Pattern introduction

The studied sample consists of nine Refah bank branches in North Khorasan province. The studied period includes 3 years (2009-2011). The reason to select these three years is due to lack of complete information related to other years. The method used in this study is a nonparametric method called data envelopment analysis (DEA). This method does not require the production function estimation and the efficiency of each unit is calculated in comparing with a group, which has the highest performance. The technique is a method based on mathematical programming and provides the possibility to calculate the technical efficiency for the decision-making units with multiple inputs and multiple outputs, and no need to assign weights to the inputs and outputs and equaling and balancing them.

There are different forms in DEA method such as relative form, growing or increasing form and covering or widespread form that in determining the efficiency of the studied units a particular method is applied in each of these forms; therefore, different methods such as single-step, two-step and multi-step methods are used. Since this analytical method is used for assessment of decision-making units that attempt to do empirical estimation of the efficiency frontier based on a set of observations, which results in a frontier function with covering all data, it is called an envelopment and universal analysis. This method is based on a series of optimization problems and there is no parameter for its analysis; thus, it is considered as a nonparametric method.

The limitations of data envelopment analysis method include as the following:

1.The measurement error of the production factors and the product change the shape and the position of the efficient frontier curve.

2.If an important product or production factor is not considered, it will results in skewed efficiency results.

3.Adding the number of firms in the DEA analysis will not lead to increased efficiency value of existing firms, which is a very important point.

4.Addition of production factor or product in DEA does not cause decrease technical efficiency rate.

5.When the observations are few and the number of products and production factors is high, many of these firms are located on the frontier curve of DEA. Thus, the sum of the variables (production factors and products) should be smaller than the three times of the number of observations (firms). According to the DEA methodology capabilities and considering more than one output in this study, and due to the specific conditions of the banks, this method will be used for doing the research.

Charnz, Cooper and Rhodes in 1987 provided their CCR model based on minimizing the production factors and assuming the constant return than to the scale (CRS).

A. The CCR model with constant returns to scale

The development if the DEA method is derived from the normal evaluation of production as the ratio of output to input, which is considered the best way to introduce it. Formulating the relative efficacy evaluation or the ratio of weighted outputs to weighted inputs had done to calculate the introduced multi-input and multiple output modes. Charnz, Cooper and Rhodes detected a problem existed in determining a common set of weights of the outputs and inputs for evaluating the efficiency of a unit. They proposed that each unit should be able to select its weights. It means that for each DMU, we will have an indicator of the ratio of the entire outputs to inputs; for example, $\frac{u'y_i}{v'x_i}$, whereas, u is an M × 1 vector of the outputs' weights and v is a K × 1 vector of the inputs' weights. To select the optimal weights, we have to determine the mathematical programming:

$$max_{u.v}(u'y_i/v'x_i)$$

$$\text{s. t: } u'y_j/v'x_j \leq 1 \quad , \qquad j = 1,2,\dots,N$$

$$u , v \geq 0$$

In this case, the values of u and v are obtained so that the efficiency indicator of the i(th) unit of decision-making is at its maximum value. However, this limitation should be considered that the efficiency indicators should be less than or equal to one. The problem of this determined ratio formula is that it has infinite answers. To avoid this problem, the $v'x_i$ =1limitation can be entered into the model:

$$max_{\mu,v}(\mu' y_i)$$

$$s.t : v'x_i = 1$$

$$\mu' y_i - \acute{\upsilon} x_i \leq 0 \quad , \qquad j=1,2,\dots,N$$

$$\mu , \upsilon \geq \mathbf{0}$$

Because of linear transformation, the μ and υ symbols have been used instead of u and v. This form is known by the name multiple-form linear programming problem. Using a dual conversion in linear programming, an alternative covering or envelopment form can be achieved for this problem:

$$max_{\theta,\lambda} \quad \theta$$

$$\text{s. t}: \quad -y_i + y\lambda \geq 0$$

$$\theta x_i - x\lambda \geq 0$$

$$\lambda \geq 0$$

λ is an N × 1 vector including constant numbers, which shows the weights of the reference set. The scalar values obtained for θ will be the technical efficiency of the i(th) firm that provides the condition of θ ≤ 1.This envelopment form includes less constraints than to the multiple form (N +1> K + M). It should be noted that the linear programming problem must be solved N times for each of the DMUs (Cooley, 1996: 9-11).

In 1984, by considering the assumption of variable return to scale (VRS) by banker, Charnz and Cooper, the DEA efficiency measurement method was developed.

B. BCC model with variable returns to scale

The assumption of variable returns to scale can be only applied if the firms operate at optimal scale. Various issues such as competitive effects, financial constraints and so cause the firm not to operate at optimal scale. Banker, Charnz and Cooper developed and extended the previous model (CCR) in a way to include the variable returns to scale. Using the assumption of constant returns to scale, when all firms do not operate at optimal scale, will disrupt the calculated values for technical efficiency analysis {with inclusion the scale efficiency, the technical efficiency consists of two components of pure technical efficiency and the efficiency due to scale savings of a firm}. The use of variable returns to scale will lead to provide a very detailed analysis by calculation of technical efficiency based on the efficiency values due to scale and efficiency due to management. In this model, the enveloping form is in a way that does not necessarily pass through the origin. As a result, the determined points in the project for inefficient units as a convex combination of the inefficient units are more than to the linear combination of constant returns to scale state in the enveloping appearance; thus, the linear programming problem in the

CCR model can easily be used to calculate the efficiency in BCC. Only by adding the convexity constraint, the following linear programming model can be achieved:

$min_{\theta,\lambda} \quad \theta$

s. t: $-Y_i + Y\lambda \geq 0$

$\theta X_i - X\lambda \geq 0$

$NI^{'}\lambda = 1$

$\lambda \geq 0$

The recent model with variable returns to scale constraint does not specify whether the firm works in the ascending or descending return area of the scale or not. This major issue is done in practice by comparing the non- ascending return constraint than to scale, that means $NI^{'}\lambda \leq 1$:

$min_{\theta,\lambda} \quad \theta$

s. t: $-Y_i + Y\lambda \geq 0$

$\theta X_i - X\lambda \geq 0$

$NI^{'}\lambda \leq 1$

$\lambda \geq 0$

In other words, the nature of the return type in scale inefficiency for a particular firm will be determined by comparison of the technical efficiency value in non-ascending return mode than to the scale. Hence, if these two are equal, then the studied firm faces with diminishing returns than to scale is. Otherwise, the ascending return condition to the scale is established.

6.1.Price information and allocative efficiency

If the price information is available and the firm objective is minimizing the costs or maximizing the income, then, measuring the allocative efficiency will be possible in addition to measuring the technical efficiency.

a. Cost minimizing method

If you want to calculate the rate of allocative efficiency by using the cost minimizing method, you need to calculate the technical efficiency in the first stage by using the DEA model based on minimizing the production factor in pervious discussions.

In the next step, calculating the allocative efficiency is as follows:

$$\min \quad W_i{}'X_i{}^*$$

$$\text{s. t:} \quad -Y_i + Y\lambda \geq 0$$

$$X_i{}^* - X\lambda \geq 0$$

$$NI'\lambda = 1$$

$$\lambda \geq 0$$

Here, the W_i is the vector of production factors' prices and the $X_i{}^*$(that will be achieved by solving the above linear programming problem) is the vector of production factors, which will lead to cost minimizing of the firm with the same price of W_i and the production level of Y_i.

In the first step, the cost efficiency (economic efficiency (EE)) can be obtained for each firm as follows:

$$economic\ efficiency = EE = W_i{}'X_i{}^*/W_i{}'X_i$$

In fact, the economic efficiency is the possible minimum cost to the available cost ratio.

In the second step, the allocative efficiency will be achieved as follows): Allocative efficiency = Cost efficiency (economic) / Technical efficiency

Note that this trend includes all scales for allocative efficiency, and usually based on the same reason, the inappropriate data combinations in different returns to scale are being explained (Farreh and Lowell, 1978: 235). The allocative efficiency can be also measured in a state of maximizing the revenue with a certain combination of production factors and with a similar method. It is worth noting that minimizing the cost and / or maximization of revenue will guarantee the maximum profits.

b. Income maximizing method

To use the income maximizing method for calculating the allocative efficiency rate, in the first step, the technical efficiency will be calculated by DEA method and based on product maximizing. Then, we will act as the following to calculate the allocative efficiency:

$$\max \quad P_i' Y_i^*$$

$$\text{s. t:} \quad -Y_i^* + Y\lambda \geq 0$$

$$X_i - X\lambda \geq 0$$

$$NI'\lambda = 1$$

$$\lambda \geq 0$$

In this section, the P_i is the production factor price vector for the i(th) firm and the Y_i^* (which is obtained by linear programming problem solving) is the possible maximum income vector (per the product values), which are obtained with the same given prices of the product and the production factor level, X_i. The income or revenue efficiency (economic efficiency (EE)) for each firm is obtained as follows:

$$(Economic\ efficiency)\ Income\ efficiency = EE = P_i' Y_i / P_i' Y_i^*$$

In fact, the revenue or income efficiency (economic efficiency) is the observed revenue to the possible maximum revenue ratio.
The allocative efficiency is obtained as follows:

Allocative efficiency = Income efficiency (economic efficiency) / Technical efficiency

7.Different attitudes in considering the bank output and input variables

In the area of inputs and outputs measurement, there are two distinct approaches in the literature and banking studies, which are classified under the headings of intermediate attitude and productive attitude in research.

Intermediate attitude

In this attitude, banks classified as an intermediary institution of financial services. According to Carl and Davis (1992), the banks work as providers of intermediary services through gathering the deposits and other debts and converting them into interest-bearing assets such as a variety of loans, securities and other investment activities.

Productive attitude

In this approach, unlike previous methods, the banks are considered as producer of loan and deposit accounts services, which use their capital and labor to provide services. In this method, the outputs measurement is based on the number of service accounts. In overseas studies, the production attitude has been mostly used, but domestically, the intermediate attitude is often used. In the present study, the intermediate attitude has been used for considering inputs and outputs. We introduce the following reasons for this choice:

1.Intermediate approach is more consistent with Islamic banking principles and philosophy and banking operation law without usury that introduces the bank as the depositor's lawyer.

2.In the intermediate approach, the value of outputs is more important than their number, since by making small the size of each output unit, their number can be easily enlarged, while their value is limited by the bank's resources amount and not be easily increased.

3.The cost of paid profit for supplying the deposits is one of the most important items in the financial statements of banks, and accounting and financial attitude requires considering this important cost as data.

4.Neglecting to consider the profit paid cost data is neglecting of financial technology process in the conversion of deposits and loans and other demands.

8.Research variables

In DEA method, two classes of variables are required:

8.1.Variable used in the section

Input in non-parametric models is a factor that with addition of one unit to it and assuming other conditions constant, the efficiency will decrease. As described, the input variables will be considered based on intermediate approach, deposits and staff.

1.Deposits: They include interest-free loan current and savings accounts balances, ordinary and special short-term deposit accounts balances, one to five-year term deposit accounts balances and other deposit accounts balances.

2.Personnel: Employing and utilization of specialist and skillful manpower has been always one of the critical and vital issues in the organizations. Thus, the number of bank staff is one of its inputs.

Calculating the allocative efficiency requires the price of inputs. The price means the average cost for each of the inputs, which is obtained from the expenditures made in each of the studied years divided by the number or value of that input. In this study, the average price or cost of a unit input for the reviewed period is considered. The prices include the average paid profit for the deposits and the average cost per employee.
Since the efficiency is related to the intrinsic factors, we will convert the prices of 2010-2011 years to the base year prices (2009) to calculate and compare the allocative efficiency and economic efficiency of the branches and review the trend of their changes in order to remove the extrinsic factors from the model. Thus, the following equation is used as an indicator price for prices adjustment and in order to reduce the inflation:

$$P_b = P_i \, (L_b/L_i)$$

P_b: Adjusted price to the base price

P_i: the price of the i year

L_b: Price index of the base year

L_i: Price index of the i year

According to the Central Bank, the price indices for years of 2009-2011 have been respectively as 183.3, 203 and 228.17. Input prices before and after inflation, meaning, based on the current and fixed prices have been provided in tables 17 to 19.

8.2.Variable used in output section

In non-parametric models, the output is a factor that with addition of a unit to it and assuming other conditions as constant, the efficiency will increase.

According to the intermediate approach, the outputs used in this study include:

1.Facilities in the form of swap contracts that include contracts of installment sales, copartnership, civic participation, time-bargain, a promise of reward and hire purchase.

2.Profit: Profit is one of the most important information sources for performance evaluation of economic units that is considered an appropriate indicator for investors' decisions, which can be called as the surplus of income earned over the occurred costs in a fiscal period.

9. Estimation and analysis of results

After gathering information from the branches of Refah Bank in North Khorasan province through referral to the banks, we have tried to calculate the efficiency scores related to the Refah bank branches using the $DEAP_{1.2}$ software and with a multi-step method for the period years of 2009-2011. These results and the conclusions regarding the optimal values of inputs and outputs, which are related to the two constant and variable returns to the scale assumptions, are given in Tables 1 to 10. Also, the optimal values in case of economic efficiency are shown in Tables 11 to 16. All tables are provided in tow CRS and VRS modes.

9.1.The branches' efficiency scores and the type of returns to scale

CRS case

The results related to the efficiency scores in the case of constant return to scale during the years of 2009-2011 are presented in Table 4 as attachment.

In 2009, as seen in table 4, among nine branches of Refah bank in the CRS case, only 3 branches are efficient regarding the technical efficiency. The efficient branches include the central branch in Bojnourd, the Samen branch in Bojnourd and the Shahid branch in Bojnourd. In terms of allocative and economic efficiencies, only two branches of Samen and Shahid in Bojnourd are quite efficient, and the other 7 branches are inefficient. The central branch in Bojnourd is only technically efficient. In other words, this branch is on the frontier production function curve, but is not efficient in regard to allocative and economic efficiencies. This branch can be placed at the production position of Samen and Shahid branches with reducing its costs. In 2010, the central branches in Bojnourd, Esfarayen and Faroj have a technical efficiency equivalent to 1 and are quite efficient, and the other 6 branches are inefficient. Among the inefficient branches, the Shahid branch in Bojnourd with 0.885 efficiency score and the central branch in Jajarm with 0.616 efficiency score allocate the highest and the lowest efficiencies to themselves, respectively. The Esfarayen and Faroj branches are the only branches with full allocative and economic efficiencies, and in addition to placing on the frontier production function curve, they have could achieved their efficient allocation due to their prices. In 2011, the central, Samen and Shahid branches in Bojnourd as well as the branch in Faroj have full technical efficiencies and the other five branches are inefficient. The highest and the lowest values of technical efficiency among the inefficient branches belong respectively to the 17 Shahrivar branch in Bojnourd with 0.876 efficiency score and Shirvan branch with 0.607 efficiency score. The Faroj branch has dedicated to itself full allocative and economic efficiencies during two consecutive years of 2010 and 2011, and the Samen branch in Bojnourd has been able to allocate full allocative and economic efficiencies to itself during two inconsecutive years of 2009 and 2011. The Table 5 in the appendix also provides information on technical efficiency scores, the maximum and minimum scores of inefficiencies in the CRS case for the three studied years. For example, in 2009, the highest technical efficiency among the inefficient branches is related to the Jajarm branch with 0.890 efficiency score, and the lowest is related to the Esfarayen branch with 0.534 efficiency score. In other words, in these two branches, their inputs are capable of producing the same current outputs.

VRS case

The results related to the efficiency scores in the case of variable return to scale and the type of branches returns during the years of 2009-2011 are presented in Table 6 as attachment. In 2009, given the mentioned table, the central, Samen, 17 Shahrivar and Shahid branches in Bojnourd as well as Faroj and Jajarm branches have full technical efficiencies, and the three other branches are inefficient. In terms of allocative and economic efficiencies, the central, Samen and Shahid branches and also the Jajarm branch are efficient. In 2010, as the same as the last year, the central and Shahid branches in Bojnourd and the Jajarm branch are quite efficient regarding the technical efficiency, in which year two Esfarayen and Faroj branches have also been added to these branches that apart from the Shahid branch in Bojnourd, the 4 branches including central in Bojnourd and the Esfarayen, Jajarm and Faroj branches are also efficient in regard to the allocative and economic efficiencies. In 2011, the central, Samen and Shahid branches in Bojnourd as well as the Jajarm and Faroj branches are technically efficient, and among them, only the 4 branches of central and Shahid in Bojnourd, Jajarm and Faroj branches are quite efficient regarding the allocative and economic efficiencies and the five other branches are inefficient. The types of returns to scale of the branches have been presented for the three studied years in Table 7 as appendix. For example, in 2011, the central, Samen and Shahid branches in Bojnourd and also the central branch in Faroj have constant returns to scale, and the central branches in Esfarayen, Shirvan and Ashkhaneh have diminishing returns to scale. The two other branches also have upward returns to scale. Indeed, these features suggest that in the efficient banks with rising returns to scale, development and expansion of banking services using other inputs can make a positive impact on their relative efficiencies in the case of remained fixed conditions in other branches. But, the three branches with constant returns to scale can increase their banking services by using more inputs and maintaining their available relative efficiency. The results related to the technical efficiency average scores, the maximum and the minimum inefficiencies scores and the number of branches with a variety of returns have been presented in table 8 as appendix for the studied period.

9.2.Covariates or auxiliary variables

The Auxiliary variables values of the branches inputs and outputs are presented on the appendix tables for the years of 2009, 2010 and 2011. These values represent the rate of input reduction or the output increase. In fact, these changes are done by moving on the efficient frontier curve, after the reduction of inputs due to the radial motion of the inefficient branches towards the efficiency frontier to resolve the problem of surpluses and obtain the optimal point. The optimal quantities of inputs and outputs are obtained from the following equation (1-4):

$$os = -Y_i + Y\lambda \qquad \& \qquad IS = \theta X_i - X\lambda$$

The X_i and Y_i are respectively the input and output variables and the λ is the branches weight of reference group for the inefficient i branch. The θX_i represents the reduction rate of inputs for inefficient branches through the radial motion. The OS and IS, are the auxiliary input variable and the auxiliary output variable, respectively. For example, based on the appendix table 9 representing the auxiliary input and output values for 2010, the IS_1 and OS_1 for the Bojnourd Samen branch are respectively as zero and 156.234512 million Rials. Thus, the interest rates should reduce as 156.234512 million Rials and no change will be made in the amount of inputs and outputs.

9.3.Reference groups

As previously described, the efficient branches are known as the reference group branches for the inefficient branches. Each of these efficient branches has a weight called as λ. By using the data related to the reference branches a better evaluation can be provided for the inefficient branches. The branches of reference group for each branch and the weight of each of them for two CRS and VRS cases are presented in the attached tables. For example, the reference group related to the 17 Shahrivar branch in Bojnourd (code 3) in 2011, according to the table 10 attached, includes Shahid (code 4) and Samen (code 2) branches in Bojnourd, and given in Table 11 attached, their weights, λ_2, λ_4, respectively, are as 0.225 and 0.799. Thus, based on the equation (1-4), it can be written:

$$\theta_3 X_3 - IS_3 = \lambda_2 X_2 + \lambda_4 X_4$$

$$Y_3 + OS_3 = \lambda_2 X_2 + \lambda_4 X_4$$

The θ is the technical efficiency rate of the Bojnourd Samen branch that has been calculated in Table 6 in attachment. The X and Y are input and output variables, respectively. OS_3 & IS_3, respectively, are the auxiliary input and output variables of the 17 Shahrivar branch in Bojnourd. The inputs and outputs of the 17 Shahrivar branch should be similar to their related reference group branches, meaning, the Shahid and Samen branches in Bojnourd to achieve the technical efficiency. Therefore, the 17 Shahrivar branch in Bojnourd should adjust its inputs and outputs as equivalent to the linear combination of its reference branches. Similarly, it can be shown for all the inefficient branches that how they should use their reference group branches' linear combination to achieve the technical efficiency.

9.4.The optimal values of input and output

The optimal quantities of inputs and outputs for all branches during the years of 2009-2011 for two CRS and VRS mode in case of technical efficiency are provided in the tables 9 and 10 in attachments. These values are determined using reference group branches. Based on the optimal values (target), the management can notify a type of strategy and planning to improve the performance of the inefficient units to each of them. These values will determine that each branch should produce how much output with what level of inputs to achieve the technical efficiency. These optimized values have been obtained using the (1-4) model and above relation. In addition, the optimal values of inputs in the presence of economic efficiency can be seen for years of 2009-2011 in appendix of Tables 11 to 16. Comparing these figures with the optimal values of inputs in the case of technical efficiency, it can be realized that they are different. Thus, the branches can minimize their costs by adjusting their inputs (the deposit rate and the number of personnel) to reach all types of efficiencies.

10. Examining the research hypotheses

In this section, we will examine the research hypotheses according to the obtained results.

First hypothesis: How much the technical efficiency in each of the Refah bank branches in North Khorasan province?

The technical efficiency rates in each of the branches in 2009-2011 years, in two constant and variable returns to scale are as the following table:

Table 23: The technical efficiency scores of the branches during 2009-2011 years in the case of constant returns to scale

	2009	2010	2011
Branch Name	Technical efficiency	Technical efficiency	Technical efficiency
Central in Bojnourd	1	1	1
Samen in Bojnourd	1	0.695	1
17 Shahrivar in Bojnourd	0.845	0.763	0.876
Shahid in Bojnourd	1	0.885	1
Central in Esfarayen	0.534	1	0.806
Central in Shirvan	0.836	0.678	0.607
Central in Ashkhaneh	0.871	0.751	0.845
Central in Faroj	0.680	1	1
Central in Jajarm	0.890	0.616	0.686

Table 24: The technical efficiency scores of the branches during 2009-2011 years in the case of variable returns to scale

	2009	2010	2011
Branch Name	Technical efficiency	Technical efficiency	Technical efficiency
Central in Bojnourd	1	1	1
Samen in Bojnourd	1	0.801	1
17 Shahrivar in Bojnourd	1	0.857	0.880
Shahid in Bojnourd	1	1	1
Central in Esfarayen	0.900	1	0.893
Central in Shirvan	0.840	0.699	0.656
Central in Ashkhaneh	0.883	0.843	0.854
Central in Faroj	1	1	1
Central in Jajarm	1	1	1

Second hypothesis: Are the inputs and outputs values the same in all the branches of Refah Bank in North Khorasan province?

In response to the present hypothesis, as shown by the results, some of the studied bank branches are not efficient in the course of the study, and since in this method, only proper and efficient use of inputs and outputs determines the presence or absence of efficiency is in the branches, it can be concluded that the inefficient banks have not been able to use their inputs and outputs identically. Therefore, the answer to this question of the hypothesis is "NO".

Third hypothesis: How much are the allocative and economic efficiencies in each of the branches of Refah Bank in North Khorasan province?

The rates of allocative and economic efficiencies in each of the branches of Refah bank in North Khorasan province, within the reviewed three years, and in tow cases of constant and variable returns to the scale, are listed as the tables below.

Table 25: The technical and economic efficiencies scores of the branches during 2009-2011 years in the case of constant returns to scale

	2009		2010		2011	
Branch Name	Allocative efficiency	Economic efficiency	Allocative efficiency	Economic efficiency	Allocative efficiency	Economic efficiency
Central in Bojnourd	0.814	0.814	0.633	0.633	0.748	0.748
Samen in Bojnourd	1	1	0.889	0.617	1	1
17 Shahrivar in Bojnourd	0.979	0.828	0.856	0.653	0.785	0.687
Shahid in Bojnourd	1	1	0.569	0.504	0.737	0.737
Central in Esfarayen	1	0.534	1	1	0.955	0.769
Central in Shirvan	1	0.836	1	0.678	1	0.607
Central in Ashkhaneh	1	0.871	0.936	0.703	1	0.845
Central in Faroj	1	0.680	1	1	1	1
Central in Jajarm	1	0.890	1	0.616	1	0.686

Table 26: The technical and economic efficiencies scores of the branches during 2009-2011 years in the case of variable returns to scale

	2009		2010		2011	
Branch Name	Allocative efficiency	Economic efficiency	Allocative efficiency	Economic efficiency	Allocative efficiency	Economic efficiency
Central in Bojnourd	1	1	1	1	1	1
Samen in Bojnourd	1	1	0.812	0.650	1	1
17 Shahrivar in Bojnourd	0.832	0.832	0.782	0.670	0.872	0.767
Shahid in Bojnourd	1	1	0.685	0.685	0.932	0.932
Central in Esfarayen	0.603	0.542	1	1	0.994	0.888
Central in Shirvan	1	0.840	1	0.699	0.997	0.654
Central in Ashkhaneh	1	0.883	0.872	0.735	1	0.854
Central in Faroj	0.734	0.734	1	1	1	1
Central in Jajarm	1	1	1	1	1	1

11.Summary and conclusions

In this study, using envelopment analysis data method, we have studied the status f technical efficiency, allocative efficiency and economic efficiency of Refah bank branches in North Khorasan province during the years 2009-2011, with input-oriented approach and considering two assumptions of constant and variable returns to scale. Base on the research results, the causes of lack of efficiency and how to reach the desired level of efficiency can be noted. The overall results show that during the years of 2009 to 2011, the three-year averages of technical efficiency, allocative efficiency and economic efficiency in the case of constant returns to scale have been respectively as 0.847, 0.922 and 0.775, and in the case of variable returns to scale, respectively as 0.92, 0.93 and 0.865. In other words, in the VRS state, the Refah bank in North Khorasan province has had technical, allocative and economic inefficiencies respectively as 0.08, 0.07 and 0.135 during these three years. Although the efficiency results in the VRS show high average of themselves, but it should be noted that this performance only indicates the short-term efficiency and the efficiency rate in short-term (having a pure technical efficiency) cannot be an appropriate standard for setting the programs for efficiency improvement. This will well reveal the broad range of more suitable planning for efficient-making of the inefficient units.

In this research, according to the input-oriented model nature , it is supposed that the branches managers (Refah Bank in North Khorasan province) have the ability to control the used inputs, so if all inefficient branches have the ability to reduce the inputs based on the suggested values (which with respect to the performance of the homogeneous branches have been determined), they will be able to prevent a significant amount of resources loss at the provincial level, and since the efficiency rates of each unit are measured compared to its almost similar units, then, as appropriate comparison has been made. Therefore, the inefficient units can produce as the same as the current output rate with less input. Also, during the years of 2009 to 2011, respectively, 33%, 33% and 44% of the branches are efficient in both CRS and VRS modes. In other words, only the same branches have the both net technical efficiency and scale simultaneously. In the opposite, during this period, 22%, 11% and 11% of the branches are efficient only in case of VRS. These branches have only the pure technical efficiency and to achieve the optimal efficiency in the long term according to the type of their return to scale, which the model determines for them, need to change the level of their productions that are in fact providing banking services. During the studied three years, two branches of Samen branch in Bojnourd and Faroj branch have been able to maintain their efficiencies in the case of constant returns to scale; so that the Samen branch in Bojnourd has been also efficient in 2009 and 2011, and the Faroj branch has been able to maintain its efficiency in two consecutive years of 2010 and 2011. In the case of variable returns to scale, in addition to the mentioned branches, the central branches in Bojnourd and Jajarm, which were efficient in 2009, have been able to maintain their efficiencies up to 2011. As seen, the numbers of efficient branches established in small cities have allocated an equal contribution to themselves compared to the efficient branches in Bojnourd city, so that have allocated 50% of the efficient banks to themselves in CRS case, and also 50% in VRS case. It seems that these branches using the lower input than their output have succeeded to gain higher efficiency scores, while the Bojnourd branches despite their high volume output, have failed in gaining the optimal efficiency due to their inadequate allocation of inputs. The gap between the average technical efficiency of the province branches and the best performance in the province in the CRS and VRS modes requires additional ancillary studies to be done in order to detect the causes of such a gap; however, in this regard, the opinions of experts and Bank staff and their perspectives should also be considered. According to the attached tables during the reviewed years, the Bojnourd central, Samen and Shahid branches as well as the Faroj branch, in the CRS mode, have been as the reference branches respectively with the mean frequencies of 3, 8, 11 and 9, while in the VRS mode, the Bojnourd central, Samen and Shahid branches as well as the Faroj and Jajarm branches with the number of frequencies as 8, 6, 6, 11 and 6 are considered as such successful branches. Finally it is necessary to emphasize that the concepts of efficiency and inefficiency in this study are relative, and what is clear regarding the data envelopment analysis method is that the efficiency frontier in this method is purely developed based on the performance of existing branches in studied samples, and performance rate of each of the branches will be measured and compared in comparison with other branches of the same sample. In this study, certainly, with entering the Refah bank branches in other provinces into the sample studied, the efficiency scores obtained for each of the branches of Refah Bank in North Khorassan province will be affected.

12.Suggestions

Since one of the most important strategies in Refah bank is to improve the performance indicators and due to its major role in the financial markets of the province, the review of its branches efficiencies status has been considered as the main objective and issue in this research. Using data envelopment analysis method and its results can guide the branches' managers in how to allocate the resources optimally and help them about its accelerating procedures. Therefore, due to the scope of the review and the current research findings, some recommendations are provided as the following:

1.The branches managers can use the reference points and the weights corresponding to each of them and with setting of the target points (optimized) to take action in order to improve the performance of their inefficient branches.

2.Creating the infrastructure necessary to achieve the target points such as expanding the mechanization system and electronic services that will lead to lower costs, would be an effective step toward the improving process of the branches efficiency.

3.Further studies on inefficient branches can develop the improvement programs and efficiency improvement in these units with more success. In this regard, some programs to increase efficiency should be provided, formulated and implemented even for the efficient branches.

4.Establishment of an appropriate and principle-based evaluation system is one effective way to create healthy competition areas among the branches, and thus, raising the incentive for increasing the efficiency.

5.In this study, the optimization of the objective function has been done due to two assumptions of constant returns to scale (CRS) and variable returns to scale (VRS). Due to the presented discussions we know that the CRS assumption will follow the long-term goals and the VRS assumption will follow the short-term goals. Thus, the units efficient in CRS mode have pure technical efficiency and scale efficiency simultaneously. But the units efficient in case of VRS only have pure technical efficiency. Therefore, short and long term objectives can be developed for the studied branches with the hope by achieving such goals, the technical efficiency of the branches will be increased.

6.To increase the economic efficiency, given the relevant optimal points, the necessary actions should be done to adjust the inputs with regard to their prices.

12.1.Research proposals

The present research has studied the status of technical efficiency, allocative efficiency and economic efficiency in the branches of the Refah Bank in North Khorasan province. Accessory studies such as review the efficiency of banking services quality and the profitability efficiency besides the measurement of production efficiency and cost of branches can evaluate the units' performance from other aspects, which are all complementary to one another. It is also recommended to use the SFA approach in subsequent studies, since other aspects of their efficiencies will be determined. In addition, to improve the performance of branches, measures such as efficient use of inputs used in branches (such as labor and capital), creating the appropriate field to move towards the optimum scale for providing banking services, and using appropriate tools to enhance the level of managerial efficiency (gross efficiency) of the branches are essential.

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Appendix Tables

Table 1: Input and output data bank in 2009

Deposits (Million rials)	Personnel (N)	profit (Million rials)	Facility in exchange contracts (million rials)	Name of Branch
615355	9	445690	563839	Markazi Bojnourd
114244	6	132786	101145	Samen Bojnourd
231893	5	190521	216014	17shahrivar Bojnourd
312064	7	327650	351205	Shahid Bojnourd
207141	5	100988	124534	Esfaraien
242352	8	200643	228102	Shirvan
134721	7	116548	132023	Ashkhaneh
43130	4	29300	33011	Farooj
22083	5	20599	22123	Jajarm

Table 2: Input and output data bank in 2010

Deposits (Million rials)	Personnel (N)	profit (Million rials)	Facility in exchange contracts (million rials)	Name of Branch
532326	11	239087	547626	Markazi Bojnourd
143272	7	150987	142312	Samen Bojnourd
156162	7	141920	165728	17shahrivar Bojnourd
332033	7	256435	271823	Shahid

				Bojnourd
117117	7	181070	190237	Esfaraien
146313	11	140764	161032	Shirvan
131532	7	139410	150121	Ashkhaneh
63452	4	543905	61142	Farooj
41312	5	39265	41312	Jajarm

Table 3: Input and output data bank in 2011

Deposits (Million rials)	Personnel (N)	profit (Million rials)	Facility in exchange contracts (million rials)	Name of Branch
107025	11	145230	168650	Markazi Bojnourd
21280	8	56089	41325	Samen Bojnourd
38922	8	65009	53541	17shahrivar Bojnourd
58139	7	89760	90153	Shahid Bojnourd
32174	8	43608	52147	Esfaraien
31416	11	37521	40152	Shirvan
17416	7	29875	31021	Ashkhaneh
14252	4	29656	30031	Farooj
13841	5	18546	20013	Jajarm

Table 4: Performance scores of branches during 2009 to 2011 at constant returns to scale (CRS)

2011	2010	2009	

Economic efficiency	Allocative efficiency	Technical performance	Economic efficiency	Allocative efficiency	Technical performance	Economic efficiency	Allocative efficiency	Technical performance	Name of Branch
0.748	0.748	1	0.633	0.633	1	0.814	0.814	1	Markazi Bojnourd
1	1	1	0.617	0.889	0.695	1	1	1	Samen Bojnourd
0.687	0.785	0.876	0.653	0.856	0.763	0.828	0.979	0.845	17shahrivar Bojnourd
0.737	0.737	1	0.504	0.569	0.885	1	1	1	Shahid Bojnourd
0.769	0.955	0.806	1	1	1	0.534	1	0.534	Esfaraien
0.607	1	0.607	0.678	1	0.678	0.836	1	0.836	Shirvan
0.845	1	0.845	0.703	0.936	0.751	0.871	1	0.871	Ashkhaneh
1	1	1	1	1	1	0.680	1	0.680	Farooj
0.686	1	0.686	0.616	1	0.616	0.890	1	0.890	Jajarm

Table 5: Results of the technical performance of branches in a state of constant returns to scale

Between the branches of a maximum score of inefficient	Minimum score of inefficient branches	Number of efficient branches	Efficiency scores	year
0.890	0.534	3	0.851	2009
0.269	0.098	1	0.253	2010
0.996	0.679	3	0.844	2011

Table 6: Performance scores of branches during 2009-2011in the case of variable returns to scale (VRS)

2011	2010	2009	

Economic efficiency	Allocative efficiency	Technical performance	Economic efficiency	Allocative efficiency	Technical performance	Economic efficiency	Allocative efficiency	Technical performance	Name of Branch
1	1	1	1	1	1	1	1	1	Markazi Bojnourd
1	1	1	0.650	0.812	0.801	1	1	1	Samen Bojnourd
0.767	0.872	0.880	0.670	0.782	0.857	0.832	0.832	1	17shahrivar Bojnourd
0.932	0.932	1	0.685	0.685	1	1	1	1	Shahid Bojnourd
0.888	0.994	0.893	1	1	1	0.542	0.603	0.900	Esfaraien
0.654	0.997	0.656	0.699	1	0.699	0.840	1	0.840	Shirvan
0.854	1	0.854	0.735	0.872	0.843	0.883	1	0.883	Ashkhaneh
1	1	1	1	1	1	0.734	0.734	1	Farooj
1	1	1	1	1	1	1	1	1	Jajarm

Table 7: Type-scale return to the branches for the years 2009 to 2011

2011	2010	2009	Name of Branch
Fixed	Fixed	Fixed	Markazi Bojnourd
Fixed	Ascending	Fixed	Samen Bojnourd
Ascending	Ascending	Ascending	17shahrivar Bojnourd
Fixed	Ascending	Fixed	Shahid Bojnourd
Descending	Fixed	Ascending	Esfaraien

Descending	Ascending	Ascending	Shirvan
Descending	Ascending	Ascending	Ashkhaneh
Fixed	Fixed	Ascending	Farooj
Ascending	Ascending	Ascending	Jajarm

Table 8: Results of the technical performance of branches in the case of variable returns to scale in 2009-2011years

Number of crs branches	Number of drs branches	Number of Irs branches	Between the branches of a maximum score of inefficient	Minimum score of inefficient branches	Number of efficient branches	Efficiency scores	year
3	0	6	0.900	0.840	6	0.958	**2009**
3	0	6	0.857	0.699	5	0.911	**2010**
4	3	2	0.893	0.656	5	0.920	**2011**

Table (9): input and output values of auxiliary variables in different branches of the VRS for the year 2010

Facility in exchange contracts (million rials)	profit (Million rials)	Personnel (N)	Deposits (Million rials)	Name of Branch
0	0	0	0	Markazi Bojnourd
0	234512.156	0	0	Samen Bojnourd
0	215042.130	0	0	17shahrivar Bojnourd
0	0	0	0	Shahid Bojnourd
0	0	0	0	Esfaraien
0	12497.271	1.080	0	Shirvan

0	195909.159	0	0	Ashkhaneh
0	0	0	0	Farooj
0	0	0	0	Jajarm

Table 10: Code reference branches in CRS for 2011

Branch code for each branch of a member of reference group			Branch Code	Name of Branch
		1	1	Markazi Bojnourd
		2	2	Samen Bojnourd
	2	4	3	17shahrivar Bojnourd
		4	4	Shahid Bojnourd
	2	4	5	Esfaraien
		2	6	Shirvan
		2	7	Ashkhaneh
	2	4	8	Farooj
		2	9	Jajarm

Table 11: Weight of branches in the Reference Group for CRS 2011

Branch code for each branch of a member of reference group			Branch Code	Name of Branch
		1	1	Markazi Bojnourd
		1	2	Samen Bojnourd
	0.799	0.225	3	17shahrivar Bojnourd
		1	4	Shahid Bojnourd
	0.560	0.136	5	Esfaraien
		0.669	6	Shirvan

		0.533	7	Ashkhaneh
	0.294	0.147	8	Farooj
		0.331	9	Jajarm

Table (12): The optimal values of input and output variables of different branches of the CRS for the years 2009 to 2011

Facility in exchange contracts (million rials)	profit (Million rials)	Personnel (N)	Deposits (Million rials)	year	Name of Branch
563839	445690	9	615355	2009	Markazi Bojnourd
	239087	1.758	26876.490	2010	
	145230	11	168650	2011	
101145	132786	6	114244	2009	Samen Bojnourd
	150987	1.110	16972.904	2010	
	56089	8	41325	2011	
216014	198675.475	4.226	195997.675	2009	17shahrivar Bojnourd
	141920	1.044	15953.655	2010	
	65009	7.965	53307.882	2011	
351205	327650	7	312064	2009	Shahid Bojnourd
	256435	1.886	28826.631	2010	
	89760	7	90153	2011	
124534	116181.618	2.482	110654	2009	Esfaraien
	181070	1.332	20354.624	2010	
	43608	5.430	35397.284	2011	
228102	212803.406	4.546	202680.550	2009	Shirvan
	140764	1.035	15823.705	2010	
	37521	5.352	27644.553	2011	
132023	123168.337	2.631	117309.336	2009	Ashkhaneh

	139410	1.025	15671.498	2010	
	29875	4.261	22011.168	2011	
33011	30796.982	0.658	29331.999	2009	Farooj
	543905	4	61142	2010	
	29656	3.379	25370.811	2011	
22123	20639.231	0.441	19657.442	2009	Jajarm
	39265	4413.897	0.289	2010	
	18546	2.645	13664.238	2011	

Table (13): The optimal values of input and output variables of different branches of the VRS for the years 2009 to 2011

Facility in exchange contracts (million rials)	profit (Million rials)	Personnel (N)	Deposits (Million rials)	Year	Name of Branch
263839	445690	9	615355	2009	Markazi Bojnourd
547626	239087	11	532326	2010	
168650	145230	11	1070125	2011	
101145	132786	6	114244	2009	Samen Bojnourd
142312	385499.156	5.604	114694.029	2010	
41325	56089	8	21280	2011	
216014	190521	5	231893	2009	17shahrivar Bojnourd
165728	356952.130	5.997	133782.827	2010	
58202.533	65009	7.037	34238.762	2011	
351205	327650	7	312064	2009	Shahid Bojnourd
271823	256435	7	332033	2010	
90153	89760	7	58139	2011	
124534	109929.441	4.500	137533.677	2009	Esfaraien
190237	181070	7	117117	2010	

52147	58163.323	7.146	28739.5	2011	
228102	212788.357	6.252	203587.903	2009	Shirvan
161032	15326.271	6.608	102251	2010	
40152	51512.063	7.215	20607.190	2011	
132023	123141.542	5.668	118924.857	2009	Ashkhaneh
150121	335319.159	5.900	110855.202	2010	
31021	31973.042	4.351	14868.055	2011	
33011	29300	4	43130	2009	Farooj
61142	543905	4	63452	2010	
30031	29656	4	14252	2011	
22123	20599	5	22083	2009	Jajarm
41312	39265	5	41312	2010	
20013	18546	5	13841	2011	

Table 14: Optimal values for the minimum cost of inputs in different branches of the CRS for the year 2009

Personnel (N)	Deposits (Million rials)	Name of Branch
9	615355	Markazi Bojnourd
6	114244	Samen Bojnourd
4.226	195997.675	17shahrivar Bojnourd
7	312064	Shahid Bojnourd
2.482	110654	Esfaraien
4.546	202680.550	Shirvan

2.631	117309.336	Ashkhaneh
0.658	29331.999	Farooj
0.441	19657.442	Jajarm

Table 15: Optimal values for the minimum cost of inputs in different branches of the CRS for 2010

Personnel (N)	Deposits (Million rials)	Name of Branch
1.758	26876.490	Markazi Bojnourd
1.110	16972.904	Samen Bojnourd
1.044	15953.655	17shahrivar Bojnourd
1.886	28826.631	Shahid Bojnourd
1.332	20354.624	Esfaraien
1.035	15823.705	Shirvan
1.025	15671.498	Ashkhaneh
4	61142	Farooj
0.289	4413.897	Jajarm

Table 16: Optimal values for the minimum cost of inputs in different branches of the CRS for 2011

Personnel (N)	Deposits (Million rials)	Name of Branch
11	168650	Markazi Bojnourd
8	41325	Samen Bojnourd
7.967	53307.882	17shahrivar

		Bojnourd
7	90153	Shahid Bojnourd
5.430	35397.284	Esfaraien
5.352	27644.553	Shirvan
4.261	22011.168	Ashkhaneh
3.379	25370.811	Farooj
2.645	13664.238	Jajarm

Table 17: Optimal values for the minimum cost of inputs in different branches of the VRS for the year 2009

Personnel (N)	Deposits (Million rials)	Name of Branch
9	615355	Markazi Bojnourd
6	114244	Samen Bojnourd
5	231893	17shahrivar Bojnourd
7	312064	Shahid Bojnourd
4.500	137533.677	Esfaraien
6.252	203587.903	Shirvan
5.668	118924.857	Ashkhaneh
4	43130	Farooj
5	22083	Jajarm

Table 18: Optimal values for the minimum cost of inputs in different branches of the VRS for the year 2010

Personnel (N)	Deposits (Million rials)	Name of Branch
11	532326	Markazi Bojnourd
5.604	114694.029	Samen Bojnourd
5.997	133782.827	17shahrivar Bojnourd
7	332033	Shahid Bojnourd
7	117117	Esfaraien
6.608	102251	Shirvan
5.900	110855.202	Ashkhaneh
4	63452	Farooj
5	41312	Jajarm

Table 19: Optimal values for the minimum cost of inputs in different branches of the VRS for the year 2011

Personnel (N)	Deposits (Million rials)	Name of Branch
11	107025	Markazi Bojnourd
8	21280	Samen Bojnourd
7.037	34238.762	17shahrivar Bojnourd
7	58139	Shahid Bojnourd
7.146	2839.500	Esfaraien

7.215	20607.190	Shirvan
4.351	14868.055	Ashkhaneh
4	14252	Farooj
5	13841	Jajarm

Table (20): data inputs branches price (million rials) in 2009

Price of deposits	Personnel Costs	Name of Branch
435670	90	Markazi Bojnourd
105439	80	Samen Bojnourd
193002	90	17shahrivar Bojnourd
287650	100	Shahid Bojnourd
187100	80	Esfaraien
226547	140	Shirvan
104521	120	Ashkhaneh
38940	120	Farooj
18760	110	Jajarm

Table (21): input price data branches (million rials) in 2010

Deposits		Personnel		Name of Branch
Fixed price	Current prices	Fixed price	Current prices	
302795.1	335693	297.97	330	Markazi Bojnourd

114175.2	126580	90.2	100	Samen Bojnourd
122581.8	135900	153.34	170	17shahrivar Bojnourd
265673.3	294538	126.28	140	Shahid Bojnourd
89076.11	98754	126.28	140	Esfaraien
113171.2	125467	162.36	180	Shirvan
81191.73	90013	126.28	140	Ashkhaneh
53300.08	59091	126.28	140	Farooj
35358.4	39200	126.28	140	Jajarm

Table (22): input price data branches (million rials) in 2011

Deposits		Personnel		Name of Branch
Fixed price	Current prices	Fixed price	Current prices	
80230.36	99870	273.1384	340	Markazi Bojnourd
13262.47	16509	144.6027	180	Samen Bojnourd
24687.69	30731	192.8036	240	17shahrivar Bojnourd
40514.45	50432	152.6362	190	Shahid Bojnourd
22015.75	27405	144.6027	180	Esfaraien
23969.49	29837	160.6697	200	Shirvan
11238.04	13989	112.4688	140	Ashkhaneh
8734.803	10873	112.4688	140	Farooj
812.208	10098	120.5023	150	Jajarm