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Measurement of the Efficiency of Bank Branches using Data Envelopment Analysis based on Balanced Scorecard

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Abstract
Background: Over the years, financial institutions, especially banks, have been placed in an almost developing competitive environment as one of the most underlying components of the economic system of the state. Hence, the measurement of the efficiency of banks has been the priority in the studies of the recent decade.
Purpose: The present study is aimed at measuring the relative efficiency of Bank Branches in Tehran.
Method/Approach: To this end, the library studies are used first to derive the desired indicators and are regulated based on a Balanced Scorecard (BSC). Then, some indicators were confirmed using the opinions of experts and were regulated based on inputs and outputs. Finally, the measurement of the efficiency of the said branches was done using Data Envelopment Analysis (DEA) and based on Balanced Scorecard (BSC).
Findings: As a result, out of the 73 branches studied, the relative efficiency of 30 branches was at a maximum level equal to 1. In other words, 30 branches were recognized as efficient ones. The other 43 branches gained efficiency in the range 0.69506 to 099714, which is relatively high efficiency.

Keywords
efficiency, Data Envelopment Analysis, Balanced Scorecard.

Introduction

Over the years, financial institutions, especially banks, have been placed in a relatively developing competitive environment as one of the most underlying components of the economic system in Iran. Banks are commercial entities that take financial mediation and distribute excess liquidity among different economic factors. In terms of microeconomics and macroeconomics, the major functions of banks include using deposits and other debts of individuals or firms as excess resources and allocating them in the form of loans and other assets to economic brokers, who lack such resources (Jiménez-Hernández et al., 2019, p.185).

The banking industry, same as other industries, has encountered many impulsions by the mediation of recent financial crises at the international and national levels. The impulsions have raised the question of how efficient the banking system and its function are based on the capital consumed for the establishment and developmental strategies (Majumder & Li, 2018). Here, the question of performance and efficiency measurement of the banking system on the establishment of different branches and managing them (as a consequence of development strategy) gains a more serious aspect, because bank branches are the major heavy physical assets (Dranove et al., 2017). These assets can decrease the reaction power of banks in financial crises, and prevent the agility and dynamicity of the management system of the economic institute. Hence, studying the issue of bank branch efficiency and the evaluation of bank strategies in this field is required using reliable methods and instruments in strategy knowledge.

However, it should be reminded that the issue of "performance" is underlying not only in crises such as the said financial crisis, but also the impact of performance management on various organizational departments such as finance departments and manpower department, and its impact on social and environmental aspects of the organization has been the subject of discussions of managers and experts in the field of management (Xiao et al. 2018, p.325). However, when the companies encounter developing competitive challenges, they increase the effort to consider the performance and to enhance the performance indicators, and the scholars pay specific attention to this issue ultimately (Hauff, Alewell & Hansen, 2017). Performance is one of the vital activities of every organization, which is affected by major policies and procedures of the organization (Marzouk & Saleem, 2018, p.1308). Hence, careful and academic evaluation can provide accurate results.

According to the significance of the banking system in current economic conditions, and due to the efforts of beneficiaries to improve the performance indicators, such as the efficiency of different economic firms, such as banks, this study tends to use the Data Envelopment Analysis (DEA) method based on Balanced Scorecard (BSC) to measure the efficiency of bank Branches in Tehran Province. In other words, this study first derived the efficiency measurement indices using the DEA method based on BSC. Then, the branches of the studied bank were ranked based on the combined method.

1. Literature Review

1-1. Performance management

Performance management is one of the issues that have been noted from the past to the date whether in the field of implementation of research. In terms of implementation, a performance management system (PMS) is today being used in about 90% of large companies (Cascio, 2006). In terms of research, about 1915 articles were published during 1980-2017 on performance on academic bases and credited magazines in the field of management (Schleicher et al. 2018). In these articles, three levels are mentioned for performance, including individual, team, and organizational performance (Guinot and Chiva, 2019). Although there are agreements on definitions of two individual and team levels, there are again disputes on the definition of organizational performance. Individual performance is defined as the scalable measures, behaviors, and outputs, which are associated with goals, and the employees try to help the realization of these goals by the advent of these factors. Also, team performance refers to the level of the working standards determined within the organization (Guinot and Chiva, 2019). On the organizational performance, however, it could be claimed that the term refers to the achievement of organizational goals efficiently (Civelek et al., 2015).

Added to the definition of different levels, one aspect of management is mostly emphasized in each period in terms of process. However, the most agreed-upon thing can be the tasks determined for a performance management system (PMS). PMS is responsible for specifying performance expectations, monitoring the performance of the company and the employees, collecting performance-related information, performance appraisal, providing feedback, and codifying training plans to promote organizational performance (Schleicher et al., 2018).

1-1-1. Performance Evaluation

The history of performance evaluation dates back to the early 1800th century and the cotton manufacturing factories in the UK. However, performance

evaluation was spread mostly after World War II, and today it is being used by employers widely (Cappelli & Conyon, 2017). According to a survey made by Aberdeen Group (2010), 91% of employers in the world use various methods of performance evaluation. Various criteria have been mentioned to date for the performance evaluation, including objective criteria such as efficiency, effectiveness, profitability, return on investment, and business growth, and subjective criteria such as quality, innovation, customer satisfaction, and so on (Guinot and Chiva, 2019). In general, the performance evaluation system can be analyzed from different aspects. Two underlying views are available on performance evaluation: traditional and modern views. In the traditional view, the underlying purpose of the evaluation is judgment and performance evaluation. However, the modern view has made the philosophy of evaluation focused on the growth and development, and improvement of evaluated capacity. The differences between traditional and modern criteria are presented in Table1. The modern indicators are new objectified performance evaluation systems (Najafi et al., 2008).

Table 1. Differentiation of evaluation criteria in traditional and modern attitudes

specifications	judgment-oriented (performance reminder – traditional view)	development-oriented (performance improvement – modern view)
The role of the evaluator	performance judgment and measurement (judge)	counselor and performance facilitator
appraisal period	past	future
appraisal standards	the opinion of the organization and senior directors	self-standardization
man's evaluation goal	controlling the evaluated	development of the capacity of the evaluated factor
system output	performance control	performance growth, development, and improvement
evaluation results	determination of the most successful managers and rewarding them	providing counseling services for the continuous and increasing improvement of activities (making incentives to improve quality and services, and activities)
post-evaluation interviewing style	command (similar to a trial)	conversation

1-2. Performance management

As the concept of efficiency is one of the most underlying and oldest concepts in the field of management and is discussed in the literature of management in detail, here the author is satisfied with just a definition relevant to the Data Envelopment Analysis (DEA) technique. Concerning the said technique as the method used in this work, efficiency can be divided into the following types (Zolanvari, 2012, p.13):

a) Economic efficiency (EE): It is the ratio of the applicable product to the resources used to produce the product. Farrell believes that economic efficiency includes two components of technical and allocative efficiencies.

b) Technical efficiency (TE): It reflects the ability of a firm to obtain maximum output from the applied inputs. The efficiency is affected by factors such as performance management, organizational scale, or operational size.

c) Allocation efficiency (AE): It reflects the ability of a firm to use inputs in an optimized ratio based on price and production technology. In Figure 1, the three efficiencies are illustrated.

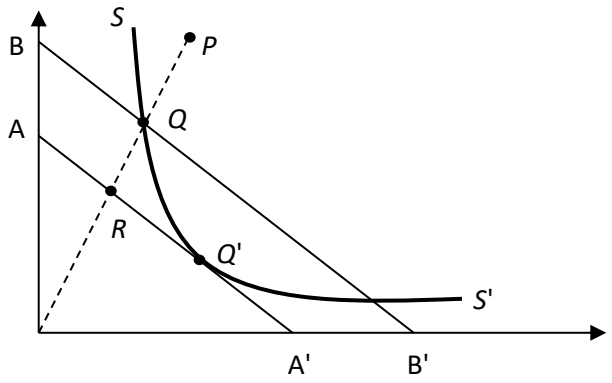

Figure 1

$$Economic\ Efficiency:\ EE_i = TE_i \times AE_I = \frac{OR}{OP} \quad (1)$$

$$technical\ efficiency\ of\ firm\ p:\ TE_i = \frac{OQ}{OP} \quad (2)$$

$$allocation\ efficiency\ of\ firm\ p: AE_i = \frac{OR}{OQ} \quad (3)$$

d) Structural efficiency (SE): Structural efficiency is usually used to measure the efficiency of an industry with various firms operating there. Accordingly, the structural efficiency of an industry is realized from the average efficiency of active firms. Hence, if the efficiency of firm j is shown as E_j and the weight given to the firm is shown as $Wj = \frac{qj}{Q}$, the structural efficiency is estimated as:

$$SE = \sum_{j=1}^{n}(w_j \times E_j) \quad (4)$$

Where q is the amount of product in firm j, and Q is the product in the whole industry.

Studying the issue of efficiency, especially in the banking industry, has developed significantly over the decade (Jiménez-Hernández et al., 2019). Hence, more than 100 articles, books, and dissertations can be referred to in the literature (Zolanvari, 2010), which is out of boredom of the article. However, due to the research background, the works done over the four years in Iran and abroad are mentioned here, and a conclusion is presented at the end of this section concerning the subject of this study.

Shakouri, Salahi & Kordrostami (2020) have studied the stability of efficiency scores in the DEA method in the banking sector. In this study, the classic model of DEA was analyzed in summary. After that, the DEA p-robust model was introduced, and the prior weight of each scenario for the DEA was estimated. To measure the prior weight of criteria in wider scenarios, the Analytic Hierarchy Process (AHP) was used. Jiménez-Hernández et al (2019) studied the efficiency of Latin American Banks. The purpose of this paper is to analyze a variety of factors that can explain the differences in commercial bank efficiency among 17 countries in Latin America (LatAm) among 409 banks for the 2014-2016 period. Findings from the first stage scores reveal the heterogeneity of average efficiency within the region. The results allow us to state that certain internal variables, such as bank size, the ratio of loans to total assets, and the ratio of non-performing loans, show the expected relationship to efficiency, in line with much of the previous literature.

Aiello & Bonanno (2018) conducted a study under the title of "On the Sources of Heterogeneity in Banking Efficiency Literature". The meta-dataset consists of 1661 observations retrieved from 120 papers published over the period 2000–2014. The results showed that parametric methods always yield lower levels of banking efficiency than non-parametric studies. Isavi et al. (2018) conducted a study under the title of "Relationship between stability indicators and technical efficiency of Iranian banks during the year

(2004-2016)". In this study, the authors analyzed the relationship between stability indicators and efficiency in 11 public and private banks during 2004-2016. The efficiency of banks was measured using the DEA and the mediational approach. Also, to measure bank stability, indicators including credit risk and liquidity risk were used. The results revealed that the improvement of stability indicators can decrease bank efficiency. This shows the inefficient performance of banks in selecting such a portfolio to improve efficiency and decrease risk simultaneously.

As mentioned before, to prevent redundancy, the results of the relevant studies are presented in the end of the literature instead of explaining each study in details: the deposit in branch, the paid facilities, the import and export bonds, the warrantees, the receivables (delayed, unpaid, and overdue receivables), net profit received from facilities, miscellaneous income, net fee received, the amount of securities distributed in the branch, credits, number of current accounts, number of saving accounts, number of issued bank cards, average waiting time to issue a bank card, number of facilities paid in the branch, average waiting time for bank customers, number of branch customers, active to stagnant accounts ratio, number of cheques issued, evaluation of branch by the customers, manpower expenses (wage and salary of branch personnel), average number of transactions per week, number of computer equipment in the branch, number of counters providing banking services to customers, value of monument and facilities of the branch, current expenses, transaction speed, experience of branch personnel (year), number of training courses for personnel, antiquity of the branch, job circulation of personnel, personnel group promotion rate, and personnel fraud rate (Zolanvari, 2010).

1-3. Strategy controlling

Usually, there is a long time gap between beginning strategy implementation and the achievement of desired results. During the period, various projects are implemented, and different investments are made. Controlling strategies to conduct the organization throughout the event are required. Such controls should provide guidelines to correct the measures and orientations of the organizations to implement the strategy and to cope with the evolutions in environmental and in-organization situations (Kordnaeij, 2017, p.429). Strategy controlling is divided into four groups including default control (on the predictions and strategy codification assumptions), implementation control (on lack of changing overall strategies and lack of violating them while implementation), strategic control (on supervising a wide range of

internal and external events threatening the strategy), and specific knowledge control (on unexpected events) (Kordnaeij, 2017, pp.430-431).

1-3-1. Balanced Scorecard (BSC)

Various instruments are available to control strategy and realize operational goals, and this study has applied the BSC method for this purpose. Four generations of BSC have been introduced to date. The first-generation BSC is used to provide a series of measures to balance the goals of stockholders, customer goals, and operational goals. The measures include learning and growth perspective (the effect of innovation and learning on organizational performance), the business process perspective (unemployment time, job circulation time, and profitability), customer perspective (customer satisfaction), and financial perspective (with criteria such as cash flow, return on investment, and income growth) (Kordnaeij, 2017, p.433). The second-generation BSC was founded in 1996 in an article under the title "Connecting BSC to strategy". Kaplan and Norton added new specifications to the second-generation to increase the strategic communications in this instrument and founded the third-generation. The considerations were associated with the accuracy and reliability of selecting strategic goals directly from the strategies and determining goals quantitatively. Finally, the fourth-generation BSC was introduced in 2008 as a comprehensive management system. Introducing this generation caused the integration of a wide range of strategy codification and performance management instruments, including mission statements, perspectives, strategy codification methodologies, dynamic budget, resource allocation, process improvement, spontaneous strategies, and economic-statistical analytic instruments (Kaplan and Norton, 2009, p.85). It should be mentioned that the instrument was used in 2009, 2010, 2012, and 2013 in the banking system of three countries, including Taiwan, Jordan, Iraq, and India (Kordnaeij et al. 2015, p.123).

2. Methodology

The present study is fundamental and slightly aligned with post-positivist philosophy in terms of typology. Besides, in terms of nature, this is descriptive-applied research. In terms of method, the library method was used for data collection based on the type of data. To obtain the indicators, library sources were used, and the official statistics in Bank were used to gain statistical data. After data collection, the DEA method was used for data analysis, along with the Anderson-Pearson Method.

In the following, three methods, including data envelopment analysis (DEA), Anderson-Pearson method, and the DEA-BSC combined method, are explained.

2-1. Data Envelopment Analysis (DEA)

The scholars in the field of performance evaluation have provided different definitions of DEA:

Charnes, Cooper& Rohdes, as the founders of the DEA method, have defined it as a nonlinear planning model, which has provided a new definition of efficiency to be used in the evaluation of the activity of non-profit institutes participating in public plans (Charnes et al., 1978, p.429). In another definition, Data Envelopment Analysis is introduced as a method for mathematical planning, which measures the relative efficiency of several decision-making units (DMU) based on the inputs and outputs and due to different measurement units (Hosseinzadeh Lotfi et al., 2010, 1977). Contreras (2020) has provided a review of this method and has mentioned that DEA is a mathematical planning technique, which measures the relative efficiency of multiple decision-making units based on the observed inputs and outputs expressed probably by types of metrics.

Farrell (1957) introduced the efficiency measurement method in a work based on economic theories (Farrell, 1957, 290: 253). However, because of practical problems in measurement and limitations in Farrell's method (constant returns-to-scale efficiency), the method could not be applied practically. The instrument considers a boundary based on the data received from DMUs and divides the decision-maker units into two efficient and inefficient groups based on the boundary. In this method, efficiency is measured by the ratio of the total weight of outputs (real outputs) to the total weight of inputs (real inputs) and can possess values in the range (0-1) (Ketkar et al. 2003, 513). The technique is recognized in the three decades as an applicable and efficient technique for the measurement of performance of banks, insurance branches, cooperative funds, educational centers, medical centers, and similar institutions (Vassiloglou et al. 1990, 591).

Data Envelopment Method (DEA) was added to economic literature by CCR through the generalization of Farrell's method in such a way that it can encompass the characteristics of production processes with multiple production factors and multiple products. The method, which is mostly recognized as an efficient measurement method in the world, provides the return to production scale efficiency, separated for firms, while measuring efficiency. With the advancement of this method, DEA is now one of the active research fields for efficiency measurement and is significantly

welcomed by scholars. This method is highly applicable for the performance evaluation of public and non-profit organizations, the price information of which is unavailable or unreliable. In this method, the term "decision-maker" (decision-making unit or decision-maker unit) is mostly used instead of the term "producer" for generalization (Zolanvari, 2012).

Figure 2 illustrates the situations of DMUs with one output and one input. Three DMUs are specified to measure their management efficiency. The production function expresses the maximum output produced by a certain value. DMUs P1 and P2 obtained the maximum output possible based on their input levels; however, P3 obtained a lower level of output compared to the output that can be obtained from input X3. To measure the efficiency of units with one input and one output, let's have:

$$\boldsymbol{Max\ h_{\circ}} = \frac{\boldsymbol{uy_1}}{\boldsymbol{vx_1}}$$

St:

$$\mathbf{1} \geq \frac{\boldsymbol{uy_1}}{\boldsymbol{vx_1}} \qquad \mathbf{1} \geq \frac{\boldsymbol{uy_2}}{\boldsymbol{vx_2}} \qquad \mathbf{1} \geq \frac{\boldsymbol{uy_3}}{\boldsymbol{vx_3}} \qquad \boldsymbol{u, v} > \mathbf{0} \qquad (5)$$

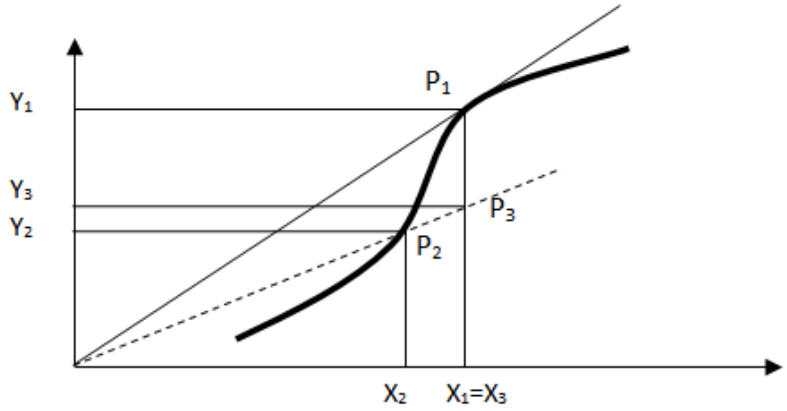

Figure 2. The diagram of the position of DMUs with one input and one output

In eq.5, $\mathbf{x_i}$ and $\mathbf{y_i}$ values show the coordinates of inputs and outputs relevant to the DMUs of Pi per i=1,2,3. As it is illustrated in the figure, the line slope tangent to the production function at point P1 is more than the crossed line of the production function at points P2 and P3. This means that DMU associated with P1 is efficient, and the other two DMUs are inefficient. Let's have (Banker et al. 1984, 1080: 1079):

$$\frac{u^* y_1}{v^* x_1} = 1 \qquad \frac{u^* y_2}{v^* x_2} = \frac{u^* y_3}{v^* x_3} < 1 \tag{6}$$

Finally, Banker, Charnes, and Cooper (1984) changed the CCR model and supplied a new model, which became known as the BCC model due to the first letters of their names. The BCC model is a model of DEA-type models, which evaluates the relative variable returns-to-scale efficiency. The constant returns-to-scale efficiency models are more restrictive than the variable returns-to-scale efficiency models. This is because constant return-to-scale efficiency encompasses fewer efficient units, and the efficiency decreases. The reason for this can be the specific nature of constant returns-to-scale efficiency compared to variable returns-to-scale efficiency.

2-2. the combined approach of DEA-BSC

Efficiency can be measured based on the total weight of the outputs to a total weight of the inputs. In the majority of relevant studies, the inputs and outputs are derived based on a series of financial and quantitative criteria. No certain process is defined for the determination of the criteria (Zolanvari, 2012). The efficiency of bank branches refers to the capacity of that branch to obtain maximum output from a certain amount of inputs. In the traditional approach, different analyses are provided using various financial ratios (such as return on assets (ROA) and return on investment ROI) to measure efficiency (Al-Tamimi et al. 2007, 334). The main issue in this study is finding a systematic method to derive appropriate inputs and outputs to evaluate the efficiency of branches based on BSC. The study is also aimed at determining the basic model based on DEA and quantifying the qualitative indices obtained to use in the efficiency measurement of the studied bank branches. Also, the study tends to separate the efficient and inefficient branches and to define the reference branches for the maximization of efficiency in the inefficient branches.

In the Balanced Scorecard (BSC) model, in addition to financial aspects, nonfinancial aspects are noted in line with the strategic goals of the organization. The model creates a balanced framework between financial and non-financial aspects, which can lead to the creation of a strategic position for transparency of organizational goals and interaction of managers and different organizational members. However, it should be noted that the model is unable to compare the performance of an organization in different years or compare the performance of similar organizations. The shortage can be met using the DEA model. In this model, the outputs of the organization are measured based on certain inputs, and the method is capable of comparing the performance of an organization during various periods or

comparing the performance of multiple similar organizations, such as branches of a bank. However, it should be noted that although the DEA model has a high ability to compare the performance and provide an improvement way, the model plays no vital role in the determination of input and output criteria. Therefore, it seems that with a combination of two models of DEA and BSC, not only can the strategic criteria of the organization be evaluated in a longitudinal process, but also the performance of different units can be compared, and the organizational performance can be evaluated in certain sections at the same time.

The combination of the two methods has paved the way for the measurement of organizational performance and to determine an improvement way. In the model, which was presented by Chen (1997) for the first time, the indicators defined by BSC are divided into two input and output groups. Then, using the DEA method, various decision-making units are compared. By determining the efficient units, the most efficient unit of an organization is specified.

3. Results

In the first step, along with analysis of the results associated with efficiency measurement of banks using the DEA method and analysis of the relevant studies in the field of BSC, the criteria derived in the studies were regulated based on the four views of the method. The criteria are the same components and indicators referred to at the end of the methodology. In this section, the criteria are presented due to the method implementation steps as the findings of the study: the deposit in branch, the paid facilities, the import and export bonds, the warrantees, the receivables (delayed, unpaid, and overdue receivables), net profit received from facilities, miscellaneous income, net fee received, the amount of securities distributed in the branch, credits, number of current accounts, number of saving accounts, number of issued bank cards, average waiting time to issue a bank card, number of facilities paid in the branch, average waiting time for bank customers, number of branch customers, active to stagnant accounts ratio, number of cheques issued, evaluation of branch by the customers, manpower expenses (wage and salary of branch personnel), average number of transactions per week, number of computer equipment in the branch, number of counters providing banking services to customers, value of monument and facilities of the branch, current expenses, transaction speed, experience of branch personnel (year), number of training courses for personnel, antiquity of the branch, job circulation of personnel, personnel group promotion rate, and personnel fraud rate.

In the second step, the opinions of the experts in the field of banking are used (Colleagues in the field of the plan and program deputy under the supervision of the Bank), and mathematical modeling is applied to the significance of each efficiency criterion listed in the first step. Also, the limitations caused by the DEA method are considered to provide a list of criteria for the experts of the Bank. Due to the easy access to information and its effect on the measurement and comparison of the efficiency of Bank Branches, a final list was prepared. The selected factors include the number of savings, the number of facilities provided, the amount of resources, consumption level, delays, number of current accounts, profit, the experience of branch personnel, education level of personnel, number of manpower, the value of electronic equipment, number of counters providing banking services to customers, and customer satisfaction.

In the third step, the abovementioned list was again sent to the personnel of the Bank, so that the criteria could be divided into two groups of inputs and outputs. Finally, the conceptual model was prepared based on the opinions of bank personnel.

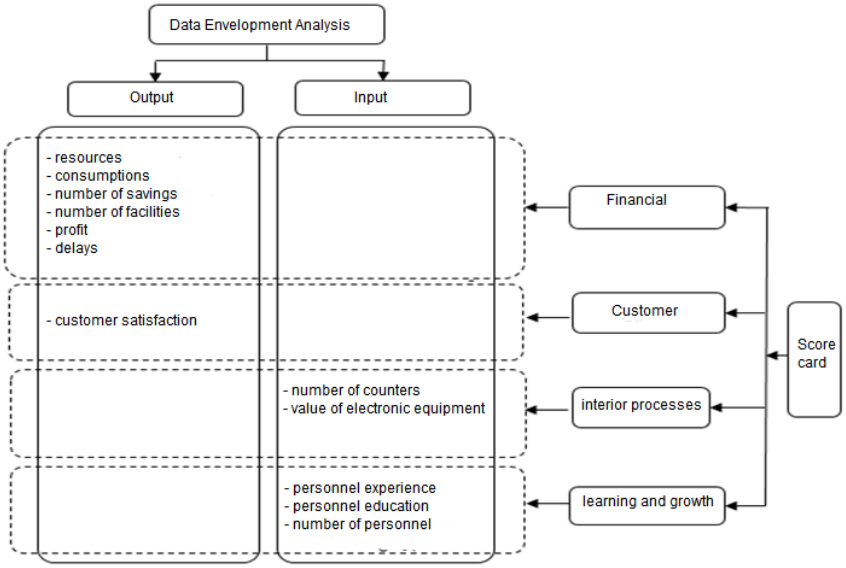

Figure 3. A conceptual model made by the combined method (DEA-BSC)

In the fourth step, the data collection is done, separated into the inputs and outputs. The data was provided by the efforts of Statistics, Research and Development Departments of the Deputy for Planning and Budget, and Human Resources, Education, and Finance Departments of the Bank.

It should be mentioned that the collected data is attributed to the fiscal year of 2012 and belongs to Bank Branches in Tehran. Besides, branches established in 2012 were excluded from the estimations. Hence, 73 branches were studied.

In the fifth step, the data analysis was conducted. After data collection and applying required changes to facilitate the DEA measurements, data-based CCR and BCC models were implemented to rank all branches in the frame of the GAMS IDE software. The results of efficiency measurement of the branches based on BSC and DEA are presented in Figure 4.

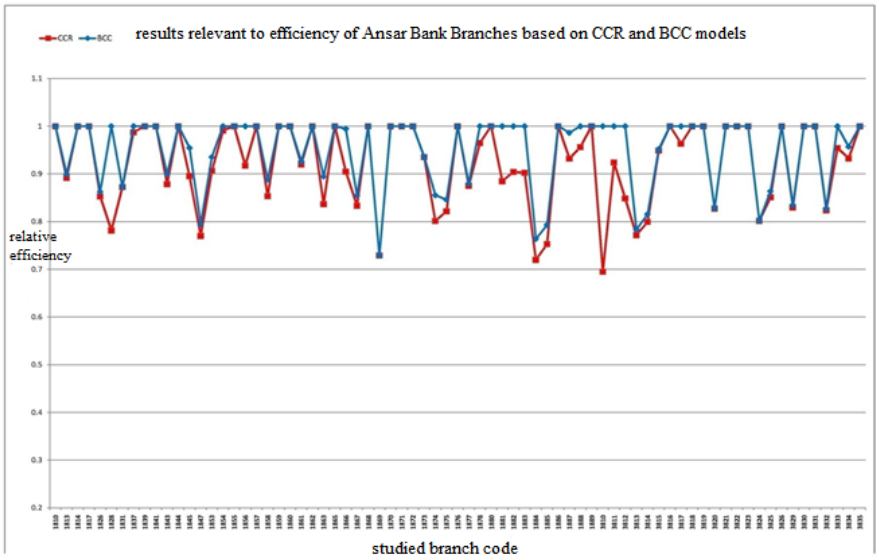

Figure 4. The diagram comparing results relevant to the efficiency of Bank Branches based on the CCR and BCC models

4. Conclusion

In the present study, due to the growing process of study in the field of efficiency, especially in the banking industry, the efficiency of bank Branches is measured. As it was mentioned in the literature, various theoretical and empirical studies have been done on applying the Balanced Scorecard (BSC) in strategic management and efficiency and performance evaluation. The instrument is one of the major instruments in the field of strategic management. On the other hand, various Persian and Latin articles are available on the measurement of efficiency of bank branches using the

Data Envelopment Analysis (DEA) method. Hence, this study has presented a model to measure the efficiency of Bank Branches using the DEA models, the criteria of which were defined in the framework of Balanced Scorecard (BSC). The combined method used in this study is an innovation compared to the previous literature.

As mentioned in the results and based on the diagrams, comparing the relative efficiency of branches measured by CCR and BCC models, there was no significant difference between the obtained results from CCR and BCC models. Hence, the return-to-scale efficiency of Bank Branches in Tehran is constant. Therefore, the results of the CCR model are considered as the basis of the analyses in this study.

Finally, based on the measurements, 30 out of 73 studied branches in Tehran possessed the maximum value and gained equal efficiency. In other words, 30 branches were efficient. The other 43 branches obtained an efficiency of 0.69506 to 0.99114, which is a relatively high efficiency.

Note: This research was conducted in a bank in the Islamic Republic of Iran, and due to ethical considerations and the authors' commitment not to publish the name of the bank, the name of the institution has been withheld.

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