

Research Article

Prioritization of the Factors Affecting Bank Efficiency Using Combined Data Envelopment Analysis and Analytical Hierarchy Process Methods

Mehdi Fallah Jelodar

Department of Mathematics, Islamic Azad University, Ayatollah Amoli Branch, Amol, Iran

Correspondence should be addressed to Mehdi Fallah Jelodar; mehdi.fallah_jelodar@yahoo.com

Received 10 December 2015; Revised 3 April 2016; Accepted 14 April 2016

Academic Editor: Adil M. Bagirov

Copyright © 2016 Mehdi Fallah Jelodar. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Bank branches have a vital role in the economy of all countries. They collect assets from various sources and put them in the hand of those sectors that need liquidity. Due to the limited financial and human resources and capitals and also because of the unlimited and new customers' needs and strong competition between banks and financial and credit institutions, the purpose of this study is to provide an answer to the question of which of the factors affecting performance, creating value, and increasing shareholder dividends are superior to others and consequently managers should pay more attention to them. Therefore, in this study, the factors affecting performance (efficiency) in the areas of management, personnel, finance, and customers were segmented and obtained results were ranked using both methods of Data Envelopment Analysis and hierarchical analysis. In both of these methods, the leadership style in the area of management; the recruitment and resource allocation in the area of financing; the employees' satisfaction, dignity, and self-actualization in the area of employees; and meeting the new needs of customers got more weights.

1. Introduction

Basically, managers of the banks are forced to select and improve methods of providing banking services, investments, marketing, human resource management, customer management, and competition with other banks and ultimately increasing the productivity and efficiency among their branches due to the economic conditions and lack of inputs, production factors, and technology. Obviously, when inefficient units become efficient, at the same time the goals are achieved, the cost of services are reduced, and wasting economic limited resources is avoided and losses due to the inefficiencies in the banks may be reduced to a minimum amount and the banking system as a whole is more efficient and, therefore, the national interests are more provided. Thus, given the role of banks in the development of country and also due to the existence of numerous branches, paying attention to the efficiency of banks has a special importance, so that a variety of studies have been conducted in recent years to identify the factors affecting performance (efficiency) in various areas, some of which are mentioned below.

In evaluating the strategic performance of the banks using fuzzy AHP method, Motameni et al. (2010) reached the conclusion that nonfinancial performance is more important than financial performance and, in the evaluation of financial performance, the criterion of resources share earned first place in terms of importance and the criteria of profitability and return on assets were placed in the next position. In non-financial performance measurement, the criterion of pricing was ranked first in importance and criteria of e-banking and service quality were next in the rank [1]. Mirjalili (2006) conducted a study to identify and improve employees' productivity using fuzzy DEA method. According to the results of this study, bank staff motivation in immaterial dimensions (unification of job and occupations and job security and equality in the organization and education) is more important compared to the material dimensions (salary, bonus, welfare, work physical environment, and safety) [2]. Mansoori (2009) compared the DEA and AHP methods using the technique of prioritizing key performance indicators (KPIs) for stock companies. The results showed no significant difference in the prioritization done by these two methods and DEA has

a higher ability to prioritize the key performance indicators compared to the Analytical Hierarchy Process (AHP) [3]. Chang and Chiu (2006) studied the long-term profitability of banks in Taiwan and reached this conclusion that the banking services are the most important factors for the increased profitability of banks' branches. Also, the bank employees were considered as the most important and basic factor to achieve increased profitability [4]. Timothy (2010) examined the tangible and intangible factors and the relative importance of each of these sources in Tanzania. Risk management, management return, services, innovation capability, and the ability to measure the market performance are five important sources affecting the performance of commercial banks in Tanzania. In addition, quantitative analysis shows that the productivity of human capital, physical capital productivity, mobilization of the funds, size of the bank, interest income, and the management return have positive influence on managerial efficiency of banks [5].

2. Literature of the Study

In this section we are going to summarize Analytical Hierarchy Process (AHP), Data Envelopment Analysis (DEA), and combined DEA/AHP methods. We will apply the last method to rank the factors affecting bank efficiency.

2.1. Analytical Hierarchy Process (AHP). Classic Analytical Hierarchy Process method, proposed by T. L. Saati, is the most popular and practical methods of MADM. This method is used when there is a need for simultaneous consideration of qualitative and quantitative aspects of a decision. AHP technique, using pairwise comparisons (one by one) and combined results, reduces the complexity of decisions; thus, not only could it help decision-makers to obtain the best decision, but also it provides a clear justification for showing that the obtained decision is the best one [6]. AHP method is the organization of decision-making at different hierarchical levels where a set of options are in lower levels, a set of decision criteria and standards are at the average level, and the static goals are at the top levels of decision-making hierarchy. Elements of decision-making usually represent a finite set of alternatives and decision-making regulations represent a set of properties that are effective in decision-making [7]. In order to control the outcome of this procedure, the consistency ratio is calculated for each paired comparison and it shows how judgments are consistent and can be relied on [8].

Some key and basic steps involved in this methodology are as follows.

Step 1 (structuring of the decision problem into a hierarchical model). It includes decomposition of the decision problem into elements according to their common characteristics and the formation of a hierarchical model having different levels. A simple AHP model has three levels (goal, criteria, and alternatives); more complex models containing more than three levels are also used in the literature. For example, criteria can be divided further into subcriteria and sub-subcriteria. Additional levels containing different actors relevant to the

problem under consideration may also be included in AHP studies.

Step 2 (making pairwise comparisons and obtaining the judgment matrix). In this step, the elements of a particular level are compared with respect to a specific element in the immediate upper level. The resulting weights of the elements may be called the local weights. The opinion of a decision-maker (DM) is elicited for comparing the elements. Elements are compared pairwise and judgments on comparative attractiveness of elements are captured using a rating scale (1-to-9 scale in traditional AHP). Usually, an element receiving higher rating is viewed as superior (or more attractive) compared to another one that receives a lower rating. The comparisons are used to form a matrix of pairwise comparisons called the judgment matrix A . Each entry a_{ij} of the judgment matrix is governed by the three rules: $a_{ij} > 0$; $a_{ij} = 1/a_{ji}$; and $a_{ii} = 1$ for all i . If the transitivity property holds, that is, $a_{ij} = a_{ik} \cdot a_{kj}$, for all the entries of the matrix, then the matrix is said to be consistent. If the property does not hold for all the entries, the level of inconsistency can be captured by a measure called consistency ratio (see next step).

Step 3 (local weights and consistency of comparisons). In this step, local weights of the elements are calculated from the judgment matrices using the eigenvector method (EVM). The normalized eigenvector corresponding to the principal eigenvalue of the judgment matrix provides the weights of the corresponding elements. Though EVM is followed widely in traditional AHP computations, other methods are also suggested for calculating weights, including the logarithmic least-square technique (LLST) and goal programming. When EVM is used, consistency ratio (CR) can be computed. For a consistent matrix A value of CR less than 0.1 is considered acceptable because human judgments need not be always consistent, and there may be inconsistencies introduced because of the nature of scale used. If CR for a matrix is more than 0.1, judgments should be elicited once again from the DM till they give more consistent judgments.

Step 4 (aggregation of weights across various levels to obtain the final weights of alternatives). Once the local weights of elements of different levels are obtained as outlined in Step 3, they are aggregated to obtain final weights of the decision alternatives (elements at the lowest level).

2.2. Data Envelopment Analysis (DEA). Data Envelopment Analysis is a mathematical programming method which is used to evaluate the efficiency of DMUs with multiple inputs and outputs. Efficiency measurement has always been considered by researchers because of its importance in assessing the performance of a company or organization. In 1957, Farrell measured efficiency of a manufacturing unit using a method such as efficiency measurement in engineering issues. The case considered by Farrell to measure the efficiency included an output and an input. Charnes, Cooper, and Rhodes developed Farrell's viewpoint (approach) and provided a model that was able to measure the efficiency with multiple

inputs and outputs. This pattern was named Data Envelopment Analysis and was used for the first time in 1978 by The University of Texas in the Ph.D. thesis (dissertation) of Edward Rhodes (supervised by Cooper), entitled “An assessment of educational progress of students in the national American schools” [9]. DEA focuses on the analysis of different concepts of relative efficiency such as cost, revenue and profit efficiency, productivity of the whole components, and factors of organizational units (the so-called decision-making units (DMUs)) in the use of inputs to produce output. Decomposition to the elements of efficiency is an opportunity to analyze the performance and to avoid the risk of non-profitability of banks. Cost efficiency reflects the company’s ability to minimize costs given a particular level of output and income return shows whether the bank has reached the maximum level of income and productivity using a part of input and ultimately the profit efficiency seeks to minimize costs and maximize income [10]. This method is not sensitive to the measurement unit and inputs can have different units and also it does not need any specific functional form of data in order to determine the efficiency of banks. In fact it is an empirical function of the observations. DEA standard does not control optimization of multiple periods and may be at the risk of managerial decision-making. Therefore, after identification of an efficient unit, one must again control data and outputs and ensure their accuracy [11]. The use of Data Envelopment Analysis model to relatively evaluate the units requires the two basic characteristics: the nature of the model (input-oriented nature and the output-oriented nature) and returns to scale (CCR fixed and BCC variable).

Consider n , DMUs with m inputs and s outputs. The input and output vectors of DMU $_j$ ($j = 1, \dots, n$) are $X_j = (x_{1j}, \dots, x_{mj})$ and $Y_j = (y_{1j}, \dots, y_{sj})$ in which $X_j \geq 0$, $X_j \neq 0$, $Y_j \geq 0$, and $Y_j \neq 0$.

By using the nonempty, constant return to scale and convexity and possibility postulates, the production possibility set (PPS) is made as follows:

$$T_c = \left\{ (X, Y) : X \geq \sum_{j=1}^n \lambda_j X_j, Y \leq \sum_{j=1}^n \lambda_j Y_j, \lambda_j \geq 0, j = 1, \dots, n \right\}. \quad (1)$$

Let DMU $_o$ be evaluated. The multiplier form of CCR model [1], in input-oriented case, is as follows:

$$\begin{aligned} \min \quad & \theta \\ \text{s.t.} \quad & \sum_{j=1}^n \lambda_j x_{ij} \leq \theta x_{io}, \quad i = 1, 2, \dots, m \\ & \sum_{j=1}^n \lambda_j y_{rj} \geq y_{ro}, \quad r = 1, 2, \dots, s \\ & \lambda_j \geq 0, \quad j = 1, 2, \dots, n. \end{aligned} \quad (2)$$

The above formula is known as envelopment form of CCR model. Its dual problem is known as the multiplier form of CCR model which is as follows:

$$\begin{aligned} \max \quad & \sum_{r=1}^s u_r y_{ro} \\ \text{s.t.} \quad & \sum_{i=1}^m v_i x_{io} = 1 \\ & \sum_{r=1}^s u_r y_{rj} - \sum_{i=1}^m v_i x_{ij} \leq 0, \quad j = 1, 2, \dots, n \\ & u_r \geq 0, \quad r = 1, 2, \dots, s \\ & v_i \geq 0, \quad i = 1, 2, \dots, m. \end{aligned} \quad (3)$$

2.3. DEAHP Method. DEA method is a useful tool for the performance evaluation of decision-making units in the management science which calculates the efficiency of each decision-making unit. The main objective of DEA is to determine the efficiency of a system or a decision-making unit which produces one or more outputs using one or more inputs. On the other hand, AHP is also a useful tool in the Multicriteria Decision-Making (MCDM) to select the best option and to rank different options. Calculation of the relative weights of the elements is the main concept of the AHP method. So far, several approaches have been provided to calculate the weight from the paired comparison matrix. In 2006, Ramanathan [12] provided a method through which the relative weight of the paired comparison matrix is obtained using DEA model. Calculation of the exact weight of each element for the consistent matrices is one of the outstanding points of this method. In this study, the meaning of efficiency in DEA method and the meaning of relative weights in AHP method have become identical. Since the proposed method is a combination of DEA and AHP methods, Ramanathan chose the name of “DEAHP” for this method. In DEAHP method, each row of the paired comparison matrix was considered as a DMU and each of its columns was considered as an output. Therefore, in a paired comparison matrix ($n \times n$), there are “ n ” decision-making units (DMUs) and “ n ” outputs corresponding to each DMU. Note that each component of the paired comparison matrix is considered as an output. DEA has logically the characteristics of an output because larger number of a_{ij} is prioritized to a component with the smaller number in AHP. Therefore, the priority in AHP can be considered as identical to the output of the DEA. In DEAHP, Ramanathan used CCR models to calculate the efficiency of each DMU and that is why he considered a fixed input equal to 1 for each DMU and efficiency score of each DMU which is obtained using different models of DEA (CCR envelopment form in the input and output nature, multiplier form of CCR model in the input and output nature) which was considered as the relative weight of each factor. Ramanathan [12] proposed model for the calculation of the relative weights of elements

TABLE 1: Indicators of each criterion.

	Management	Financial	Staff	Customers
1	Management information systems	Attraction and optimal allocation of resources	Training and empowerment of human resources	Customer orientation and providing an appropriate image
2	Ability and emphasis on innovation and creativity	Decreased deferred items and increased rate of loans turnovers	Adequate income	Improvement of quality and speed of services
3	Creating an appropriate organizational culture	Promotion of activities in the field of foreign currency and opening of L/C	Participation of all employees	Adjustment of the loans' rate
4	Leadership style	Electronic banking	Employees' satisfaction about their dignity and self-actualization	Knowledge, expertise, and personnel accountability
5	Management of attracting key customers and relationship with them	Using new tools of financing and direct investment	Appropriate evaluation system for the staff promotion	To meet new needs of customers
6	Creating an effective and efficient internal control system	Increase in the issuance of bank guarantees	Job security	Increased interest on deposits
7	Risk management	Increased ratio of nonoperating income to nonoperating costs	Desired job characteristics	Suitability of the location, structure, and layout of branches

in a paired comparison matrix using multiplier form of CCR is as follows:

$$\begin{aligned}
 \max \quad & e_{i_0} = \sum_{j=1}^n u_j a_{i_0, j} \\
 \text{s.t.} \quad & v = 1 \\
 & \sum_{j=1}^n u_j a_{ij} - v \leq 0, \quad i = 1, \dots, n \\
 & u_j, v \geq 0, \quad j = 1, \dots, n.
 \end{aligned} \tag{4}$$

One may normalize the obtained efficiency scores as follows to be used in AHP content:

$$w_j = \frac{e_j}{\max\{e_j\}}, \quad j = 1, \dots, n. \tag{5}$$

All the weights are less than or equal to 1 and their summation becomes unity by the above normalization.

This paper is organized as follows: An introduction and literature review are presented in the first two sections. Ranking of the factors affecting bank efficiency is discussed in Section 3. Analysis of the results and conclusion are presented in Sections 4 and 5.

Participants in this study are 80 people, including experts, managing directors engaged in branches management, and managers of Mellat banks in Tehran. Since the current study is related to the collection of standards and options and provides the possibility of deciding on the selection and giving importance to the indicators, therefore, it is an applied research. But, in terms of technique, it is descriptive-survey study because it provides the possibility of analyzing the subject and decision-making through describing the criteria and decision alternatives and also because in this study a

questionnaire is designed to complete the calculations. At first, in this study, scientific literature related to the subject and the primary criteria for decision-making were identified using desk method and searching in the valid databases. Then, identified criteria were classified into four categories, management, investors, employees, and customers, and distributed as a questionnaire among experts and professionals and they were asked to provide their comments through pair comparison of the indicators.

3. Prioritization of the Factors Affecting Efficiency

Given the mentioned concepts, factors affecting the efficiency were first prioritized using AHP method. In this method, prioritization of factors affecting performance (efficiency) has been considered at the first level which is the purpose of using this method and the second level is composed of 4 criteria of management, finance, staff, and customers and the third level consisted of 7 items in each field which are summarized in Table 1. Following hierarchical modeling of the decision concept, elements (indicators or options) of any level were compared to the corresponding elements in higher level (2 by 2) and 50 questionnaires were completed. In order to combine tables of the paired comparisons of all respondents, the geometric mean was used and the relative weight was obtained from the arithmetic mean. In all four areas, the consistency ratio was less than 0.1 which represents the good consistency ratio among the comparisons. Then, in the second method, weights of options were calculated based on the model proposed by Ramanathan using GAMS software which is DEA linear programming model. The results of both methods were similar to each other. The first priority is the same in all 4 areas and other indicators were ranked with a slight difference and the obtained percentages had also

TABLE 2: Prioritization of factors affecting performance (efficiency) in the field of management using AHP and DEA methods.

AHP method		DEAHP method	
(1) Ability and emphasis on creativity	0.1891	(1) Ability and emphasis on creativity	0.2262
(2) Management information systems	0.1843	(2) Management information systems	0.1746
(3) Management of attracting key customers and relationship with them	0.1532	(3) Management of attracting key customers and relationship with them	0.1647
(4) Risk management	0.1340	(4) Creating an effective and efficient internal control system	0.1239
(5) Creating an appropriate organizational culture	0.1317	(5) Creating an appropriate organizational culture	0.1138
(6) Creating an effective and efficient internal control system	0.1212	(6) Risk management	0.1098
(7) Ability and emphasis on creativity	0.0865	(7) Ability and emphasis on creativity	0.0867

TABLE 3: Prioritization of factors affecting performance (efficiency) in the field of financial using AHP and DEA methods.

AHP method		DEAHP method	
(1) Attraction and optimal allocation of resources	0.2512	(1) Attraction and optimal allocation of resources	0.3100
(2) Decreased deferred items and increased rate of loans turnovers	0.1729	(2) Electronic banking	0.1643
(3) Using new tools of financing and direct investment	0.1068	(3) Decreased deferred items and increased rate of loans turnovers	0.1542
(4) Electronic banking	0.1494	(4) Using new tools of financing and direct investment	0.1440
(5) Increased issuance of bank guarantees	0.0932	(5) Promotion of activities in the field of foreign currency and opening of L/C	0.0838
(6) Increased ratio of nonoperating income to nonoperating costs	0.0867	(6) Increased ratio of nonoperating income to nonoperating costs	0.0747
(7) Promotion of activities in the field of foreign currency and opening of L/C	0.0859	(7) Increased issuance of bank guarantees	0.0687

a small difference. The results are summarized in Tables 2, 3, 4, and 5.

4. Analysis of the Results and Research Suggestions

The results of this study can be used by senior executives, managers, and heads of branches and all bank experts and personnel who are involved in a way with the bank and operational plans. Due to the different types of users and uses of the results of this study, recommendations on the most important indicators that have the first priority are as follows.

4.1. First Stage: Resource Attraction. Given that the attraction and allocation of resources have been chosen as the most important financial indicators, thus the volume and quality of resources are very important. Meanwhile, paying attention to the competitive position and the share (percentage) of the whole network resources should also be considered; therefore, the following recommendations are offered.

- (1) Paying attention to the attraction of resources with the lower operating costs. At first, banks should

consider different types of non-cost-bearing and low-cost-bearing deposits including interest-free current and savings deposits and then cost-bearing savings, such as short-term and long-term investments by providing high-quality services and more competitive advantage over rival banks.

- (2) Percentage of growth in the current resources of public institutions.
- (3) Percentage of growth in other Rial resources such as increase in the Rial guarantees and the opening of domestic L/Cs to receive cash deposits and advance payments of L/Cs and increase in the bank cheques and advance payments of bank loans.
- (4) The share of total market of resources: increase in the bank assets, compared with other banks, promotion of the bank's brand, and increase in the incentives of the Mellat bank's customers as their first bank.
- (5) Granting loans: granting loans together with the proper authentication to gain profit margin and to cover operating and nonoperating costs.

TABLE 4: Prioritization of factors affecting performance (efficiency) in the field of staff using AHP and DEA methods.

AHP method		DEAHP method	
(1) Employees' satisfaction about their own dignity and self-actualization	0.2369	(1) Employees' satisfaction about their own dignity and self-actualization	0.2584
(2) Job security	0.1834	(2) Appropriate evaluation system for the staff promotion	0.1594
(3) Appropriate evaluation system for the staff promotion	0.1661	(3) Job security	0.1471
(4) Desired job characteristics	0.1137	(4) Desired job characteristics	0.1197
(5) Training and empowerment of human resources	0.1135	(5) Adequate income	0.1178
(6) Adequate income	0.0997	(6) Training and empowerment of human resources	0.1164
(7) Participation of all employees	0.0868	(7) Participation of all employees	0.0808

TABLE 5: Prioritization of factors affecting performance (efficiency) in the field of customers using AHP and DEA methods.

AHP method		DEAHP method	
(1) To meet new needs of customers	0.2578	(1) To meet new needs of customers	0.3364
(2) Improvement of quality and speed of services	0.1683	(2) Improvement of quality and speed of services	0.1615
(3) Knowledge, expertise, and personnel accountability	0.1494	(3) Knowledge, expertise, and personnel accountability	0.1284
(4) Customer orientation and providing an appropriate image	0.1237	(4) Increased interest on deposits	0.1146
(5) Increased interest on deposits	0.1162	(5) Customer orientation and providing an appropriate image	0.1010
(6) Adjustment of the loans' rate	0.1098	(6) Adjustment of the loans' rate	0.926
(7) Suitability of the location, structure, and layout of branches	0.0749	(7) Suitability of the location, structure, and layout of branches	0.652

4.2. *Employees' Satisfaction from Their Dignity and Self-Discovery.* These personnel have a sense of purpose towards their jobs or lives compared to others. Employees can implement the best innovations and inventions with a sense of excitement, ownership, and pride and they work with a sense of responsibility and prefer interests of the organization to their own interests. Consequently, it is necessary to take the following measures:

- (1) Creating a free, dynamic, and competent environment for the managers and staff.
- (2) Strengthening and enhancing the spirituality and preserving human values in all layers of an organization.
- (3) Promoting the commitment, loyalty, belonging to the organization, reliability, and understanding the needs of the organization.
- (4) Making all personnel in all levels of the business activities involved in the operational programme activities and transition of steering committee meetings from the staff level of the bank region to the inside of bank branches.
- (5) Enhancing the coordination and interaction morale among personnel through cooperation and coordination between the executive directors.

- (6) Identifying and developing the talents and planning strength and modeling and encouraging colleagues to submit their proposals and viewpoints.

4.3. *New Solutions to Meet the Needs of New Customers.* New solutions to meet the needs of new customers are as follows:

- (1) At first, customers should be prioritized and their needs should be identified. Then there should be attempts to attract their attention and to provide favorable expectations and develop a marketing culture among employees with a defined scientific approach and to arrange team talks with customers in order to meet all the needs of the customers.
- (2) New financing tools can include a variety of stock securities, mortgage, future securities, transaction options, and derivatives of stock and commodity markets and certificates of deposit and bonds and strengthening value chains of banks through insurance and leasing companies, currency exchange, funding, and other brokerages.
- (3) Another solution is providing comprehensive financial services to corporations and institutions including equity and debt securities subscription programming, acquisitions and mergers activities, giving

corporate restructuring advice, security trading and sales, granting loans and commitment services, and managing receipts and payments and providing services such as risk management, liquidity management, and proprietary trading.

- (4) Fourth solution would be providing integrated financial and investment services and giving advice to certain clients with high amount of deposit in their accounts and managing their assets. Of course, all of these themes will help Mellat bank to become a bank with a variety of banking services and a bank that will have a brilliant future in the field of competition through providing different banking services and implementing strategic themes and paying attention to the human resources and customers and it will be raised as a superior and valuable brand in the domestic and international banking system.

5. Summary and Conclusion

Measuring the performance of different organizations and comparing the efficiency of their different units are among those major issues that are discussed in today's economy. Among various organizations, banking system plays a very important role in Iran's economy; thus, given the important role of the banks in the development of our country and benefiting from the opinions of bank experts and desk studies, 28 important factors affecting the performance of banks were selected and divided into 4 areas. Then, hierarchical analysis was used to prioritize these factors and weights obtained from the paired comparisons were ranked using DEAHP integration method and the results were presented. These results can be used for operational decision-making in the Mellat bank and other banks to allow administrators to allocate their scarce resources to these factors based on priority. One can also prioritize these factors and other internal and external factors affecting the performance (efficiency) through the use of other nonparametric methods and compare them with the results of this study and select the best possible options which suit the economic conditions of our country at the time of selection.

Competing Interests

The author declares that there are no competing interests.

References

- [1] A. Motameni, M. Javadzadeh, and M. Tizfahm, *Strategic Management Studies*, vol. 1 of *Strategic Management Studies*, Springer, Berlin, Germany, 2010.
- [2] M. Mirjalili, *Offering an integrated algorithm based on multiple analysis methods and fuzzy DEA method to identify and improve the productivity of bank employees [M.S. thesis]*, Tehran University, 2006.
- [3] S. Mansoori, *Comparison between AHP and DEA approaches using prioritized KPIS key performance indicators for companies listed on the Stock Exchange [M.S. thesis]*, Imam Khomeini International University, 2009.
- [4] T.-C. Chang and Y.-H. Chiu, "Affecting factors on risk-adjusted efficiency in Taiwan's banking industry," *Contemporary Economic Policy*, vol. 24, no. 4, pp. 634–648, 2006.
- [5] V. Timothy, *A study on the determinants of commercial bank performance in Tanzania: a resource-based view [doctoral dissertation]*, Liaoning University, Shenyang, China, 2010.
- [6] R. V. Rao and J. P. Davim, "A decision-making framework model for material selection using a combined multiple attribute decision-making method," *International Journal of Advanced Manufacturing Technology*, vol. 35, no. 7-8, pp. 751–760, 2008.
- [7] O. Çakir, "On the order of the preference intensities in fuzzy AHP," *Computers & Industrial Engineering*, vol. 54, no. 4, pp. 993–1005, 2008.
- [8] B. Nepal, O. P. Yadav, and A. Murat, "A fuzzy-AHP approach to prioritization of CS attributes in target planning for automotive product development," *Expert Systems with Applications*, vol. 37, no. 10, pp. 6775–6786, 2010.
- [9] M. R. Mehregan, *Advanced Operations Research*, Academic Books (Kتاب-e-Daneshgahi), Tehran, Iran, 4th edition, 2008.
- [10] A. Kryvko, M. Afsharian, and P. Reichling, *Efficiency and Its Impact on the Performance of European Commercial Banks*, Otto-Von-Guericke University—Department of Banking and Finance, 2011.
- [11] M. D. Fethi and F. Pasiouras, *Assessing Bank Efficiency and Performance with Operational Research and Artificial Intelligence Techniques*, 2010.
- [12] R. Ramanathan, "Data envelopment analysis for weight derivation and aggregation in the analytic hierarchy process," *Computers & Operations Research*, vol. 33, no. 5, pp. 1289–1307, 2006.



Hindawi

Submit your manuscripts at
<http://www.hindawi.com>

