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Integration of analytic hierarchy process and data envelopment analysis for assessment and optimization of personnel productivity in a large industrial bank

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ABSTRACT

This paper presents an integration of analytical hierarchy process (AHP) and data envelopment analysis (DEA) for assessment and optimization of personnel productivity in a large private bank. In this algorithm the effective personnel operation indicators are evaluated by the management which is usually in qualitative forms and converted to quantitative forms by using AHP. Then, the ranking and efficiency of the organization will be assessed and optimized by DEA. Principal components analysis (PCA) and numeral taxonomy (NT) are applied to verify and validate the ranking results of the DEA method. We applied this algorithm in various branches of the Bank of Industry and Mine in Iran. The proposed framework may be used to study and optimize personnel productivity in large banks. This is the first study that integrated DEA and AHP for optimization of personnel productivity in large banks based on both qualitative and quantitative indicators.

Significance: The employees are essential for every organization and their way of behavior and operation could lead to improve the organization. Good management and utilization of the human resources are determinant factors to solve various economic problems. Unfortunately, the traditional banks merely pay attention to the profit indicators for operating evaluation. However, profit indicators are not the only determinant factor for evaluation of banking systems. In this regard, it is required to consider the effective qualitative and quantitative indicators affecting the human resources operations. Moreover, an integrated AHP–DEA has been used to assess the impact of quantitative factors in addition to qualitative factors which affect personnel productivity in large banks. This algorithm specifies the strength and weak points of each branch from human operation viewpoints. This in turn helps the managers to have better understanding of their employees operations to make proper decisions.

1. Introduction

Financial indicators are essential for integrated assessment of banking institutions. Good management and utilization of integrated tools are determinant factors to resolve such problems. Unfortunately, the traditional banks merely pay attention to the profit indicators for operating evaluation. However, profit indicators are not the only determinant factor for evaluation of banking systems. Also, the ranking and assessment methods have their own limitations and advantages. So, researchers are seeking for methods with fewer limitations which sometimes cover more general areas of operational activities for the organization. Moreover, because of poor financial assessment analysis in its discrete form, researchers are interested in shifting toward cluster analysis which utilizes all information and their effects in an integrated analysis form. This type of analysis is one of the most famous methods recently considered by most scientists in the capital adequacy, asset quality, management quality, earning ability, liquidity, and sensitivity to market risk (CAMELS) method. This method implemented in US Central Bank is a part of estimating ranking system or system estimating examination ratings (SEER). The CAMELS ranking represents the quality and financial conditions plus anticipation of total bank operations and risks. This method takes into account six factors which are capital adequacy, asset quality, management quality, earning ability, liquidity, and sensitivity to market risk. Each of these factors is given a rank from 1 (for perfect operation) to 5 (for poor operation). The sum of these grades indicates the final bank ranking and the level of stability and performance. Identification of anticipated and experimental results verifies that banks with grades 1 and 2 are in better situation and performance stability than banks with grades 3, 4 and 5. Consequently, poor CAMELS test results warn controllers to im-

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prove the operations. One of the main barriers of utilizing CAMELS model in Iran is that the evaluation of bank management sufficiency is a very critical task, because Iranian banks are governmental and so the managers are bounded to fallow the duties imposed by the government (Deputy of Economic Affairs, 2002). Moreover, the capital values of the banks are not real, mostly because of the inflation conditions which have been experienced during last two decades without renewing the assets assessments since about 10 years ago. Since there is no risk management department in the banking system of the country, a risk study and assessment which challenges the management is inefficient. Furthermore, to prevent bankruptcy and financial instabilities in such a bounded system, the confidential obligations are inevitable and only the inspectors and managing council can access to the results.

1.1. Data envelopment analysis

DEA has been widely used for the efficiency determination of every organization and banking system (Deputy of Economic Affairs, 2002). DEA, formally developed by Charnes, Cooper, and Rhodes (1978), is a performance measurement technique which could be used for evaluating the relative efficiency of DMUs in organizations. Charnes et al. (1978) generalized the single-output to single-input ratio definition of efficiency to multiple inputs and outputs. In their original DEA model, Charnes, Cooper and Rhodes (CCR model) proposed that the efficiency of a DMU can be obtained as the maximum of the ratio of weighted outputs to weighted inputs, subject to the condition that the same ratio for all DMUs must be less than or equal to one. The DEA model must be run n times, once for each DMU, to get the relative efficiency of all DMUs. The envelopment in CCR is constant returns to scale meaning that a proportional increase in inputs results in a suitable increase in outputs. Banker, Charnes, and Cooper (1984) developed the BCC model to estimate the pure technical efficiency of decision making units (DMUs) with reference to the efficient frontier. It also identifies whether a DMU is operating in increasing, decreasing or constant returns to scale. So CCR models are a specific type of BCC models (Toloo, Sohrabi, & Nalchigar, 2009).

1.2. Analytic hierarchy process

The analytic hierarchy process (AHP) is a multi criteria decision making method allowing decision makers to model a complex problem in a hierarchical structure which consists of the goal, objectives (criteria), sub-objectives, and alternatives (Saaty, 1980). AHP provides an overarching view of the complex relationships in the problems and helps to assess whether the evaluation criteria are of the same order of magnitude. So the decision maker can compare such homogeneous alternatives accurately (Lee & Kozar, 2006). The decision maker should determine the weight of all criteria in order to do pair wise comparison between them. The main procedure of AHP is as follows:

(1) Determining the objective and evaluation attributes.
(2) Developing hierarchical structure levels with goals, contracture, criteria and the alternatives.
(3) Finding out the importance of different attributes considering the goals.

AHP is a tool that helps decision makers to incorporate a group agreement using a questionnaire for comparing each element and geometric mean to arrive at a final solution (Vaidya & Kumar, 2006).

1.3. Objective

In this study, in order to consider comprehensive quantitative indicators including customer-related indicators, an integrated AHP and DEA method have been proposed with respect to a set of comprehensive indicators to assess and optimize personnel productivity in banking institutions. This approach specifies the strength and weakness of each branch within the banking systems. This in turn, helps the decision makers to have better understandings of the financial operation to make proper decisions. The applicability and robustness of the proposed algorithm have been shown for various branches of a large private bank in Iran.

The remainder of this paper is structured as follows. In Section 1, the related literature has been reviewed. In Section 2, the problem and analysis methods such as DEA, PCA, and NT are described. In Section 3, the proposed approach including DEA, PCA, and NT models is defined. In Section 4, numerical experiments are used to test the accuracy and applicability of the model in a large private bank in Iran and Section 5 presents the conclusions of the study.

2. Literature review

2.1. DEA methods

DEA methods have been used in different studies of domestic and foreign banks operation evaluations. Barr, Killgo, Siems, and Zimmel (1999) studied the operation and efficiency of the US commercial banks using DEA method. Barr et al. (1999) considered five variables namely: (1) laboring costs, (2) fixed assets, (3) interest costs, (4) non-interest costs and (5) deposit as essential bank inputs and three other variables namely: (1) revenues, (1) interest incomes and (3) non-interest incomes as bank outputs. This study which was based on the data belonged to the years 1984–1998 and in addition to determine the banks efficiencies, had more interesting results: it indicated that DEA is a reliable tool for determining banks operation efficiencies. Another interesting result of this study was ranking identification in both DEA and CAMELS methods from efficiency point of view, i.e. the efficient banks in DEA system were the same in CAMELS ranking systems with ranks 1 and 2, while the inefficient banks mostly were those with ranks 3, 4 and 5 in CAMELS ranking systems. Another significance of this method was comparability of the financial indicators among the banks with low and high efficiency. Comparing the financial indicators of each group yields the meaningful data which lead us as a criterion for comparing the operational efficiencies of the banks (Deputy of Economic Affairs, 2002).

Manandhar and Tang (2002) introduced a new structure for evaluating the operation of bank branches by using DEA method. Manandhar and Tang (2002) believed that in the banking operation evaluation, there are some non-sensible aspects that should be taken into account and considered three types of efficiencies including operational efficiency, servicing efficiency and profitability efficiency.

Paradi and Schaffnit (2004) evaluated the performance of the commercial branches of a large Canadian bank by using DEA method. Paradi and Schaffnit (2004) presented two models. The first model called production model was utilizing a source with the most profit for the bank branch and the second model called strategic model was considering the financial results which were more important for the managing director. Also they considered environmental and growth factors which state the regional economic circumstances.

Haslem, Scheraga, and Bedingfield (1999) applied DEA method to analyze the 1987 and 1992 efficiency of US banks operating internationally. In 1987, these banks received the refunds from