PERFORMANCE EVALUATION USING A COMBINED BSC-FUZZY AHP APPROACH

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Abstract

This study aims to develop a set of appropriate performance evaluation factors mainly based on BSC for evaluating the performance of banking sector. To this aim, first the factors affecting on banking performance were collected from the BSC literature and screened by the experts as the basic evaluation factors. Then, a fuzzy Analytic Hierarchy Process method namely EA (Extent Analysis) was used to evaluate affecting factors on banking performance in Mellat bank branches of Rasht city in IRAN. It is revealed from the results that “Financial” perspective (0.398), “Customer” perspective (0.334), “Internal process” perspective (0.208) and “Learning and Growth” perspective (0.092) respectively, are of more importance in evaluation of banking sector. The analysis Results from this effective evaluation model enables bank board of directors to improve banking performance for achieving aspired/desired level and achieve a competitive advantage.

Keywords: Performance Evaluation, Balanced Scorecard, Fuzzy AHP, Banking Sector.

1. Introduction

In developing countries the banking system plays a vital role in the progress of economic development. The traditional performance rankings of banks is based on simple and consistent factors such as financial returns, returns on asset (ROA) and returns on earning (ROE). Nevertheless, performance rankings conducted in this way may not precisely illustrate institutions that embrace strategies for sustaining top performance (Hanley and Suter, 1997). However, non-financial criteria such as customer satisfaction, community and employee relations can be vital to a bank’s winning strategy, because using only ROA or ROE for performance ranking may not necessarily determine which institution offers the highest returns to the investors, nor does it accurately prove which one is most profitable (Wu et al., 2009).

Kaplan and Norton (1992) proposed the balanced scorecard (BSC) approach in order to overcome these shortcomings. The BSC as a new emerging approach for organizational evaluation reflects a balance between short- and long-term objectives, financial and non-financial measures, lagging and leading indicators, and external and internal measures. It is a tool of strategic management, strategic communication and performance management,

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providing frequently measured performance and regular reviewing and refinement strategy with an ongoing evaluation process. The BSC evaluates an organization from four perspectives: financial measures, customer satisfaction, internal operations, and company learning and growth (Tjader et al., 2014). Therefore, BSC acts as a strategic management system rather than an operational system that gives tactics only (Kaplan and Norton, 1996).

For many years, several different theories and methods have been applied in corporation with BSC for better evaluation of various organizations. These approaches include ratio analysis, total production analysis, regression analysis, Delphi analysis, Multiple criteria decision making (MCDM), Data Envelopment Analysis (DEA) and others. Each method has its own basic concept, aim, advantages and disadvantages (Dessler, 2000, Gilaninia et al., 2012). Which one is chosen by management or decision makers for assessing performance depends on the status and type of the organization. Among the above, MCDM methods as disciplines aimed at supporting DMs faced with numerous and sometimes conflicting evaluations. These methods have attracted much attention from academics and practitioners (Tolio-Eshlaghy and Homayounfar, 2011). The development of MCDM methods has been motivated not only by a variety of real-life problems requiring the consideration of multiple criteria, but also by practitioners’ desire to propose enhanced decision making techniques using recent advancements in mathematical optimization, scientific computing, and computer technology. The impact that the MCDM paradigm makes on business, engineering, and science is being reflected in the large number of articles with MCDM-type studies and analyses which are presented at professional meetings in various disciplines (Wieck et al., 2008, Rezvani et al., 2011). In this study, the BSC Based Fuzzy AHP method is employed to determine the importance of the essential factors in evaluation of bank performance. The decision-making procedure, conducted based on the domestic list of factors, guides the decision maker in weighing the various perspectives and their factors. The results analysis illustrates the applicability of the evaluation model through an empirical analysis.

2. Balanced Scorecard (BSC)

The balanced scorecard (BSC) approach, introduced by Kaplan and Norton (1992), is well-known as one of the most popular methods in performance evaluation. The cardinal purpose of BSC is to replace traditional performance system focusing on assessing one single financial index to obtain more adequate and comelier performance evaluation model. This concept gets out of the traditional performance evaluation model merely based on financial accounting. For BSC, financial perspective is still the core of performance evaluation but the other four perspectives such as customer, internal process and, learning and growth should be included in as well to enable the performance evaluation method to be more balanced and also having the effectiveness of encouraging organizations. This is for setting up a complete performance evaluation system and forming a whole set of performance indices to assess strategies so that the strategies and prospect of organizations could be achieved (Wu et al., 2011).

Hence, although the BSC conceptual framework has been widely accepted in the business community, the proper method of implementing the framework remains an issue (Tseng, 2010). Huang (2009) proposed an integrated approach for the balanced scorecard tool and knowledge-based system using the analytic hierarchy process (AHP) method, and then develops an intellectual BSC knowledge-based system for strategic planning that sets or selects firm management or operational strategies based on the Four BSC perspectives. Wu et al. (2009) proposed a hybrid Fuzzy Multiple Criteria Decision Making (Fuzzy AHP, SAW, TOPSIS and VIKOR) approach for banking performance evaluation. The relative weights of the chosen evaluation indexes were calculated by Fuzzy Analytic Hierarchy Process (FAHP). Kuo and Chen (2010) applied the four perspectives of the BSC to construct key performance appraisal indicators for the mobility of the service industries through the fuzzy Delphi method.

Through literature review and experts who have real practical experiences in banking, 61 performance evaluation factors for 4 BSC perspectives have been selected. Then utilizing the statistical tests of collected questionnaires from the experts, 23 more important factors have been determined and classified into the four BSC dimensions, “Finance (F₁–F₇)”, “Customer (C₁–C₄)”, “Internal Process (P₁–P₇)”, and “Learning and Growth (L₁–L₅)” (Table 1).

<table>
<thead>
<tr>
<th>Perspectives</th>
<th>Factors</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial (F)</strong></td>
<td>(F₁) Operating Income</td>
<td>Earnings before interest and taxes (EBIT)</td>
</tr>
<tr>
<td></td>
<td>(F₂) Non operating income</td>
<td>The portion of an organization's income that is derived from activities not related to its core operations.</td>
</tr>
<tr>
<td></td>
<td>(F₃) Return on assets</td>
<td>After-tax profit/ loss divided by average total assets</td>
</tr>
<tr>
<td></td>
<td>(F₄) profit margin</td>
<td>After-tax profit/ loss divided by total operating revenues</td>
</tr>
<tr>
<td></td>
<td>(F₅) Bank sales</td>
<td>The granted loans to customers in different types</td>
</tr>
<tr>
<td></td>
<td>(F₆) Bank claims</td>
<td>The bank demanded loans that are not returned at maturity</td>
</tr>
<tr>
<td></td>
<td>(F₇) Resources</td>
<td>Attracted funds from depositors, including short-long term accounts,</td>
</tr>
<tr>
<td><strong>Customer (C)</strong></td>
<td>(C₁) Customer satisfaction</td>
<td>Satisfaction of customers to products and services</td>
</tr>
<tr>
<td></td>
<td>(C₂) Profit per customer</td>
<td>After-tax earnings divided by total number of customers</td>
</tr>
<tr>
<td></td>
<td>(C₃) Number of customers</td>
<td>Number of total customers of a given branch</td>
</tr>
<tr>
<td></td>
<td>(C₄) Customers increasing rate</td>
<td>Growth rate of new customers</td>
</tr>
</tbody>
</table>
The BSC as a performance measurement framework allows managers to look at their business performance from four performance perspectives. Since, the importance of each perspective is an important factor in performance evaluation, it’s necessary to use a proper method to calculate the weights.

3. Fuzzy Analytic Hierarchy Process (FAHP)

The analytic hierarchy process is often used as an effective tool in structuring and modeling multi-criteria problems because it attempts to quantify human judgment and opinion that other approaches might ignore. However, by using pairwise comparison the calculation of preference between criteria is mainly based on some quantitative business data and the subjective judgment from senior management level. No matter how professional they are, the results based on the judgment of those decision-makers somewhat are subject to imprecision (Yuan and Chiu, 2009).

Buckley (1985) incorporated the fuzzy theory into the AHP and afterward many generation of Fuzzy AHP method proposed by various authors (Buckley, 1985; Chang, 1996; Cheng, 1997; Deng, 1999; Leung and Cao, 2000; Mikhailov, 2004 and Van Laarhoven and Pedrycz, 1983). These methods are systematic approaches to the alternative selection and justification problem by using the concepts of fuzzy set theory and hierarchical structure analysis. Decision-makers usually find that it is more confident to give interval judgments than fixed value judgments, because usually they are unable to judge explicitly about their preferences due to the fuzzy nature of the comparison process (Gumus, 2009). In this study, we prefer Chang (1996) extent analysis method because the steps of this approach are easier than the other fuzzy-AHP approaches (Fuzzy sets and AHP are not detailed here because of being well-known applications).
The steps of Chang (1996) extent analysis approach are as follows: Let \( X = \{x_1, x_2, \ldots, x_n\} \) be an object set, and \( U = \{u_1, u_2, \ldots, u_m\} \) be a goal set. According to the method of Chang (1996) extent analysis, each object is taken and extent analysis for each goal, \( g_i \), is performed, respectively. Therefore, \( m \) extent analysis values for each object can be obtained, with the following:

\[
\tilde{M}_{gi}^1, \tilde{M}_{gi}^2, \ldots, \tilde{M}_{gi}^m, \quad i = 1, 2, \ldots, n
\]

Where all the \( \tilde{M}_{gi}^j (j = 1, 2, \ldots, m) \) are triangular fuzzy numbers.

Step 1: The value of fuzzy synthetic extent with respect to the \( j \)-th object is defined as

\[
\tilde{S}_j = \sum_{i=1}^{m} \tilde{M}_{gi}^j \otimes \left[ \sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{M}_{gi}^j \right]^{-1}
\]

To obtain \( \sum_{i=1}^{n} \tilde{M}_{gi}^j \), perform the fuzzy addition operation of \( m \) extent analysis values for a particular raw, as

\[
\sum_{j=1}^{m} \tilde{M}_{gi}^j = \left( \sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j \right)
\]

and to obtain \( \left[ \sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{M}_{gi}^j \right]^{-1} \), perform the fuzzy edition operation of \( m \) extent analysis values for a particular matrix such that

\[
\sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{M}_{gi}^j = \left( \sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i \right)
\]

and then compute the inverse of the vector in above equation, such that

\[
\left[ \sum_{i=1}^{n} \sum_{j=1}^{m} \tilde{M}_{gi}^j \right]^{-1} = \left( \frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i} \right)
\]

Step 2: As \( \tilde{M}_1 \) and \( \tilde{M}_2 \) are two triangular fuzzy numbers, the degree of possibility of \( \tilde{M}_1 = (l_1, m_1, u_1) \geq \tilde{M}_2 = (l_2, m_2, u_2) \) is defined as,

\[
V(\tilde{M}_1 \geq \tilde{M}_2) = \sup \{ \min \mu_{\tilde{M}_1}(x), \min \mu_{\tilde{M}_2}(x) \}
\]

and can be equivalently expressed as follows:

\[
V(\tilde{M}_1 \geq \tilde{M}_2) = \text{hgt} (\tilde{M}_1 \cap \tilde{M}_2) = \mu_{\tilde{M}_1}(d) = \begin{cases} 
1 & \text{if } m_1 \geq m_2 \\
0 & \text{if } l_2 \geq u_1 \\
(u_1 - l_2)[(u_1 - l_2) + (m_2 - m_1)] & \text{otherwise}
\end{cases}
\]

Where \( d \) is the ordinate of the highest intersection point \( D \) between \( \mu_{\tilde{M}_1} \) and \( \mu_{\tilde{M}_2} \) (see Figure 2).

![Fig. 2. The intersection between \( \tilde{M}_1 \) and \( \tilde{M}_2 \)](image-url)
Step 3: The possibility degree for a convex fuzzy number to be greater than \( k \) convex fuzzy numbers \( M_i (i = 1, 2, \ldots, k) \) can be defined by,

\[
V(\tilde{M} \geq \tilde{M}_1, \tilde{M}_2, \ldots, \tilde{M}_k) = \min \left\{ V(\tilde{M} \geq \tilde{M}_i) , \ (i = 1, 2, \ldots, k) \right\}
\]

(6)

Assume that \( d'(A_i) = \min V(S_i \geq S_j) \) for \( i = 1, 2, \ldots, k ; k \neq i \). Then the weight factor is given by

\[
W' = (d'(A_1), d'(A_2), \ldots, d'(A_n))^T
\]

(7)

Where \( A_i (i = 1, 2, \ldots, n) \) are \( n \) elements.

Step 4: Via normalization, the normalized weights vector is

\[
W = (d (A_1), d (A_2), \ldots, d (A_n))^T
\]

(8)

Where \( W \) is a non-fuzzy number.

The membership function of the linguistic variables are summarized in table 2.

<table>
<thead>
<tr>
<th>Importance</th>
<th>Linguistic variable</th>
<th>Positive TFN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal or not important</td>
<td>(1, 1, 1)</td>
</tr>
<tr>
<td>3</td>
<td>Weak important</td>
<td>(1, 3, 5)</td>
</tr>
<tr>
<td>5</td>
<td>Moderate important</td>
<td>(3, 5, 7)</td>
</tr>
<tr>
<td>7</td>
<td>Strong important</td>
<td>(5, 7, 9)</td>
</tr>
<tr>
<td>9</td>
<td>Extreme important</td>
<td>(7, 9, 9)</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>Intermediate value between two adjacent judgments</td>
<td></td>
</tr>
</tbody>
</table>

Where, 2, 4, 6 and 8 are intermediate triangular fuzzy measures.

4. Calculating the weights of the BSC perspectives and Factors

Based on the hierarchical framework of the BSC performance evaluation indexes, the FAHP (EA) questionnaire using TFN (Table 2) was distributed among the experts for soliciting their professional opinions. Then, FAHP established the relative importance of four BSC perspectives as well as their evaluation factors. The results show that the critical order of the four BSC dimensions and their factors for banking performance evaluation are ‘‘F: Finance (0.398)’’, ‘‘C: Customer (0.334)’’, ‘‘P: Internal process (0.208)’’, and ‘‘L: Learning and growth (0.092)’’.
Table 1. Summary of BSC performance factors of banking

<table>
<thead>
<tr>
<th>Perspective</th>
<th>Indicator</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial (0.398)</strong></td>
<td>(F₁)</td>
<td>Operating income (0.0641)</td>
</tr>
<tr>
<td></td>
<td>(F₂)</td>
<td>Non operating income</td>
</tr>
<tr>
<td></td>
<td>(F₃)</td>
<td>Return on assets (0.1234)</td>
</tr>
<tr>
<td></td>
<td>(F₄)</td>
<td>Profit margin (0.0641)</td>
</tr>
<tr>
<td></td>
<td>(F₅)</td>
<td>Bank sales (0.0247)</td>
</tr>
<tr>
<td></td>
<td>(F₆)</td>
<td>Bank claims (0.0291)</td>
</tr>
<tr>
<td></td>
<td>(F₇)</td>
<td>Resources (0.0004)</td>
</tr>
<tr>
<td><strong>Customer (0.334)</strong></td>
<td>(C₁)</td>
<td>Customer satisfaction</td>
</tr>
<tr>
<td></td>
<td>(C₂)</td>
<td>Profit per customer (0.1526)</td>
</tr>
<tr>
<td></td>
<td>(C₃)</td>
<td>Number of customers (0.0047)</td>
</tr>
<tr>
<td></td>
<td>(C₄)</td>
<td>Customers increasing rate (0.0638)</td>
</tr>
<tr>
<td><strong>Internal Process</strong></td>
<td>(P₁)</td>
<td>Transaction efficiency (0.0682)</td>
</tr>
<tr>
<td><strong>(0.208)</strong></td>
<td>(P₂)</td>
<td>Management performance (0.0291)</td>
</tr>
<tr>
<td></td>
<td>(P₃)</td>
<td>Sales performance (0.0414)</td>
</tr>
<tr>
<td></td>
<td>(P₄)</td>
<td>No. of VPOS accounts (0.0539)</td>
</tr>
<tr>
<td></td>
<td>(P₅)</td>
<td>No. of E-wallets (0.0042)</td>
</tr>
<tr>
<td></td>
<td>(P₆)</td>
<td>No. of internet bank services (0.0112)</td>
</tr>
<tr>
<td></td>
<td>(P₇)</td>
<td>No. of mobile bank services (0.0000)</td>
</tr>
<tr>
<td><strong>Learning and</strong></td>
<td>(L₁)</td>
<td>Employee training (0.0184)</td>
</tr>
<tr>
<td><strong>Growth (0.092)</strong></td>
<td>(L₂)</td>
<td>Personnel productivity (0.0277)</td>
</tr>
<tr>
<td></td>
<td>(L₃)</td>
<td>Employee satisfaction (0.0370)</td>
</tr>
<tr>
<td></td>
<td>(L₄)</td>
<td>Job rotation (0.0007)</td>
</tr>
<tr>
<td></td>
<td>(L₅)</td>
<td>Information system (0.0082)</td>
</tr>
</tbody>
</table>

The evaluation indexes of customer perspectives are “F1: Operating Income (0.0641)”, “F2: Non operating income (0.0927)”, “F3: Return on assets (0.1234)”, “F4: profit margin (0.0641)”, “F5: (0.0247)”, “F6: (0.0291)”, “F7: (0.0004)”. The evaluation indexes of customer perspective are “C1: Customer satisfaction (0.1129)”, “C2: Profit per customer (0.1526)”, “C3: Number of customers (0.0047)”, “C4: Customers increasing rate (0.0638)”. The evaluation indexes of Internal process perspective are “P1: Transaction efficiency...
(0.0682)

P2: Management performance (0.0291)

P3: Sales performance (0.0414)

P4: No. of VPOS accounts (0.0539)

P5: No. of E-wallets (0.0042)

P6: No. of internet bank services (0.0112)

P7: No. of mobile bank services (0.0000)

The evaluation indexes of learning and growth perspective are

L1: employee training (0.0184)

L2: employee productivity (0.0277)

L3: employee satisfaction (0.0370)

L4: job rotation (0.0007)

L5: information system (0.0082)

The relative importance (fuzzy weight) of each performance index analyzed by FAHP is listed in Table 1 using Equations (1) to (8).

6. Conclusion

The Balanced Scorecard is a popular tool that provides insights into corporate performance not only for managers seeking ways to improve performance, but also for investors wanting to gauge the organizations’ ongoing health. Based on the extensive content of the BSC evaluation factors for banking performance as selected from the relevant literature and the objective opinions synthesized from the experts, the FAHP adopted in the performance analysis for computing the fuzzy weights of the factors. The relative fuzzy weights calculated by FAHP revealed that financial (0.398), customer (0.338), internal process (0.208) and learning and growth (0.092) perspectives, respectively as the more important BSC perspectives in bank performance evaluation. In addition, among BSC indexes, profit per customer, return on assets, customer satisfaction and non operating revenue are four critical indexes, respectively.

References:


