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BSE Index Ranking and Performance Evaluation Using MCDM Techniques

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Abstract - *It is very difficult to select best index with multiple equally important criterion. Multi Criteria Decision Making (MCDM) is the best method used for ranking alternatives for decision making and performance evaluation with conflicting criterion. Indices have different criterion like P/E ratio, P/B ratio, Dividend etc.. In this research we use two popular MCDM techniques AHP and TOPSIS for index ranking. The performance evaluation is also done using both methods. Six indices namely BSE SENSEX, BSE BENKEX, BSE GREENEX, BSE CARBONEX, BSE AUTO and BSE 100 from Bombay Stock Exchange (BSE) of year 2016-17 are used in experimental work to find best index. Applying AHP and TOPSIS method BSE SENSEX identifies as the top ranked index.*

Key Words: **Multi criteria decision making (MCDM), Analytical Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method, Bombay Stock Exchange (BSE), Index Ranking.**

1. INTRODUCTION

High return of investment is based on selection of best indices from the financial market. Selection of best indices for the investment is the challenging task for the fund manager as well as investors. The main challenge is to manage all criterion which is conflicting in nature. Multi Criteria Decision Making (MCDM) techniques are ranking based methods used to calculate the performance of indices. The ranks of indices help the investor to make decisions for investment. A portfolio is basically a collection of stocks held by an institution or individual which may be more reliable than individual stock. On the other hand portfolio selection is a process of choosing which assets and in what proportion will be best with respect to the investor's preferences for achieving an expected return with minimum risk . Investment in the portfolio may be less risky with less gain as compare to individual stock, but taking the decision to choose best portfolio by the decision makers either as investor or financial manager is a tedious and risky job. Due to complex market competitions under the extremely competitive business environment, financial institutions try their best to make an ultimate policy for portfolio selection to optimize the investor returns. Risk was quantified such that investors could analyze risk return choices. Moreover, quantification of risk, enabled investors to measure risk reduction generated by diversification of investment. So it is essential to diversify the investment to create an efficient portfolio. A framework for mean-variance portfolio optimization is proposed by Markowitz in 1952[1] , the researchers are always investigating to enhance the framework by applying sophisticated quantitative or qualitative techniques. Portfolio selection problem may be considered as multi criteria decision making problem, where the portfolio may consists conflicting nature of criteria. Analytical Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method, Simple Additive Weighting(SAW) etc. are some very popular methods for selection process. So many domains are there like engineering, science etc. where AHP is very useful MCDM method used by the researchers. Fuzzy AHP and TOPSIS method are used by author [2][3][4] for the ranking of teacher's performance in different educational fields. Another author [6] has used multi-criteria decision approach for choosing optimal blanching-freezing system. AHP and TOSIS method are also used to evaluate the performance of healthcare industry [6][7].

2. PRAPOSED WORKFLOW

The proposed workflow of this research is presented in fig1.

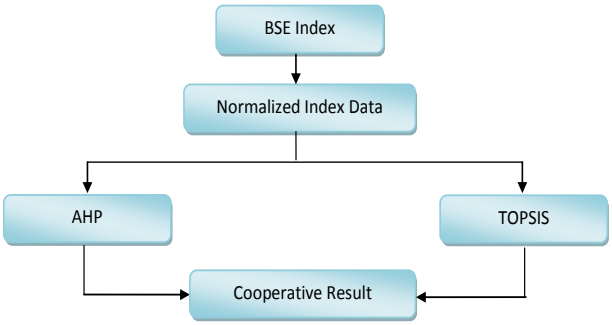

Fig -1: Workflow

2.1 Index Data

In this research five popular indices of BSE (Bombay Stock Exchange), downloaded from www.bseindia.com. BSE SENSEX, BSE BENKEX, BSE GREENEX, BSE CARBONEX, BSE AUTO and BSE 100 are index with six criterion High (C1), Low (C2), Close (C3), P/E ratio (C4), P/B ratio (C5) and Dividend (C6) used for the experimental work.

2.2 Ranking Methods

AHP and TOPSIS are the most popular MCDM techniques. These methods are widely used for the ranking alternatives having conflicting criterion. Method description is as follows:

(i)AHP - Satty [8] was proposed a most popular MCDM method for decision making named AHP. The overall ranking is doen using AHP method by assessing the relative importance of these criteria, comparing alternatives for each criterion.

The method is described as follows:

Step 1: Determine the objective with alternative and criteria.

Step 2: Now we prepared a normalized object data for the portfolio ranking . For this we divides all value of a column with max value of that column . Let A is a column now calculation is done through following formula-

$$Ai=(Ai/\max(A)) \quad (1)$$

Here ith value is divided by the maximum value of corresponding column for normalized value

Step 3: Now construct a pair-wise comparison matrix using a scale of relative importance [10]. The judgments are entered using the fundamental scale of the analytic hierarchy process. An attribute compared with it is always assigned the value "1", so the main diagonal entries of the pair-wise comparison matrix are all "1" and the rating is based on Saaty's nine point scale .Assuming M attributes, the pair–wise comparison of attribute i with attribute j yields a square matrix $B_{M\times M}$where a_{ij}denotes the comparative importance of attribute i with respect to attribute j, this matrix is represented as A1. In the matrix b_{ij}=1 when i=j and

$b_{ji}=\frac{1}{b_{ij}}$

Find the relative normalized weight (Wj) of each attribute by

(i) Calculating the geometric mean of the ith row, and

(ii) Normalizing the geometric means of rows in the comparison matrix. This can be represented as:

$$GM_j=\left[\prod_{i=1}^{M} b_{ij}\right]^{1/M} \quad \text{and} \quad W_j=GM_j/\sum_{i=1}^{M} GM_j \quad (2)$$

Calculate matrices E1 and E2 such that E1(A3)=A1$\times$A2 and E2= A3/A2, where A2=[w1,w2,……..,wi]T.

Determine the maximum Eigen value λ_{max}that is the average of matrix A4. Calculate the consistency index

$$CI=\frac{(\lambda_{max}-M)}{(M-1)} \quad (3)$$

Obtain the random index (RI) for the number of attributes used in decision making [11]. Calculate the consistency ratio

$$CR=CI/RI \quad (4)$$

Step 4: In this step, we need to obtain the overall or composite performance scores for the alternatives by multiplying the relative normalized weight (Wj) of each attribute (obtained in step two) with its corresponding normalized object data for each alternative and summing over the attributes for each alternative.

(ii) TOPSIS- Another method is TOPSIS method praposed by Hwang et al.[4] that is effectively used for ranking alternative. The weight of criterion can be obtained using different opinion pool or other method like AHP. Steps in TOPSIS are as follows:

Step 1- Input weights obtained through method like AHP.
Step 2:- Calculate normalized decision matrix N, using following equation

$$r_{ij}=x_{ij}/\left[\sum_{i=1}^{M} x_{ij}^{\ 2}\right]^{1/2} \quad (5)$$

Step 3:- Multiplying each row or N by respected weight obtained previously to obtain weighted decision matrix W.

Step 4:- Obtain set of positive ideal values and negative ideal values of each criterion to find positive ideal (A*) and the negative ideal (A-) solution.

Step 5:- Calculate separation measures (S*) from positive ideal solution and (S^-) from negative ideal solution for all the alternatives.

For i = 1....m.

$$S_i^*=\sqrt[2]{\sum_{j=1}^{n}(v_{ij}-v_j^*)^2} \quad (6)$$

$$S_i^-=\sqrt[2]{\sum_{j=1}^{n}(v_{ij}-v_j^-)^2} \quad (7)$$

Step 6:- Calculate relative closeness Ci to the ideal solution for each alternative using following equation:
(Ci*, i = 1.....m) As

$$C_i^*=S_i/(S_i^*+S_i^-) \quad (8)$$

Step 7:- Determine the preference order by arranging the alternative in the descending order of Ci* , i=1...m.

3. EXPERIMANTAL WORK

Six indices BSE SENSEX(I_{Snsex}), BSE BENKEX (I_{Bankex}), BSE GREENEX($I_{Greenex}$), BSE CARBONEX($I_{Carbonex}$), BSE AUTO(I_{Auto}), BSE 100(I_{100}) with six criterion High (C1), Low (C2), Close (C3), P/E ratio (C4), P/B ratio (C5) and Dividend (C6) of year 2016-17 used for the experimental work downloaded from www.bseindia.com. The normalized matrix N with five indices and six criterion calculated using equation 1 shown in Table 1.

For the consistence weight it is necessary that vale of CR should be less than 0.1. The evaluation of criterion weights is already done by Hota et al[9] presented in Table 2. Hoat et al.

calculates the value of CR is 0.099 which is less than 0.1. Therefore criterion weights assigned by the expert are accepted and can be used to find the rank of indices. Finally process as explained in step 4 in AHP applied for index ranking and presented in Table 3.

Table -1: BSE Index Data of Year 2016-17

S. N.	Name of Portfolio	Criteria					
		High	Low	Close	P/E ratio	P/B ratio	Dividend
1	I_{Snsex}	1	1	1	0.79	0.69	1
2	I_{Bankex}	0.83	0.72	0.82	0.84	0.49	0.67
3	$I_{Greenex}$	0.09	0.09	0.09	1	0.71	0.76
4	$I_{Carbonex}$	0.05	0.05	0.05	0.89	0.65	0.93
5	I_{Auto}	0.78	0.70	0.74	0.87	1	0.59
6	I_{100}	0.32	0.70	0.32	0.86	0.65	0.94

Table -2: Weights of corresponding criteria calculated through AHP method

C1	C2	C3	C4	C5	C6
0.42	0.08	0.23	0.13	0.08	0.05

Table -3: Index Ranking Using AHP Method

Index	AHP	
	Weighted Score	Rank
I_{Snsex}	0.95	1^{ST}
I_{Bankex}	0.78	3^{RD}
$I_{Greenex}$	0.29	5^{TH}
$I_{Carbonex}$	0.26	6^{TH}
I_{Auto}	0.78	2^{ND}
I_{100}	0.48	4^{TH}

For the performance analysis TOPSIS method is also applied for BSE index ranking of year 2016-17. Normalized value is calculated using equation 1 and presented in Table 4. A decision matrix V is calculated using step 3 of TOPSIS method and presented in Table 5 in which positive ideal solution (PIS) and negative ideal solution (NIS) as highlighted in bold and underlined letters respectively. Now using equation 6 and 7 Separation measures of each alternative is calculate for PIS and NIS presented in Table 6. Finally the relative closeness value is calculated using equation (4) and rank of six stock indices are obtained and presented in Table 7.

Table -4: Normalized portfolio data applied with TOPSIS with six stock indices and six attributes

S. No	Stock index	Criteria					
		High	Low	Close	P/E ratio	P/B ratio	Dividend
1	I_{Snsex}	0.65	0.69	0.65	0.37	0.40	0.49
2	I_{Bankex}	0.53	0.49	0.54	0.39	0.28	0.33
3	$I_{Greenex}$	0.06	0.06	0.06	0.47	0.41	0.37
4	$I_{Carbone}$	0.03	0.03	0.03	0.41	0.37	0.46
5	I_{Auto}	0.50	0.49	0.49	0.41	0.57	0.29
6	I_{100}	0.21	0.21	0.21	0.40	0.37	0.46

Table -5: Weighted decision matrix (V)

S. No	Stock index	Criteria					
		High	Low	Close	P/E ratio	P/B ratio	Dividend
1	I_{Snsex}	0.35	0.07	0.189	0.04	0.05	0.02
2	$I_{Bankex,}$	0.11	0.02	0.06	0.02	0.02	0.02
3	$I_{Greenex}$	0.11	0.02	0.06	0.11	0.02	0.03
4	$I_{Carbone}$	0.11	0.02	0.06	0.03	0.04	0.02
5	I_{Auto}	0.04	0.01	0.022	0.03	0.04	0.02
6	I_{100}	0.12	0.02	0.069	0.03	0.03	0.02

Table -6: Separation Measurers

	I_{Snsex}	I_{Bankex}	$I_{Greenex}$	$I_{Carbonex}$	I_{Auto}	I_{100}
Si*	0.07	0.33	0.28	0.29	0.36	0.27
Si-	0.38	0.07	0.12	0.08	0.024	0.10

Table -7: Obtained rank using TOPSIS for the financial year 2013-14

Stock index	CI*(Relative Closeness)	Rank
I_{Snsex}	0.94	1^{ST}
I_{Bankex}	0.31	3^{RD}
$I_{Greenex}$	0.07	5^{TH}
$I_{Carbonex}$	0.04	6^{TH}
I_{Auto}	0.75	2^{ND}
I_{100}	0.28	4^{TH}

4. COMPARATIVE ANALYSIS FOR PERFORMANCE EVALUATION

The performance evaluation is done and presented in table for financial year 2016-17 of all the method AHP and TOSIS. The result in table 8 clearly shows the consistency of ranks of indices is maintained for both methods.

Table -8: Rank comparison of BSE indices of Year 2016-17

S. No.	AHP	TOSIS
BSE SENSEX	1ST	1ST
BSE BANKEX	3RD	3RD
BSE GREENEX	5TH	5TH
BSE CARBONEX	6TH	6TH
BSE AUTO	2ND	2ND
BSE 100	4TH	4TH

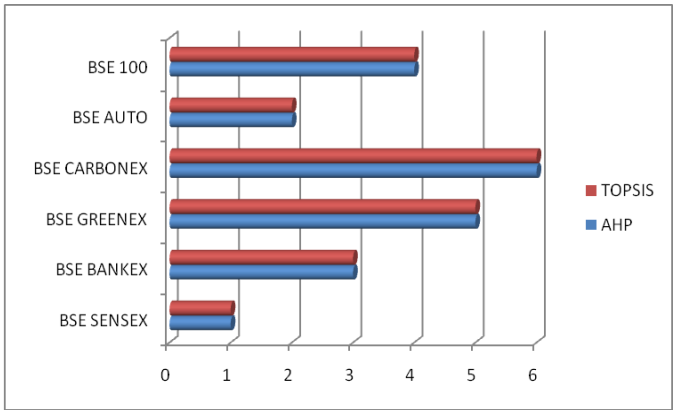

Fig-2: Comparative Analysis of ranks using AHP and TOPSIS

Figure 2 represents that BSE SENSEX has been identified as 1st ranked index both AHP and TOPSIS method.

5. CONCLUSION

Ranking of indices are best method used for decision making for investor and managers. MCDM techniques are used for index ranking with multiple conflicting criterion. AHP and TOPSIS are two popular MCDM techniques. Six BSE indices of year 2016-17 are used for index ranking in experimental study. The comparative analysis of both the method we found that BSE SENSEX is the best index for investment.

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