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AHP Method Applied for Portfolio Ranking of Various Indices and Its Year Wise Comparison

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Abstract: *One of the decision problems in the financial domain is portfolio selection in investor's point of view on the other hand portfolio management is in management point of view ,in both the cases ranking of the portfolio will be required.. While facing the 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. Multi criteria decision making (MCDM) is one of the technique which can be applied in better way to evaluate portfolio performance and finally decide ranking of the portfolio based on the multiple conflicting criteria of the indices. A portfolio may have many criterion such as low ,high, dividend, yearly return, price earnings ratio (P/E),price-to-book ratio(P/B) etc.. In this research work a popular MCDM method: Analytical Hierarchy Process (AHP) is applied to obtain the rank of portfolio for further decision making process. Data of six portfolios of Bombay Stock Exchange (BSE) namely S&P BSE SENSEX, S&P BSE MID CAP, S&P BSE SMALL CAP, S&P BSE100, S&P BSE200 and S&P BSE500 of three consecutive financial years: 2011-2012, 2012-2013 and 2013-2014 are collected for the study and to find out best portfolio. After applying AHP method S&P BSE SENSEX is found to be better than other portfolios as first rank consistently for all three financial years.*

Keywords: *Multi criteria decision making (MCDM), Portfolio, Analytical Hierarchy Process (AHP).*

1. INTRODUCTION

A portfolio is basically a collection of stocks held by an institution or individual which may be more reliable than individual stock. 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 as either investor or financial manager. Portfolio selection is a process of choosing which assets and in what proportion will best respect the investor's preferences for achieving an expected return with minimum risk [1].In order to face the 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 that is essential to create an efficient portfolio. A framework for mean-variance portfolio optimization is proposed by Markowitz in 1952[2] , 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.

AHP is very popular MCDM method utilized by the researchers in many domains like engineering, science etc.. Author [3][4][5] used Fuzzy AHP and TOPSIS method for the ranking of teacher's performance in different educational fields. One [6] is used multi-criteria decision approach to choosing the optimal blanching-freezing system. There are some other researchers [7-8] who have used AHP and TOPSIS method about performance evaluation in healthcare industry. However very less literatures relate to application of AHP in financial domain are available. AHP may be one of the

choice for the researchers to be utilized for portfolio selection. A portfolio may have many criterion like high, low, dividend, yearly return, P/E ratio etc. but all these criterion may be of conflicting in nature, due to this it is a tedious task to decide the rank of the portfolio.

In this paper we have used AHP method to obtain ranking of the portfolio. A number of functional characteristics make AHP a useful methodology. Three years financial data of six different portfolios are considered for the study. These portfolios consists six different conflicting criterion as shown in Table 1. A year wise comparative rank for three financial years show that S&P BSE SENSEX is consistently performing better than other portfolios considered in this study.

Table1. *Portfolio quantitative criteria*

Criteria	Id	Meaning
High	C1	This contain the highest values of portfolio in a certain year.
Low	C2	This contain the lowest values of portfolio in a certain year.
Close	C3	This contain the closing point at march 31 in a certain year.
P/E ratio	C4	A quantitative ratio of a company current share price compared to its per-share earnings. It can be define as market price per share divided by annual earnings per share.
P/B ratio	C5	A ratio used to compare a stock's market value to its book value which is calculated by dividing stock's current closing price by the latest quarter's book value per share.
Dividend	C6	This is a payment made by a corporation to its shareholders, usually as a distribution of profits.

2. FORMULATION OF ANALYTIC HIERARCHY PROCESS (AHP)

One of the most popular MCDM technique for complex decision-making problem is the AHP which is originally proposed by Satty [9] , is an approach for decision making that involves structuring multiple choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criteria, and determining an overall ranking of the alternatives.

The overall procedure of AHP using the radical root method (Also called the geometric mean method) is 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-

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

Here i^{th} 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 i^{th} row, and

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

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

$$\text{and } W_j=GM_j \Big/ \sum_{i=1}^{M} GM_j$$

Calculate matrices E1 and E2 such that E1(A3)=A1×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.

3. PORTFOLIO RANKING USING AHP

The portfolio data for the experiment is downloaded from financial site (www.bseindia.com) of BSE. BSE, established in 1875, is Asia's first & fastest stock exchange it has also facilitates the Indian's corporate sector growth by providing it an efficient capital-raising platform.BSE system also processes are designed to safeguard market integrity, drive the growth of Indian capital market and stimulate involution competition across all market all the market segment. There are many popular BSE's equity index like S&P BSE SENSEX, S&P BSE MID CAP, S&P BSE 100 etc. are available [12].

The normalized BSE data of six portfolios for financial year 2013-2014 with six different criterion is shown in Table 2. This is the initial 6X6 matrix from which AHP method can be applied. In the study only one financial year data is used for the purpose of demonstration and clarity of applying AHP method for portfolio selection and ranking and in the similar way AHP may be applied for other two financial years.

Table2. *Normalized portfolio data applied with AHP with six portfolios and six attributes (Criteria)*

S.N.	Name of Portfolio	Criteria					
		High	Low	Close	P/E ratio	P/B ratio	Dividend
1	S&P BSE SENSEX	1	1	1	0.335	1	0.852
2	S&P BSE MID CAP	0.315	0.293	0.316	0.221	0.660	0.932
3	S&P BSE SMALL CAP	0.315	0.291	0.315	1	0.488	1
4	S&P BSE 100	0.299	0.293	0.299	0.317	0.932	0.847
5	S&P BSE 200	0.119	0.117	0.119	0.314	0.909	0.858
6	S&P BSE 500	0.370	0.361	0.370	0.302	0.871	0.864

Table3. *Relative importance matrix (pair-wise comparison: Criteria to Criteria)*

A_{ij}	C1	C2	C3	C4	C5	C6	GM	Relative Normalized Weight (W=A2)	E1(A3)= A1*A2	E2= A3/A2	λ_{max}	CI	CR
C1	1	5	3	5	3	5	3.22	0.42	2.70	6.42	6.62	0.12	0.099
C2	0.2	1	0.33	1	1	1	0.63	0.08	0.51	6.18			
C3	0.33	3	1	3	3	3	1.73	0.22	1.42	6.32			
C4	0.2	1	0.33	1	5	3	1	0.13	0.96	7.36			
C5	0.33	1	0.33	0.2	1	3	0.63	0.08	0.58	6.98			
C6	0.2	1	0.33	0.33	0.33	1	0.44	0.05	0.37	6.44			
							7.67						

A relative importance matrix as shown in Table 3 is constructed using Saaty's 9 point scale [9] and based on the experience of financial experts. As per requirement, value of each attribute (A_{ij}) is assigned. Some of the investor selects a portfolio based on higher value of P/E ratio and dividend then the other criteria. In the Table 2, High is more important than Low in portfolio selection problem, so a relative importance value of 5 (A_{12} =5) is assigned to High (C1) over Low (C2) and a relative importance value 1/5=0.2 is assigned to Low (C2) over High (C1). Similarly other values in the

matrix are assigned based on the expert judgment. In the matrix A_{ij} =1 for i=j, means when a criteria is compared with itself, relative importance value will be always 1.Now using equation 2,3 and 4 respectively geometric mean, consistency index (CI) and consistency ratio (CR) are calculated and presented in the same table (Table 3). The basic aim of the weighted matrix is to calculate the value of CR which should be less than 0.1 which proves good consistency in the judgements made by the experts. As per calculation the value of CR is 0.099 which is less than 0.1,hence the weights assigned by the expert are consistent and can be used in the selection process to obtain final rank of portfolios.

Ones the weight are proved to be consistent, AHP is further applied as explained in the previous section to find out rank of portfolios as shown in Table 4.

The entire process as explained above is applied for stock portfolio data of the financial year 2012-2013 and 2011-2012 and obtained rank of portfolios are presented in Table 5.The rank of the portfolio of three consecutive financial years may be compared to check the consistent performance of the portfolios over the years for decision making process, rank of these three financial years are presented in Table 6, from which it is clear that S&P BSE SENSEX is continuously performing well by holding first rank in all three years. Rank of other portfolios are however not consistent but S&P MID CAP, S&P BSE200 and S&P BSE500 are gaining same ranks at least in two financial years out three however portfolio for 2nd and 5th rank not consistent over the years.

Table4. *Obtained rank using AHP for the financial year 2013-14*

S.No.	Portfolio	Weight value	Rank
1	S&P BSE SENSEX	0.904	1st
2	S&P BSE MID CAP	0.344	5th
3	S&P BSE SMALL CAP	0.447	2nd
4	S&P BSE 100	0.380	4th
5	S&P BSE 200	0.247	6th
6	S&P BSE 500	0.418	3rd

Table5. *Obtained rank using AHP for the financial years 2012-13 and 2011-12*

S.No.	Portfolio	Financial Year 2012-13		Financial Year 2011-12	
		Weight	Ranks	Weight	Ranks
1	S&P BSE SENSEX	1.161	1st	1.193	1st
2	S&P BSE MID CAP	0.478	4th	0.489	4th
3	S&P BSE SMALL CAP	0.484	3nd	0.498	3rd
4	S&P BSE 100	0.460	5th	0.482	5th
5	S&P BSE 200	0.326	6th	0.343	6th
6	S&P BSE 500	0.514	2rd	0.507	2nd

Table6. *Year wise comparison of portfolios*

Year	S&P BSE SENSEX	S&P BSE MID CAP	S&P BSE SMALL CAP	S&P BSE 100	S&P BSE 200	S&P BSE 500
2013-14	1st	5th	2nd	4th	6th	3rd
2012-13	1st	4th	3rd	5th	6th	2nd
2011-12	1st	4th	5th	2nd	6th	3rd

4. CONCLUSION

For smart and intelligent decision making process in investment point of view, rank of the portfolio must be determined. AHP is a popular MCDM method which is used to obtain rank in case of conflicting criteria. Six criterions are selected based on suggestion of financial experts for the study with six different portfolios. The simulated data for the three consecutive financial years are used to check the performance of these portfolios year-by-year. After going through the AHP process it is found that S&P BSE SENSEX is consistently performed well by holding first rank for all three financial years, which helps the investors to rely on this portfolio more as compare to other portfolios selected in this study.

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