Acta Ciencia Indica, Vol. XLII M, No. 2, 139 (2016)

TOWARDS A GOAL PROGRAMMING METHODOLOGY FOR CONSTRUCTING EQUITY MUTUAL FUND PORTFOLIOS

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RECEIVED : 17 May, 2016

The evaluation of the performance of mutual fund [MF] portfolios has been a very interesting research topic not only for researchers, but also for managers of financial, banking and investment institutions. In this chapter, a multicriteria decision aid framework is proposed for the construction of MF portfolios. The proposed methodology is based on a Goal Programming approach to determine the proportion of each MF in the constructed portfolios. This methodology is applied on a sample of Indian MFs over the period 2007-2006 with encouraging results.

KEYWORDS : Mutual Fund Port Folio**:** Goal Programming.

INTRODUCTION

A mutual fund is a financial intermediary that pools the savings of investors for collective investment in a diversified portfolio of securities. A fund is "mutual" as all of its returns, minus its expenses, are shared by the fund's investors. The Securities and Exchange Board of India (Mutual Funds) Regulations, 1996 defines a mutual fund as a 'a fund established in the form of a trust to raise money through the sale of units to the public or a section of the public under one or more schemes for investing in securities, including money market instruments'. According to the above definition, a mutual fund in India can raise resources through sale of units to the public. It can be set up in the form of a Trust under the Indian Trust Act. The definition has been further extended by allowing mutual funds to diversify their activities in the following areas: Portfolio management services · Management of offshore funds - Providing advice to offshore funds · Management of pension or provident funds · Management of venture capital funds· Management of money market funds · Management of real estate funds A mutual fund serves as a link between the investor and the securities market by mobilising savings from the investors and investing them in the securities market to generate returns. Thus, a mutual fund is akin to portfolio management services (PMS). Although, both are conceptually same, they are different from each other. Portfolio management services are offered to high net worth individuals; taking into account their risk profile, their investments are managed separately. In the case of mutual funds, savings of small investors are pooled under a scheme and the returns are distributed in the same proportion in which the investments are made by the investors/unit-holders. Mutual fund is a collective savings scheme. Mutual funds play an important role in mobilising the savings of small investors and channelizing the same for productive ventures. Saving is the surplus of income over expenditure and when such savings are invested to generate more money, it is called investment. Livestock, land and precious metals are some of the traditional investment options. During 19th century, revolution in investment took place through the banking system as it provide many investment options like Fixed deposits (FDs), government bonds, Public Provident Fund (PPF) to its investors. With the development of capital market, investment in stocks became a good option for generating higher returns. However, greater risk and lack of knowledge about the movement of stock prices were also associated with them. Therefore, mutual funds emerged as an ultra modern method of investment to lessen the risk at low cost with experts' knowledge. According to Association of Mutual Funds in India (AMFI), a Mutual Fund is a trust that pools the savings of a number of investors who share a common financial goal and invest it in capital market instruments such as shares, debentures and other securities. The income earned and capital appreciation thus realized are shared by its unit holders in proportion to the number of units owned by them. Thus, it offers to common man an opportunity to invest in a diversified, professionally managed basket of securities at a relatively low cost. In India, Mutual Fund industry started in 1963 with the formation of Unit Trust of India (UTI). It was the first phase (1964–1987) of Indian mutual fund industry during which UTI enjoyed a complete monopoly. In the second phase (1987–1993), Government of India allowed public sector banks and financial institutions to set up mutual funds.

Third phase (1993–2003) started with the entry of private sector and foreign funds. The fourth phase (since February 2003 till date), is the age of consolidation and growth. As on 31 March 2012, there are 44 mutual fund companies with 1309 schemes and the average asset under management as Rs 66,47,920 million with a wide variety such as Open-Ended, Close-Ended, Interval, Growth, Income, Balanced, Equity Linked Savings Scheme (ELSS) and so on that caters to the investors' needs, risk tolerance and return expectations. Because of the large number of mutual fund companies and schemes, retail investors are facing problems in selecting right funds. Also, it is of paramount importance for policy makers, governing bodies and mutual fund companies to analyze as which schemes are efficient performers. Therefore, to study the performance of mutual funds in terms of efficiency and the methods of improving it is of crucial importance. In general, Net Asset Value (NAV) is taken as criteria for the performance measurement and it is based on the risk return.

DATA OF THE PROBLEM

The sample used in this study is provided from the ICICI Mutual Fund Company and consists of daily data [Returns] of all domestic equity MFs operating in the Indian market over the period 2004-2006. At the end of 2007, the sample consisted of 72 domestic equity MFs. Nevertheless, not all MFs have been in operation for the whole three-year time period of the analysis. Actually, there were full data for the whole period for only 33 MFs. Therefore, in order to eliminate the effect that could be caused by the fact that not all MFs were in operation for the same period, it was decided to consider only these 33 MFs for which complete data were available. For application of the proposed methodology, further information is derived from the Bombay Stock Exchange and the Reserve Bank of India, regarding the return of the market portfolio and the three-month Treasury bill rate, respectively.

Table 1: Performance of the Selected MFs on the Evaluation Criteria

	Criteria								
	Standard deviation	**% Change**	**Geo. mean of excess Return [%]**	**Sharp index**	**β coefficient**	**Jensen α coefficient**	**HM's α coefficient**	**HM's γ coefficient**	**Treynor and Black index**
Mutual funds	**σ [%]**	**In NAV**							
Alpha Trust Infrastructure [Domestic][a,b]	59.112	2262.886	69.896	-0.302	0.913	0.016	0.115	-0,154	0.018
Alpha HDFC Domestic Equity[3]	54.941	1878.566	26.841	-0.893	0.908	0.005	0.031	-0.074	0.009
Alpha Domestic Equity Fund[a]	52.754	855.662	23.470	-0.985	0.871	0.001	0.021	-0.028	0.002
ICICI Value Index Domestic Equity[a,b]	51.092	2840.323	40.730	-0.756	0.810	-0.022	-0.030	0.010	-0.040
HSBC Growth[a,b]	53.340	25.538	36.588	-0.781	0.879	0.025	0.084	-0.079	0.045
Interamerican Small Capitalisation[a]	56.407	1047.875	6.509	-1.173	0.918	-0.009	0.074	-0.089	-0.014
tnteramerican Dynamic MF Equity[a]	51.502	4.770	9.054	-1 .262	0.876	-0.010	0.032	-0.041	-0.030
Sogen Invest Domestic Equity Fund[a,b]	55.164	-22.720	28.473	-0.850	0.881	0.105	0.183	-0.113	0.138
European Reliance Growth Fund[a,b]	54.775	224.262	12.231	-1.133	0.914	-0.013	-0.022	0.035	-0.034
Alpha Trust Growth Domestic Equity[b]	63.298	127.021	30.181	-0.716	1.016	0.027	0.051	-0.070	0.035
Alpha Trust New Enterprises Dom[b]	56.699	220.131	38.405	-0.680	0.872	0.016	0.096	-0.140	0.019
HSBC Dom. Equity Fund FTSE/ASE20[b]	45.232	79.781	-1.157	-1 .641	0.773	-0.021	-0.038	0.021	-0.067
Alpha Growth Domestic Equity Fund[b]	48.198	370.110	21.285	-1.121	0.821	-0.027	-0.032	0.008	-0.081
Laiki Indian Equity Fund[b]	56.397	1925.976	24.621	-0.888	0.878	-0.035	0.031	-0.091	-0.048
Teiesis Equity Domestic Fund[b]	48.763	166.397	23.913	-1.051	0.800	-0.019	0.018	-0.049	-0.037
Most/least preferred value	51 .0927	2840.323/	69.8967	-0.3027	0.8107	0.1057	0.1837	0.035/	0.1387
[1st grouping scenario]	59.112	-22.720	6.509	-1 .262	0.918	-0.022	-0.030	-0.154	-0.040
Most/least preferred value	48.198/	2840.323/	69.8967	-0.302/	0.7737	0.1057	0.1837	0.0357	0.1387
[2nd grouping scenario]	63.298	-22.720	-1.157	-1.641	1.016	-0.035	-0.038	-0.154	-0.081

[a]MF considered for the 1st grouping scenario.

[b]MF considered for the 2nd grouping scenario.

Furthermore, in the present study, for the selection of MFs used in portfolio composition, the MFs under consideration are classified in two homogeneous predefined groups. The classification is accomplished with the help of Indian MF managers. It was decided to employ an approach involving the classification of MFs according to their performance in relation to the Bombay Stock Exchange General Index [BSE-GI], which is used as a proxy of the market.

Table 2. Investment policy scenarios and weights of the evaluation criteria

Weights of the evaluation criteria					
Scenarios	**Return**	**Risk**	**Manager's ability**	**NAV**	**Diversification**
1	1	1	1	1	2
2	2	2	2	1	2
3	2	5	2	1	2
4	2	1	2	1	2
5	5	2	2	1	2
6	1	2	2	1	2
7	2	2	5	1	2
8	5	5	2	1	2
9	5	1	2	1	2
10	1	5	2	1	2
11	5	2	5	1	2
12	5	2	1	1	2
13	1	2	1	1	2
14	2	2	1	1	2
15	1	1	2	1	2
16	1	2	1	1	2
17	2	1	1	1	2
18	2	1	1	1	2
19	2	1	5	1	2
20	2	1	1	1	2

This approach leads to the classification of the MFs as opposed to the BSE-GI used as the reference/benchmark point. Two grouping scenarios are considered in this context. In both scenarios, the classification of the MFs is determined on the basis of their return R as opposed to the return of the market [R_M] as follows:

Group 1: High performance funds with $R > R_M [1 + k]$, and

Group 2: Low performance funds with $R < R_M [1 + k]$.

Both the MFs return R as well as the market return R_M [return of BSE-GI] are considered for the first semester in 2007 [1st January 2007 - 30th June 2007]. Bearing in mind that data used in the analysis cover the period 2004-2006, it is clear that this classification of the MFs is based on their future returns over a subsequent time period, thus providing a basis for relating their past performance characteristics to their future prospects as investment opportunities. The parameter k is given different values in the two grouping scenarios. In the first scenario, k is set equal to 10 per cent, whereas in the second scenario, k is set equal to 5 per cent. In that respect, the first scenario corresponds to a more risk-prone portfolio management style, whereas the second scenario corresponds to a less risk-prone approach.

Within this context, the MFs of the first group are the ones with the best perspectives and constitute good investment opportunities compared with the other MFs.

In contrast, the MFs of the second group are the ones with lower performance than the ones of the first group.

According to the first grouping scenario, 21 MFs in the sample are assigned to the first group, and 12 funds in the second group. Similarly, in the second grouping scenario, 24 MFs belong to the first group, while nine MFs belong to the second group. It should be noted that other grouping scenarios were also tested -with varying values for the parameter *k* but, given the small sample, there was a significant imbalance between the numbers of MFs in each group, thus leading to poor results.

From the initial set of 33 MFs, the ones that belong in the first group and have the higher performance are selected. In particular, for the first grouping scenario, nine MFs are selected, while for the second grouping scenario 11 MFs are selected, for the composition of appropriate MF portfolios.

GOAL PROGRAMMING MODEL

A GP model has the following general form:

Min $f(d_i^+, d_i^-)$

Subject to: $g_i(x) + d_i^+ - d_i^- = t_i$;

$$x \in B; \quad d_i^+, d_i^- \geq 0$$

where g_i is the goal *i* defined as a function [linear or non-linear] of the decision variables *x, t,* is the target value for goal g_i as defined by the decision maker, d_i^+, d_i^- are decision variables corresponding to the deviations from the target values [Under achievement and Overachievement of the goals], *B* is the set of feasible solutions defined by a set of constraints, and /is a function [usually linear] of the deviational variables. In using a GP model in practice, the decision maker must specify all relevant constraints that define the feasible solutions, express his/her goals as functions of the decision variables, define the appropriate target values for the goals and specify the deviations from the target values which are relevant to the analysis [e.g. in some cases only the under achievements of the goals are relevant].

EVALUATION CRITERIA

The criterion used in the present study are the following:

[1] the standard deviation of the returns,

[2] the percentage change of the Net Asset Value [NAV],

[3] the geometric mean of excess return over benchmark,

[4] the Sharpe index,

[5] the systematic risk,

[6] Jensen's a,

[7] the Henriksson—Merton a coefficient,

[8] the Henriksson—Merton *y* coefficient and

[9] the Treynor—Black ratio.

A brief description of these criteria is given below.

The standard deviation is the most commonly used measure of variability. For an MF, the standard deviation σ is used to measure the variability of its daily returns, thus representing the total risk of the fund. The standard deviation of daily returns [752 observations] is transformed in this analysis to refer to the three-year time period using the simple transformation $\sigma\sqrt{752}$.

The return of MFs and other risky investments is often considered in relation to a risk-free asset. In the case of MFs, the measure used to consider this issue is the geometric mean of their excess returns over the return R_f of a risk-free asset. The excess return of a fund is considered as the difference between the fund's return and the risk-free return. The geometric mean of a fund's excess return over a benchmark [Risk-free asset] shows how well the manager of the fund was able to pick stocks. In this analysis, the three-month Treasury bill rate is used as a proxy for R_f. The beta [β] coefficient is a measure of a fund's risk in relation to the market risk. It is called systematic risk, and the CAPM implies that it is crucial in determining the prices of risky assets. For the calculation of the beta [β] coefficient, the following regression was used: $R = \alpha + \beta R_M + \varepsilon$, where α is a coefficient measuring the return of a fund when the market is constant and ε is an error term that represents the impact of non-systematic factors that are independent from the market fluctuations.

The traditional total performance measure, the Sharpe index, **Sharpe [1966]**, is used to measure the expected return of a fund per unit of risk. This measure is defined as the ratio $[R — R_f]/\sigma$. The evaluation of MFs with this index shows that an MF with higher performance per unit of risk is the best-managed fund, while an MF with lower performance per unit of risk is the worst-managed fund.

Jensen's alpha measure is the intercept in a regression of a fund's excess returns against the excess returns on the benchmark, **Jensen [1968]**. The use of this measure assumes that investors are well diversified and therefore, they are only taking into account systematic risk when evaluating a fund's performance. The Jensen alpha [α] measure is given by the regression model $R - R_f = \alpha + \beta(R_M - R_f) + \varepsilon$, Coefficient α will be positive if the manager has some forecasting ability and zero if he has no forecasting ability.

The **Henriksson-Mertoii Model [1981]** measures both market timing and the security selection abilities of funds' managers and it is expressed in the form of the regression model $R - R_f = \alpha + \beta(R_M - R_f) + \gamma Z_M + \varepsilon$, where $Z_M = \max(0, R_M - R_f)$. In this model, the parameters α and γ provide estimates on the performance of the MF managers. In particular, α shows the stock selection ability of the manager, while the parameter γ shows his market-timing ability. Positive values for α and γ show that the MF manager has forecasting abilities, negative values indicate forecasting inability, and values close to zero show no ability at all.

Finally, another measure regarding the MF managers' forecasting abilities is the **Treynor and Black [1973]** appraisal ratio, defined as the ratio α/s, where α *the Jensen alpha coefficient and 5 is* is the standard deviation of the error term in the regression used to obtain the α coefficient. Higher [lower] values of this measure show higher [lower] forecasting ability of the manager.

On the basis of these criteria, the proposed Goal Programming formulation for the construction of the final portfolio is solved for both grouping scenarios. The data of the problem are noted as c_{ij}, where c_{ij} is the performance of MF i on criterion j, i = 1, . . ., 9 [First grouping scenario]; = 1, ..., 11 [Second grouping scenario] and j =1,…,9 [Nine criteria for both grouping scenarios]. Table 1 presents the performance of the selected MFs on the selected criteria. Within a portfolio construction context, it is necessary to express the above criteria in terms of the composition of the portfolio [The proportion w_i of each MF i in the portfolio]. This is performed as follows:

- The standard deviation of returns of portfolio p is denoted by c_1^p and is calculated in matrix form as follows: $c_1^p = \sqrt{w^i \Sigma w}\sqrt{N},$ where w is a $m \times 1$ vector of the proportion of the available capital invested in each MF [m = 9 for the first scenario and m = 11 for the second scenario], w^i is the transpose of $w,$ and Z is the variance-covariance matrix of the MFs' daily returns.
- The percentage change of net asset value of portfolio p is denoted by c_2^p and is expressed as a linear function of the following form: $c_2^p = \Sigma c_{i2} w_{i'}$, where c_{i2} is the percentage change of net asset value for MF i.

The geometric mean of excess return over benchmark of portfolio p is expressed as c_3^p and is calculated as follows **Bernstein and Wilkinson [1997]**;

$$c_3^p = (1 + R_{pg} - \sigma_{pg}^2)^{N-1},$$

where R_{pg} the expected excess is return of the portfolio over a benchmark [risk-free interest rate] and σ_{pg}^2 is the corresponding variance.

In a matrix form, the calculation of the expected excess return R_{pg} of the portfolio p is calculated as follows: $R_{pg} = r_g' w$.

The expected excess return r_g is referred to as the mean excess return over the risk-free interest rate and is calculated as follows: $r_g = [r - r_f]\,[r_M - r_f]$, where r is a $[m.1]$ vector of the expected MF returns and r_M is the expected market return.

- The Sharpe index for portfolio $p,$ is denoted by c_4^p and is calculated as follows $c_4^p = R_{ps} / \sigma_{ps}$, where R_{ps} the expected excess return of portfolio p is over the risk-free asset $[R_{ps} = (r - r_f)' w]$ and σ_{ps} is the corresponding standard deviation.
- The beta coefficient of portfolio $p,$ is denoted by and is expressed as a linear function of the following form: $c_5^p = \sum w_i c_{i5}$ is the beta coefficient for MF i.
- The Jensen alpha [α] measure of portfolio $p,$ is denoted by c_6^p and is expressed as a linear function of the following form : $c_6^p = \sum w_i c_{i6}$, where c_6^p is the Jensen coefficient α for MF i.

- The alpha coefficient [α] of the Henriksson - Merton model of portfolio *p,* is denoted by c_7^p and is expressed as a linear function of the following form: $c_7^p = \sum w_i c_{i7}$, where c_7^p is the Henriksson-Merton coefficient for MF *i.*
- The γ coefficient of the Henriksson-Merton model of portfolio *p,* is denoted by c_8^p and is expressed as a linear function of the following form: $c_8^p = \sum w_i c_{i8}$, where c_8^p is the Henriksson-Merton γ coefficient for MF *i.*
- The Treynor and Black appraisal ratio of portfolio *p,* is denoted by c_9^p and is calculated as follows **Miller [1999]**; $c_9^p = \alpha[\sigma_p^2 / N - (\sigma_M^2 / N)\beta^2]^{-1/2}$, where α is the Jensen coefficient of portfolio *p,* σ_p^2 is the variance of portfolio *p* and σ_M^2 is the variance of the market [BSE-GI].

STANDARDIZATION OF THE DATA

In using a GP model, it is often appropriate to scale the goals so that they are of approximately the same order of magnitude, thus ensuring that the effect of the different scales on the obtained solution is eliminated. In the MF portfolio composition problem considered in this paper, the standard deviation is expressed as a percentage, the β coefficient takes values very close to unity, and the Jensen α coefficient takes values close to zero, etc. To eliminate the effect of these different scales, a standardization of the data is initially performed. The standardization is employed only for the criteria for which the performance of the portfolio is a linear function of the proportion of each MF in the portfolio. These criteria [linear criteria] are the following: percentage change of NAV, β coefficient, Jensen's α coefficient, Henriksson and Merton's α and γ coefficients. The standardization is performed through the following simple linear transformation:

$$c_{ij}^{'} = \frac{c_{ij} - c_j^{\min}}{c_j^{\max} - c_j^{\min}} \in [0,1]$$

where $c_{ij}^{'}$ denotes the standardized performance of MF *i* on criterion, c_j, c_{ij} denotes the unstandardized performance of MF *i* on criterion c_j, $c_j^{\max}$ is the most preferred value of criterion c_j, and $c_j^{\min}$ is its least preferred value. For the linear criteria to -which the above standardization is applied, their most and least preferred values are easily found directly from the unstandardization data of the selected MFs [*cf.* Table 5.1].

For instance, the most [least] preferred performance on the NAV change criterion is simply its maximum [minimum] value for the selected MFs in each grouping scenario [Higher NAV change indicates a better MF]. The same also applies to Jensen's α coefficient, and Henriksson and Merton's α and γ coefficients. In contrast, for the β coefficient the most [least] preferred performance is determined as the maximum

[Minimum] value of β the coefficient for the MFs in each grouping scenario [higher β coefficient indicates higher risk].

MATHEMATICAL FORMULATION OF THE GOAL PROGRAMMING PROBLEM

The proposed GP formulation for the composition of the final portfolio is expressed as follows:

$$\text{Min} f = p_1 d_1 + p_2 d_2 - p_3 d_3 - p_4 d_4 + p_5 d_5 + p_6 d_6 + p_7 d_7 + p_8 d_8 + p_9 d_9 + \sum_i k_i d_i^- \quad \ldots (1)$$

Subject to the constraints:

$$c_j^p - d_j = 0, \text{ for criteria } j = 1, 3, 4, 9 \quad \ldots (2)$$

$$c_j^{'p} + d_j = 1, \text{ for criteria } j = 2, 5, 6, 7, 8 \quad \ldots (3)$$

$$w_i - d_i^- + d_i^+ = B, \text{ for MFs } i = 1, 2, \ldots.. 9 \text{ and } i = 1, 2, \ldots. 11 \text{ in the first and second grouping scenarios} \quad \ldots (4)$$

$$\sum_i w_i = 1 \quad \ldots (5)$$

$$w_i, d_i^-, d_i^+ \geq 0, \text{ for MFs } i = 1, 2, \ldots.. 9 \text{ and } i = 1, 2, \ldots. 11 \text{ in the first and second grouping scenarios} \quad \ldots (6)$$

$$d_j \geq 0, \text{ for criteria } j = 1, 2, 5, 6, 7, 8 \quad \ldots (7)$$

$$d_j \text{ Unrestricted in sign for criteria } j = 3, 4, 9 \quad \ldots (8)$$

Constraints [2] – [3] describe the performance of portfolio p on the selected criteria expressed in terms of the proportion of each MF in the portfolio [the proportions $u>_t$ sum up to unity, cf constraint [5]]. In particular, goal constraint [2] applies only to the non-linear criteria which are not standardized [j = 1 for standard deviation, j = 3 for geometric return, j = 4 for Sharpe's index, and j= 9 for the Treynor and Black index]. For these criteria, zero [the left-hand side of constraint [2]] is selected as the reference point with which the performance of the constructed portfolio is compared. For the standard deviation criterion, zero corresponds to the ideal case of a zero-risk portfolio and, consequently, deviation d_1 from this ideal case should be minimized. For the other three non-linear criteria [j = 3, 4, 9], constraint [5.2] implies that the constructed portfolio should have a performance as high as possible compared with the zero-level reference point. For instance, for the geometric return criterion [j = 3], setting the reference point at zero level implies that the constructed portfolio should have as much positive geometric return as possible. In this case, the deviation d_3 between the portfolio's geometric return and the zero-level geometric return should be as positive as possible [d_3 is unrestricted in sign to consider the possibility that the portfolio's geometric return may be negative]. Constraint [2] is used in the same way for the two other non-linear criteria involving Sharpe's index [j = 4] and Treynor and Black's index [j= 9].

In contrast, goal-constraint [3] applies only to the linear criteria [j = 2 for the NAV change, j = 5 for the β coefficient, j = 6 for Jensen's α, j = 7 for HM's α and j = 8 for HM's γ]. The use of constraint [3] implies that the performance of the constructed portfolio on these criteria should be as close as possible to the ideal values of the criteria, which arc equal to unity in the standardized [0, 1] scale.

In addition to goal constraints [2]—[3] which involve the performance of the constructed portfolio on the selected criteria, portfolio diversification is also imposed through goal constraint [4]. This constraint imposes a goal regarding the maximum proportion B of each MF in the portfolio [In this analysis, B is set equal to 0.4]. An over achievement of this goal for an MF i indicates that the proportion w_i of this fund in the constructed portfolio is too high [higher than 40 per cent]. For diversification reasons, such an over achievement is undesirable and should be minimized.

The over achievement of this goal for an MF i is measured through the deviational variable d_i^+ which is to be minimized. The objective of the GP model [1]—[8] minimizes a weighted sum of the deviations from the aforementioned goals. The coefficients p_j and k_i $(p_j, k_i \geq 0)$ used in the objective function [1] represent the relative importance of the goals. In particular, the coefficients P_J involve the goals on the selected portfolio construction criteria [j = 1, 2, …, 9]; while coefficients k_i involve the diversification goals regarding the maximum proportion of each MF's i in the portfolio. These weighting coefficients can be specified according to the investment policy of the MF manager.

RESULT AND ANALYSIS

For each one of the two grouping scenarios, the GP problem [1]—[8] is solved under a set of different investment policy scenarios. Each scenario corresponds to different values of the weighting coefficients p_j used in the objective function which represent the relative importance of the goals on the selected portfolio construction criteria.

In all scenarios, the values assigned to coefficients p_j range in the interval [1, 5], in order to obtain a portfolio that best matches the predetermined goals. The weights assigned to the diversification goal were set equal to 2 [low to medium importance] in all cases. Similarly, the NAV change criterion was assigned low significance [p_2=1] in all scenarios because the performance of the MFs considered on this criterion was [in most cases] remarkably high. The rest of the portfolio construction criteria are grouped into three major categories as follows:

- **Return criteria:** Geometric Mean, Sharpe's index, Jensen's α.
- **Risk criteria:** Standard Deviation, β coefficient.
- MF managers' evaluation criteria: HM's α coefficient, HM's γ coefficient, Treynor and Black ratio.

On the basis of this categorization, 20 different investment policy scenarios were explored regarding the significance of each category of criteria assuming that within each category all criteria are equally important.

The presented results involve the average proportion of each MF in the 20 constructed portfolios constructed for each weighting scenario of Table 2.

Table. 3 Summarizes the results of the analysis regarding the composition of the constructed portfolios for the two grouping scenarios.

According to the results obtained, three MFs have the higher proportion in both grouping scenarios. In the first grouping scenario, the Alpha Trust Infrastructure, the BSE-GI and the Reliance Invest Domestic Fund had proportions higher than 32 per cent in 8, 13 and 16 investment policy scenarios, respectively. In the second grouping scenario, the Alpha Trust Infrastructure, the BSE-GI and the Reliance Invest Domestic Fund had proportions higher than 37 per cent in 12, 7 and 16 investment policy scenarios, respectively. These MFs performed fairly well in most of the examined criteria. All the other MFs have a very small proportion [approximately 1 per cent].

Table 3: Average Proportions [%] of the MFs in the Constructed Portfolios

Mutual funds	1st Grouping scenario	2nd Grouping scenario
Alpha Trust infrastructure	20.65	28.26
Alpha HDFC	1.60	
Alpha Domestic Equity Fund	2.17	
ICICI Value Index	32.55	20.57
HSBC Growth	3.19	2.78
Interamerican Small Cap	0.95	
Interamerican Dynamic	1.23	
Reliance Invest Domestic Fund	36.58	37.90
European Reliance Growth	1.09	1.13
Alpha Trust Growth		1.15
Alpha Trust New Enterprises		1.92
HSBC Fund-FTSE/ASE20		1.62
Alpha Growth Domestic		1.65
Laiki Indian Equity Fund		1.15
Telesis Equity Domestic Fund		1.7

Furthermore, Table 4 summarizes the results of the analysis regarding the performance of the constructed portfolios for the two grouping scenarios on the nine evaluation criteria. The presented results involve the rate of closeness of the portfolios [1] performance to the best values of each criterion. It is important to note that all the constructed portfolios performed fairly well in most of the examined criteria in both grouping scenarios.

Table.4: The Rate of Closeness [%] of the Constructed Portfolios to the Most Preferred Values of the Goals on the Criteria

Criteria	1st Grouping scenario	2nd Grouping scenario
σ	69.06	52.54
NAV	51.25	44.69
R	53.62	51.07

Sharpe	55.47	70.45
β	48.55	59.07
Jensen's α	44.79	53.28
HM's α	53.85	62.41
HM's γ	42.19	33.33
Treynor and Black	50.68	62.84

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