Testing the Efficiency of the Treynor Black Model in the Post Global Financial Crisis Era

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Abstract

Active portfolio management by the Treynor Black Model (T-B Model) calls for constructing a combined portfolios that is a mix of benchmarked index portfolio, with the mispriced securities selected on the basis of security analysis. This combined portfolio provides greater risk-adjusted returns when compared to the returns of benchmarked market portfolios. The superior risk-adjusted returns of combined portfolios are measured in terms of Sharpe Ratio, Jensen's Alpha and Treynor measure. This paper attempts to test the efficiencies of the T-B Model in context of the Indian capital market, in a post global financial crisis period. 40 securities have been selected on the basis of security analysis belonging to mid-cap funds from the stocks listed on BSE. 15 combined portfolios have been constructed, each consisting of 20 securities randomly selected from 40 covered securities along with BSE Mid Cap fund, which is substituted for benchmarked passive portfolio. The result provides valuable insights to the fund managers, for following active portfolio management proposed by the T-B Model in the context of the Indian capital market, to obtain superior portfolio returns.

Keywords: Portfolio management; Treynor Black Model; Active Portfolio Management; Equity Portfolio Selection

Introduction

The paper draws its insight from the celebrated work of Treynor-Black (T-B Model), which points out the inconsistencies in the presumptions of market efficiencies, referring to the rapidly growing fund management industry associated with active portfolio management (TreynorandBlack, 1973). It is a common practice to see that investors often delegate the task of the management of investable funds to the professional fund managers, with the expectation that the latter will select a portfolio that will beat the returns of the benchmarked passive portfolio.T-B advocates for the construction of the optimal portfolio by mixing the benchmarked passive portfolio with the set of securities referred to as covered securities, selected by the fund managers, for getting superior returns in comparison to the returns of the benchmarked portfolio (Kane et. al., 2012). To achieve this objective, the T-B Model introduces a critical deviation from the efficient market hypothesis, while maintaining the overarching framework of an efficient market (Brown, 2015). The fund manager carries out the security selection, based on the security analysis, along with using their access to the information about the future performance of individual securities under review, which is not reflected in the current market prices.

The covered securities are selected on the basis of Alpha, which is in excess of forecasted future return over its market risk-adjusted return (Jensen, 1968). These covered securities with positive Alphas are added with the benchmarked portfolio, to construct a combined portfolio. The presence of covered securities with positive Alphas in the combined portfolio, in turn, guides the fund manager to place a greater reliance on the covered securities in comparison to the passive portfolio. This results in better proportionate fund allocation for covered securities in comparison to the passive portfolio in combined portfolio. The efficiency of the T-B Model is a function of the fund manager's ability to identify the securities with Alpha returns. The result must be a robust, reliable and quantifiable forecast about the individual securities' performance in excess of risk-adjusted market returns. This combined portfolio is expected to provide superior returns than the standalone returns of a benchmarked passive portfolio. These superior returns are measured in terms of Sharpe Ratio. (Sharpe, 1963; Sharpe, 1994).The authors have tried to test the efficiency of Active Portfolio Management proposed by T-B, in the Indian capital market. The motivation for the same was quite intuitive in nature, as outperforming the benchmarked portfolio is the holy grail of fund managers (Jin et. al., 2020). Active portfolio management, despite having encouraging results, has found little appeal amongst the fund managers (Ambachtsheer and Farrell, 1979). We tested the efficiencies of T-B Model with the objective of providing adequate insights based on our findings to the fund managers operating in the Indian Capital Market.

Literature Review

The first-ever Modern Portfolio Theory (MPT) featured the Mean-Variance portfolio, and focused on choosing a portfolio on its initial two moments - portfolio returns and portfolio variance (Markowitz, 1952). The mean-variance analysis was extended and developed to support the portfolio theory (Roy, 1952). Following MPT, the concept of Tangency Portfolio was framed, that maximised the excess returns to portfolio volatility, the ratio is known by Tobin's quotient (Tobin, 1958). The asset-pricing models of Sharpe (1964), Lintner (1965), and Black (1972) have defined expected returns and risk as functions of the market returns and market risk. The model explores the relation between the systematic risk and the expected return of the security. It is primarily used to compute the intrinsic prices of risky assets (preferably stocks). The common predictions of three laureates were that the market portfolios are mean-variance efficient as described by Markowitz (1959). For the mean-variance portfolios to be successful, computational inefficiencies had to be removed. The calculations for variance and co-variances for the selection of asset weights excessively complex as the number of assets were increased (Elton et al., 1976).

To assess the portfolio performance, Sharpe ratio and portfolio return per unit of portfolio risk was employed to find the better portfolio with higher returns at a minimal risk (Sharpe, 1963; Sharpe, 1994). Sharpe demonstrated that the combination of investment in risk-free assets and market portfolios, is optimal and confirm to CAPM. In other words, Sharpe advocated that a passive investment strategy is optimal. Shukla (2004) justifies the growth of Index Mutual Funds along with ETF, which facilitates the trading of shares of Index Mutual funds in conformity with the passive investment strategy being optimal. This strategy remains popular despite empirical findings which negate the underlying assumption that asset returns follow CAPM. As optimal portfolio management is more complex than passive strategy, active fund management remains a favourite of fund managers. This is justified by the development of various analytical measures, like Treynor Ratio, Sharpe Ratio and Jensen Alpha. Majority of the works in the area supported the Modern Portfolio Theory and the Sharpe Ratio until the three-factor model provided by Eugene Famaand Kenneth French was published in the Journal of Finance. The duo emphasized on the factors of size and value of the security (Tversky and Kahneman, 1974; Fama and French, 1992). Other measures of assessing portfolio efficiency include the Treynor Ratio (Treynor and Mazuy, 1966), calculated as excess returns divided by portfolio beta; the Information Ratio, calculated as excess returns divided by the risk of the portfolio residual returns to assess the portfolio managers' skill to outperform the market index. It also measures the consistency of their performance using a tracking error (Roll, 1992). Another measure, Jensen's Alpha (Jensen, 1968) discussed excess returns of portfolio against the average required returns. The Treynor and Black model (Treynor and Black, 1973) is derived from the Capital Market Line, with the level of risk being measured by the standard deviation of the portfolio returns. The generalised Treynor Ratio (Hübner, 2005) is calculated as the abnormal returns of portfolio divided by premium weighted idiosyncratic risk of the market portfolio. The generalised ratio is insensitive to portfolio leverage against the original ratio. The Modiglianirisk-adjusted or M2 performance measure (Modigliani and Leah, 1997) is calculated by multiplying the Sharpe ratio with risk associated with benchmark index portfolio, and adding the risk-free rate of return to it.

Recent studies focus on measures such as Sortino Ratio or upside potential ratio (Rom and Ferguson, 1994; Sortino et al., 1999), which is similar to the Sharpe ratio, except for the fact that it only considers the downside risk against the whole standard deviationas risk for portfolio returns. The Sharpe ratio punishes the portfolio for its positive deviations and Sortino Ratio overcomes this limitation of the traditional ratio. Another modern R-squared measure, as supported by Sharpe (1992), explains R-squared as the percentage change in an asset's performance because of the result of a change in benchmark. Stoyanov (2007) considers different optimisation problems that arise out of the choice of different ratios and measures, which have an influence in portfolio weight determination process. Different optimisation techniques are proposed on the basis of ratios and measures for selection, ranging from linear to quadratic optimisation techniques. Howard (2014) used behavioural portfolio management against the modern portfolio theory, as a better alternative for active portfolio management. He argued that the market prices are more influenced due to cognitive errors rather than underlying value and thus, behavioural techniques are more suited for forecasting portfolio risk and returns.Statman (2014) listed the improvisation of behavioral finance over normal finance. He discussed the relevance of behavioural portfolio theory over modern portfolio theory by attacking the irrational assumptions of the Markowitz's theory. Parikh et al.,(2018) compare the excess returns across portfolio management styles, with respect to risk aversion and consistency in returns. He compared manager returns with market returns, dispersion, and volatility factors. Henriksson et al.,(2019) used ESG as factors in identifying securities for portfolio allocation. They believe that companies with a good ESG score enjoy lesser cost of capitals, higher market to book ratios and, thus, better valuations. Authors calculated the Good Minus Bad (GMB) factor for computing excess returns and portfolio weights. Their study contributed to the formulation of a methodology for incorporating ESG factor to the portfolio optimisation.

Existing literature on active fund management is not without criticism. Positive Alphas indicate the presence of arbitrage opportunities. Jarrow (2010) explained on two counts that positive Alphas are more a fantasy than fact, as first, arbitrage opportunities are not common and second, the inability of such opportunities to persist for long. He argued that false positive Alphas are generated in case there are unobservable risk factors present. He concluded that true positive Alphas persist if some market imperfection exists and arbitrageurs shall have a regular source of wealth lost. Recent studies are more focused on portfolio optimisation of global securities, and the Treynor and Black model is difficult to compute in such circumstances. For the Treynor and Black model to work, a portfolio manager needs one active portfolio which is constructed with the best chosen securities and second, one passive portfolio which could be the market benchmark portfolio. However, if global securities are considered, the passive portfolio of one country might not be the benchmark for another and thus, the assumption of the model will be violated. To overcome the limitation of T-B Model, keeping the T-B model as base, B-L Model (Black and Litterman, 1992) is used, wherein an investor's views are taken into consideration to determine the deviations of final asset allocation from the initially calculated portfolio weights. Multiple combinations of mean and variance are then optimised to maximize the expected return at a pre-decided objective risk tolerance level.

The active fund management strategy requires the fund managers to move away from mean – variance frontier (Roll, 1992). As fund managers tread away from the M-V frontier in search of superior returns, they select the overly risky portfolio for investors. Alexander and Baptista (2010) proposed a method to contain the tendency of the fund manager to select the overly risky portfolio, by having an objective function of selecting a portfolio with some given level of ex-ante Alpha alongside minimising tracking error variance. The motivation for current study started taking shape when the authors observed that not much research work has been undertaken, testing the efficiencies of T-B Model in post global financial crisis era, except few cases of doctoral thesis . In the Indian contest, the authors have not come across any research work that has explored the efficiency of active fund management strategy, suggested by the T-B model. Assets Under Management (AUM) of the Indian Mutual Fund Industry as on 30 April 302021 stood at Rupees 32,37,985 crore. The AUM of the Indian MF Industry has grown from Rupees 7.85 trillion as on 30 April 302011 to Rupees 32.38 trillion as on 30 April 302021, showing more than a four-fold increase in a span of 10 years. Such growth in active fund management is a good enough motivation to provide the fund managers a model which gives superior returns in comparison to the passive investment strategy.

The paper has the following sections-

a) Research Methodology b) Data Analysis, finding and discussion, c) Conclusion and d) a brief on managerial implications based on our findings.

Research Methodology

To test the efficiency of the T-B Model in the Indian Capital Market, the authors studied the securities listed in the Bombay Stock Exchange, falling under Mid-cap category as defined by the Association of Mutual Fund of India. . Forthe Indian capital market, SEBI has defined the Mid-Cap Securities (SEBI, 2017) as the ones which fall in the range of 101st to 250thposition,if all the securities listed on the exchange are ranked in the order of the market capitalisation, in descending order.A set of 40 securities belonging to the Mid-cap segment, of various sectors, are selected on the basis of fundamental analysis. Fundamental parameters particularly Price to Earnings Ratio (PE Ratio), Price to Book Value Ratio (P/B Ratio), Return on Capital employed (RoCE), Dividend Yield and Debt Equity Ratio are used to filter stocks from the securities belonging to the mid-cap segment. Companies were chosen on basis of favorable fundamental qualities. While considering PE measure, securities with low PE ratio are preferred as they outperform the high PE stocks. Value stocks outperform growth stocks in the long term. (Beneda, 2002). Similarly, the stock with low price to book value ratios are selected as they outperform the market in long run (Hidayat and Hendrawan, 2017).The stock with high returns on capital employed are selected as they give better returns than the market in the long run (Andersson et al., 2006). Maritoa and Sjarifb (2020) advocated that companies with lower debt equity ratio out-performed their leveraged peer. For testing the efficiency of the T-B Model, we followed the method explained in Investment (Bodie et al., 2013).The list of covered securities selected after carrying out fundamental analysis is provided in Table 1.

S&P BSE Mid Cap Index is taken as proxy to the Market portfolio . This index represents the 15 per cent of the total market capitalisation of the S&P BSE All Cap (AMPHI India, December). It tracks the performance of an index portfolio that is made of 98 securities, belonging to the mid-cap segment of all the stock listed at BSE. The historical daily closing price of all selected 40 securities are extracted from the BSE Website from the Historical Data section . The period under the review is post global financial crisis covering the duration of 10 years (Jan 2010 to Dec 2020).

For the matching period, the closing prices for the BSE Mid-Cap index are obtained from the same source. Daily log returns from the adjusted closing prices are calculated for all selected 40 and the BSE Mid-Cap Index.

The T-B Model uses excess returns for constructing optimum portfolios. The risk-free rate for each year under consideration is taken from the RBI website which are essentially the T- Bill rate of maturity. Daily T-bill rates for each year is calculated from this data. Daily excess returns for selected 40 securities and BSE Mid-Cap Index Fund, are calculated by subtracting the daily risk-free rate from the daily log returns. This leads to the calculations of mean annual returns, annualised standard deviations and variances of all 40 securities and index funds. As represented in Table 2, the authors calculated Alpha, Beta (slope coefficient), total variance of the excess return, variance due to systematic factors, variance due to unsystematic factors, i.e., residual variance for each of the 40 securities by regressing the daily adjusted excess returns of these securities against the BSE Mid Cap Index daily excess return. To find whether active portfolio management strategy suggested by the T-B Model produces superior Sharpe Ratio in context of Indian Capital Market, 15 portfolios are constructed, each portfolio consisting of 20 covered securities. For selecting the constituent securities in each portfolio, the set of above selected 40 securities are ranked from 1 to 40, and then sample of 20 securities are randomly selected using sampling function, provided in the Data Analysis section of MS Excel. Thus running 15 iterations, 15 portfolios of 20 securities each are obtained.

According to the T-B Model, active portfolio strategy tries to identify mispriced securities by constructing a combined portfolio of mispriced securities, i.e., a portfolio consisting of covered securities and passive portfolio. The suggested optimal portfolio, i.e., combined portfolio is a mix of covered securities and the index portfolio. The T-B Model suggest that the combined portfolio of active portfolio and passive portfolio will result in obtaining optimal risky portfolio.The underlying assumption in the T-B Model is that security markets are efficient, and any positive Alphas are competed away. Therefore, the Alpha of passive portfolio is considered zero. Accordingly, in our paper, Alpha of BSE Mid Cap Fund is considered as zero. We have represented active portfolio, which is a portfolio of selected covered securities, as A and passive portfolio as M in our present work. R_A, represents excess return on active portfolio (i.e. $R_A = E(r_A) - r_F$) and R_M, represents excess return on the market portfolio (i.e. $R_M = E(r_M) - r_F$). Excess return on active portfolio according to Single Index Model, given by Sharpe (*) is expressed as

$$\boldsymbol{R_A = \alpha_A + \beta_A R_M} \qquad - (1)$$

Further σ AB, represent the covariance between active portfolio and index portfolio and expressed as (Bodie, Kane and Marcus (*))

$$\boldsymbol{Cov_{(A,M)} = \sigma_{AB} = \beta_A \sigma_M^2} \qquad - (2)$$

The variance of active portfolio is calculated using the formula suggested by Single Index Model.

$$\boldsymbol{\sigma_A^2 = \beta_A^2 \sigma_M^2 + \sigma_{e_A}^2} \qquad - (3)$$

Here the expression $\sigma_{e_A}^2$, represents the variance of residual of active portfolio. Taking further insight from Single Index Model, the optimal weight of active portfolio in the combined portfolio of two assets, i.e. asset 1 being active portfolio and asset 2 being passive portfolio, (here BSE Mid Cap Index) is obtained by:

$$\boldsymbol{W_1 = \frac{R_1\ \sigma_2^2 - R_2\,\sigma_{12}}{R_1\ \sigma_2^2 + R_2\,\sigma_1^2 - [R_1 + R_2\,]\sigma_{12}}} \qquad -(4)$$

We followed the methodology provided in Bodie , Kane & Marcus. From equation (1) and (4)

$$W_A = \frac{(\alpha_A + \beta_A R_M)\sigma_M^2 - R_M\,(\beta_A \sigma_M^2\,)}{(\alpha_A + \beta_A R_M)\,\sigma_M^2 + R_M \sigma_A^2 - [\alpha_A + \beta_A R_M + R_M](\,\beta_A \sigma_M^2\,)} \qquad - (5)$$

On dividing numerator and denominator by variance of market, i.e. σ_M^2 , equation (5) is modified as:

$$W_A = \frac{[(\alpha_A + \beta_A R_m)\sigma_m^2 - R_m\,\beta_A \sigma_m^2\,]\,/\,\sigma_m^2}{\{(\alpha_A + \beta_A R_m)\sigma_m^2 + R_m\,\sigma_A^2\,[\alpha_A + \beta_A R_m + R_m]\beta_A \sigma_m^2\,\}/\sigma_m^2}$$

$$W_A = \frac{\alpha_A}{\alpha_A\,(1 - \beta_A) + \frac{R_m\left(\beta_A^2\,\sigma_m^2 + \sigma_{e_A}^2\right)}{\sigma_m^2} - \beta_A^2\,R_m}$$

$$W_A = \frac{\alpha_A}{\alpha_A\,((1-\beta_A) + R_M \left[\frac{\sigma_{e_A}^2}{\sigma_M^2}\right]} \qquad - (6)$$

In order to find the initial weight in active portfolio, we take a momentary assumption that slope coefficient of active portfolio equal to 1, i.e. βA = 1. The result of equation (6) will change to

$$W_A = \frac{\alpha_A}{\frac{R_M\ \sigma^2_{e_A}}{\sigma^2_M}}$$

$$W_A{}^{\circ} = \frac{\frac{\alpha_A}{\sigma^2_{e_A}}}{\frac{R_M}{\sigma^2_M}} \qquad \text{- (7)}$$

This initial position in the active portfolio is denoted by $W_A{}^{\circ}$. The objective was to achieve superior Sharpe ratio than the Sharpe ratio of the passive portfolio, which by definition is efficient and does not provide any Alpha. Therefore, the Alpha of BSE Mid Cap Index, which is our proxy for the passive portfolio, is taken as zero ($\alpha_M = 0$). This provides the clue that we must look for positive Alphas beyond the passive portfolio. Further the intuition is that the passive portfolio which is a proxy for market portfolio, is a well-diversified and moving outside it, may fetch positive Alphas but this will come at cost, i.e., penalty. This penalty will come in form of bearing some additional unsystematic risk or residual variance. In equation (7), which state the initial position in the active portfolio ($W_A{}^{\circ}$), the numerator term, explains about the contribution of the active portfolio in way of positive Alpha (α A), at the cost of per unit of residual variance ($\sigma_2 e_A$). Here α_A, represents additional contribution obtained from the TB model by active portfolio management and the cost of getting additional contribution, is captured by residual variance ($\sigma_2 e_A$), of the active portfolio, which is the penalty term. On the other hand, the denominator provides us the information about the contribution of the index portfolio (RM) and the cost of contribution is captured by variance of the index portfolio's excess return (σ^2_M).

Intuition suggests that if numerator term ($\alpha_A / \sigma^2 e_A$), is more than the denominator term (RM / σ^2_M) in the equation (7), we shall place more weight on the active portfolio. On the contrary our investment in the passive portfolio should be more, if denominator term provides better result than the numerator. Finally, as we develop a broad judgement about α A, $\sigma^2 e_A$, RM and σ^2_M, the momentary assumption of β_A = 1, considered earlier is relaxed. This assumption facilitated us to have our focus on additional contribution that we can have by constructing active portfolio and associated cost, in contrast to the contribution from indexed portfolio and its volatility. For all practical reason β_A, can assume any value, and when we relax this momentary assumption, we get the final position in the active portfolio A.

$$W_A^O = \frac{\frac{\alpha_A\,\sigma^2_m}{R_m \sigma^2_{eA}}}{\frac{\alpha_A + (1-\beta_A)\sigma^2_m}{R_m \sigma^2_{eA}}} + 1$$

In above expression, the numerator term represents the initial position in A

$$W_A^* = \frac{W_A^O}{W_A^O(1-\beta_A)+1} \qquad \text{- (8)}$$

$$W_m = 1 - W_A^* \qquad \text{- (9)}$$

So, we have incorporated the possibility of β_A of any value. Need for assumed β=1 is not there anymore. Further we have

$$\alpha_A = \sum_{i=1}^{n} w_i\,\alpha_i \qquad \text{- (10)}$$

$$\beta_A = \sum_{i=1}^{n} w_i\ \beta_i \qquad \text{- (11)}$$

In their work (Kane et al., 2012) suggested that larger the systematic risk of the active portfolio, the diversification with the index portfolio will be less effective and hence more reliance in terms of weight allocation should be there on active portfolio.

The Sharpe Ratio is defined as the excess return divided by the S.D. of excess return (Bodie et al. 2013), so the Sharpe Ratio of the complete portfolio is calculated using,

$$S_P^2 = \frac{[W_A(\alpha_A + \beta_A R_M) + (1-W_A)R_M]^2}{W_A^2(\beta_A^2\sigma_M^2 + \sigma_A^2) + (1-W_A)^2\,\sigma_M^2 + 2\,W_A(1-W_A)\beta_A\sigma_M^2\,)} \qquad \text{- (12)}$$

$$S_P^2 = S_M^2 + \frac{\alpha_A^2}{\sigma_A^2} \qquad \text{- (13)}$$

Here, in eq. (13), ($\alpha_A{}^2 / \sigma^2_A$) represent that appraisal ratio, as referred by Kane et al. (2012), which is also the information ratio stated by Bodie (2013), which determines the incremental contribution to the Sharpe ratio of the passive portfolio. This information ratio, in turn, helps us in assigning the weight on the individual securities, which facilitates the maximisation of the information ratio and combined portfolio gives a superior Sharpe ratio. Negative values of weights in active portfolio represents short sales.

Data Analysis, Findings and Discussions

Using the above methodology and template provided in the book Investments (Bodie et al. 2013), Sharpe ratio of 15 combined portfolios are worked out. These 15 portfolios, each consisting of 20 securities selected on the basis of random sampling from the set of 40 securities picked up by us on the basis of security analysis. The objective behind doing so is to find out whether active portfolio management consistently provide superior Sharpe ratio. For each combined portfolio the Sharpe ratio of the passive and combined portfolio is calculated, and the results are tabulated in Table 2. We could see a marginal but clear increase in the Sharpe ratio of all the 15 combined portfolios, compared with the Sharpe Ratio of passive portfolio. To statistically test whether these differences are significant, t- test is carried out. We found the test results are significantly different.

Treynor Measure is also applied , to find whether the combined portfolio constructed on the basis of the Treynor Black Model provides better risk-adjusted returns or otherwise. Here, excess returns of the combined portfolio as well as of the passive portfolios are divided by its respective β values. Corresponding Treynor ratios are calculated for all 15 combined portfolios (i.e., Run 1 to 15) and we tested whether these results are significantly different from the corresponding Treynor ratios of passive portfolios. On running the t-test we found that the Treynor ratios for risk-adjusted excess returns for a set of 15 portfolios are significantly different from the corresponding Treynor ratios of passive portfolio. Jensen's Alpha calculated for all the 15 combined portfolios resulted into positive Alphas for all the 15 portfolios. This also establishes that these portfolios are giving returns in excess of predicted returns based on CAPM. The numerical values for the Sharpe Ratios, Treynor Ratios and Jensen's Alphas are provided in the Table 3. This establishes that the Treynor – Black Model when applied to construct combined portfolios consisting of securities from the mid cap companies from Indian capital market produces better result than following the passive portfolio strategy.

Conclusion

In our work, we tested the efficiencies of Active Portfolio Management strategy proposed by the Treynor – Black (Treynor and Black, 1973) in post global financial crisis. We tested the model in context of the Indian capital market and found that active portfolio management strategy is optimal, i.e., it provided superior risk-adjusted returns in comparison to returns on passive portfolio. The inherent challenge we observed while testing the T-B Model was the selection of the covered securities based on the security analysis. As understandable, the historical data does not predict the future performance, the success of the model largely depends on the forecasting abilities of the fund managers.

The Managerial Implication

The managerial implication can be drawn from this test result that the active portfolio management strategy suggested by the Treynor Black Model provides better returns on investment considering the associated risk, i.e., superior Sharpe ratio, applied to the Mid cap securities from the Indian capital market. Nevertheless, this has to be seen in context of the asset management cost which is associated with active portfolio management, i.e., fund management fee. The marginal benefits from active portfolio management suggested by the Treynor – Black model shall be considered, when resulting returns outweigh the associated fund management cost.

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Appendices

Table 1 Selected Stocks on the basis of Security Analysis

S.no.	Name of firm	S.no.	Name of firm	S.no.	Name of firm	S.no.	Name of firm
1	Escorts	11	Schaffler	21	Whirlpool India	31	Tata Chemical
2	Honeywell Automation	12	Astrazenca Pharma	22	Oil India	32	NavinFlourine
3	Tata Communication	13	Deepak Nitrite	23	Pfizer	33	UCO Bank
4	Manappuram	14	Atul	24	Tata Power	34	Container Corp
5	Balkrishna	15	Page	25	JKCement	35	Colgate Palmolive
6	Bata India	16	PFC	26	Indian Hotel	36	Natco Pharma
7	Ashok Leyland	17	Zee	27	Phoniex Mill	37	NHPC
8	SAIL	18	Trent	28	Akzo Nobel	38	Supreme Industries
9	Adani Power	19	Jindal Steel and Power	29	Motilal Oswal	39	Rajesh Exports
10	Vinati	20	3M India	30	Procter & Gamble Health	40	CRISIL

Table 2 Performance Measure of Combined Portfolio

	Sharpe Ratio		Jensen's Alpha	Treynor Measure	
	Passive Portfolio	*Complete Portfolio*	*Jensen's Alpha*	*Passive Portfolio*	*Complete Portfolio*
Run 1	0.0959651	0.0962623	0.0001017	0.0169382	0.0170433
Run 2	0.0959651	0.0962504	0.0000985	0.0169382	0.0170391
Run 3	0.0959651	0.0962225	0.0000887	0.0169382	0.0170292
Run 4	0.0959651	0.0962731	0.0001063	0.0169382	0.0170471
Run 5	0.0959651	0.0962226	0.0000881	0.0169382	0.0170292
Run 6	0.0959651	0.0962887	0.0001102	0.0169382	0.0170526
Run 7	0.0959651	0.0961571	0.0000661	0.0169382	0.0170060
Run 8	0.0959651	0.0962643	0.0001027	0.0169382	0.0170440
Run 9	0.0959651	0.0961666	0.0000691	0.0169382	0.0170094
Run 10	0.0959651	0.0962058	0.0000822	0.0169382	0.0170233
Run 11	0.0959651	0.0961723	0.0000715	0.0169382	0.0170114
Run 12	0.0959651	0.0962395	0.0000935	0.0169382	0.0170352
Run 13	0.0959651	0.0961367	0.0000595	0.0169382	0.0169988
Run 14	0.0959651	0.0962934	0.0001132	0.0169382	0.0170543
Run 15	0.0959651	0.0962623	0.0001017	0.0169382	0.0170433

Table 3 Computation of weights and significant ratios for combined portfolio (Run 1) as per T-B Model

		BSE MidCap	Active Portfolio	Pfizer	Jindal Steel and Power	Procter & Gamble Health	Whirlpool India	3M India	Honeywell Automation	NHPC	Trent	Tata Power	Phoniex Mill	CRISIL	Zee	NavinFlourine	Deepak Nitrite	UCO Bank	Page	Rajesh Exports	Tata Power	Escorts	Manappuram	Combined Portfolio
$\sigma^2(e_i)$				0.07	0.16	0.09	0.10	0.08	0.09	0.06	0.55	0.56	0.12	0.54	0.18	0.36	0.58	0.13	0.09	0.12	0.56	0.13	0.72	
$\alpha_i / \sigma^2(e_i)$	*Sum= Σ [ai /σ2(ei)]*		0.0211	0.00	0.00	0.01	0.01	0.01	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.00	0.00	0.00	0.00	
W^0 (i)	*Proportion*		1.0000	0.22	-0.23	0.30	0.35	0.34	0.37	-0.41	-0.04	-0.12	0.07	-0.06	-0.11	0.05	0.03	-0.34	0.47	0.11	-0.12	0.15	-0.06	
$[W^0 (i)]^2$	*(Proportion)^2*			0.05	0.05	0.09	0.12	0.11	0.14	0.17	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.12	0.23	0.01	0.01	0.02	0.00	
α_A	*$W^0 (i) * \alpha_i$*		0.0027	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$\sigma^2(e_A)$	*Sum = $\Sigma [W0 (i)]^2 * \sigma^2(ei)$*		0.1289	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.01	0.00	0.00	
W^0_A	*$[(\alpha_A / \sigma^2(e_A)) / (E (R_m)/ \sigma^2_m]$*		0.0387																					
W^*	*$W^* = W^0_A / [1+ (1- \beta_A) W^0_A]$*	0.9625	0.0375	5.93	-6.00	8.11	9.32	8.94	9.97	-10.9	-1.06	-3.23	1.94	-1.50	-2.82	1.43	0.78	-9.09	12.66	2.96	-3.23	4.07	-1.55	
Beta	*β_A*	1.0000	0.1617	0.09	-0.37	0.20	0.33	0.23	0.28	-0.34	-0.04	-0.14	0.03	-0.03	-0.10	0.04	0.03	-0.45	0.32	0.07	-0.14	0.23	-0.08	0.9686
Risk Premium	*$\alpha_A + \beta_A * E (R_m)$*	0.0169	0.0055																					0.0165
SD		0.1765	0.3601																					0.1715
Sharpe Ratio		0.0960	0.0151																					0.0963
Treynor Ratio		0.0169	0.03372																					0.0170