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Portfolios Constructed with Cut-Off Points Based on Heteroscadastic Betas and OLS Betas

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ABSTRACT

This paper endeavors to build an optimal portfolio by assuming a single-index model, the justification for which is obtained by analyzing the returns of 37 stocks of the Indian stock market from NIFTY 50 using two approaches: Single index model and APT model. Stock prices in the period from April 2008 to August 2016 is considered in this study. The APT model which proved to be a successful model of stock returns for countries like USA fails to produce significant coefficients, which gives an understanding that the Indian capital market is not yet sufficiently developed to identify all information affecting the stock price movements. The Single Index model leads to the decision that the market index is the most important factor in the Indian capital market. This gives an understanding that the Indian investors respond quickly to the publicly disclosed information. The Treynor's ratio is computed for each asset with the beta of single index model. Two variations of betas are considered in this paper. The betas are estimated with OLS model and with the intervention of GARCH effects. The portfolios are formed by defining a special cut off point and the stocks having overabundance of their normal return over risk free rate of return are chosen. The comparative analysis of OLS betas and GARCH betas identifies the best approach for beta computation and our optimal diversified portfolio comprises of 12 stocks chosen out of 37 stocks.

Keywords: Factor Models, Risk Premium, Stock Returns, Estimated Sensitivities, Regression Analysis, Treynor's Index, Portfolio Of Stocks, GARCH, TARCH,EGARCH.

I. INTRODUCTION

The availability of too many investment alternatives is a blessing for an average investor but it is a blessing in disguise. Financial portfolio optimization is a widely studied problem in mathematics, statistics, financial and computational literature. It adheres to determining an optimal combination of weights that are associated with financial assets held in a portfolio. In practice, portfolio optimization faces challenges by virtue of varying mathematical formulations, parameters, business constraints and complex financial instruments. Empirical nature of data is no longer one-sided but is reacting upside and downside with repeated yet unidentifiable cyclic behaviors potentially caused due to high frequency volatile movements in asset trades. Portfolio optimization under such circumstances is theoretically and computationally challenging. This work presents a novel mechanism to reach to a solution by considering the traditional betas and betas with intervening GARCH effects. It conceptualizes the role of volatility of returns that contribute the best solution as compared to traditional method.

II. METHODS AND MATERIAL

2. Review of Literature

Investment decision remained a confusing task till early 1950, investors used to make investment decisions solely on return, they talked about the risk but there was no measure for it. To build a portfolio model however investors had to quantify their risk variable. The basic portfolio model was developed by Harry Markowitz (1952), who developed the measure of expected rate of return and expected risk. He showed that weighted average of historical returns and the variance of these returns represent the expected return and expected risk respectively. He showed a linear relationship between risk and return. William Sharpe (1964) added the risk free asset in Markowitz portfolio theory; this led to the base of Capital Market Theory. With addition of risk free asset the options for the investors were extended and a model to determine the risk premium was developed known as Capital Asset Pricing Model (CAPM). Lintner (1965) derived the similar theories independently. The capital asset pricing model calculates risk premium for a given portfolio by multiplying the market risk premium with beta measure of systematic risk. John Lintner (1969) criticized the CAPM for its assumptions of investor's homogenous expectations, availability of risk free lending and borrowing facility and absence of taxes and transaction costs.

Factor models focus on systematic investment risk, i.e., the one that cannot be avoided by investment diversification. Factor models are based on the Arbitrage Pricing Theory (APT), introduced by Ross (1976). The well-known paper of Fama and French (1992), for example, analyzes firm-specific microeconomic variables such as market beta, firm size, earnings-price ratio, leverage ratio and book-to-market equity in explaining stock returns, thus representing the fundamental factor model. Variables used by Chen, Roll and Ross (1986) in their notable study on U.S. stock returns include industrial production, inflation, risk premium, term structure, market index, consumption and oil prices. The authors found that the industrial production, unanticipated change in the risk premium, unanticipated inflation, and, a slightly weaker, the unanticipated change in term structure, are the most important factors affecting expected stock returns. Bodurtha, Cho and Senbet (1989) expanded the work of Chen, Roll and Ross (1986) by including international factors.

In order to eliminate some economic and econometric difficulties associated with factor analysis techniques, McElroy and Burmeister (1988) modified the APT as a multivariate non-linear regression model. They used four macroeconomic variables, namely, the risk premium, term structure, unexpected deflation and unexpected growth in sales, as well as the residual market factor. Within the multivariate non-linear regression model all five factors were significant in explaining stock returns.

Considering that smaller firms have higher average returns, Chan, Chen and Hsieh (1985) investigated the firm size effect on stock returns. The change in the risk premium showed as the most important factor influencing on the difference in return for firms of different sizes, followed by the market index and the industrial production change.

3. Research Objectives/Research Questions/Hypotheses

- To identify appropriate model for the returns of the assets.
- To compute betas for the assets using OLS and GARCH models.
- To identify a cut-off point based on which the portfolio for each method is identified.
- To identify the method which contributes the best portfolio.

4. Research Methodology

4.1. Data

Data for the study are secondary in nature. They are collected from

a. Handbook of Indian statistics, published by RBI.
b. Official website of The Department of Industrial Policy and promotion, G.O.I, Ministry of Commerce and Industry.
c. Official website of Securities and exchange Board of India.

The sample includes monthly data from April 2008-August 2016 on NIFTY 50, Gold price, Inflation, CPI, Exchange rate, Currency in circulation and 3-month Treasury bill rate. This paper analyzes returns on 37 stocks of the Indian stock market, using two models: Single equation model and APT .The stocks from NIFTY 50 are chosen for the analysis, based on availability and credibility of data. The stock return is calculated as the monthly change in the stock price by the following formula:

R(*t*) =(SP(*t*) / SP(*t-1*))*100 where SP(*t*) is the average stock price in month t and SP(*t-1*) is the average stock price in the previous month.

4.2. Methodology

Model1: This is a single factor model named as a Single Index Model(SIM) in which market index is considered as an explanatory variable.

$$R_i = \alpha_i + \beta_i R_m + \varepsilon_i \text{-------------------(1)}$$

where R_m is the market index. Then to assess the model's ability to describe the data, we run the following cross-sectional regression.

$$\bar{R}_i = \lambda_0 + \lambda_1\beta_i + \varepsilon_i \text{-------------------------(2)}$$

Model 2: The Arbitrage Pricing Theory(APT) model is formed with the assumption that the asset markets are perfectly competitive and each asset return is linearly related to k factors plus its own idiosyncratic disturbance.

$$R_i = \alpha_i + \beta_{1i}GR_i + \beta_{2i}CIC_i + \beta_{3i}EXR_i + \beta_{4i}CPI_i + \beta_{5i}IIP_i + \beta_{6i}INT_i + \varepsilon_i \text{----------(3)}$$

$$\bar{R}_i = \lambda_0 + \lambda_1\beta_1 + \lambda_2\beta_2 + \lambda_3\beta_3 + \lambda_4\beta_4 + \lambda_5\beta_5 + \lambda_6\beta_6 + \delta_i \text{-------------------(4)}$$

Then the estimated beta coefficients are used as independent variables and average stock returns are used as dependent variables in cross-sectional regression. This gives the time series of risk premiums for each macroeconomic factor. For this model, the macroeconomic variables are selected based on the literature reviewed in the introduction part of the paper.

The next step is to assess which one of the two competing models is supported by the data. The two models, SIM and APT, are non-nested. One method to discriminate among non-nested models was suggested in Davidson and MacKinnon (1981).

Let R_{APT} *and* R_{sim} be the expected returns generated by the APT and the Single index model. For comparing SIM and APT ,the following equation is formed.

$$R_i = \alpha R_{APT} + (1-\alpha)R_{SIM} + \varepsilon_i \text{------------------------(5)}$$

Here α is a measure of the effectiveness of APT. When α is close to 0, the SIM is the correct model relative to the APT. The Single Index model $R_i = \alpha_i + \beta_i R_m + \varepsilon_i$ is then framed using OLS and with the intervention of GARCH(General Auto Regressive Conditional Heteroscadastic model)effects. The models considered for identification of GARCH beta are described below.

1.Engle (1982) introduced the Autoregressive Conditional Heteroscadastic [ARCH(q)] model assuming that the conditional variance depends on past volatility measured as a linear function of past squared values of the process ε_t, i.e., $\sigma_t^2 = \boldsymbol{\omega} + \boldsymbol{\alpha_1 \varepsilon_{t-1}^2} + \cdots \boldsymbol{\alpha_q \varepsilon_{t-q}^2}$ where $\varepsilon_t = u_t$ is an independently and identically distributed sequence with zero mean and unit variance. An alternative and potentially more parsimony parameter structure is the Generalized ARCH, or GARCH(p,q) model proposed by Bollerslev (1986),

$$\sigma_t^2 = \boldsymbol{\omega} + \sum_{i=1}^{p} \boldsymbol{\delta_i \sigma_{t-i}^2} + \sum_{i=1}^{q} \boldsymbol{\alpha_i \varepsilon_{t-i}^2} = \boldsymbol{\omega} + \boldsymbol{\delta(L)\sigma_t^2} + \boldsymbol{\alpha(L)\varepsilon_t^2} \text{------------(6)}$$

whereδ(L)σ_t^2 is the GARCH term of order p and α(L)ε_t^2 is the ARCH term of order q.

2. In financial stock markets it is often observed that positive and negative shocks have different effects on the volatility, in the sense that negative shocks are followed by higher volatilities than positive shocks of the same magnitude (Engle and Ng, 1993). To deal with this phenomenon, Glosten, Jagannathan and Runkle (1993) and Zakoian (1994) introduced independently the Threshold ARCH, or TARCH model, which allows for asymmetric shocks to volatility. The conditional variance for the simple TARCH(1,1) model is defined by

$$\sigma_t^2 = \boldsymbol{\omega} + \boldsymbol{\delta\sigma_{t-1}^2} + \boldsymbol{\alpha\varepsilon_{t-1}^2} + \boldsymbol{\gamma\varepsilon_{t-1}^2 d_{t-1}} \text{--------------------(7)}$$

Where d=1 if $\varepsilon_t$is negative, and 0 otherwise.

3. An alternative for asymmetric volatilities is the Exponential GARCH, or EGARCH model, introduced by Nelson (1991). The conditional variance of EGARCH (1,1) model is defined by

$$\boldsymbol{log\sigma_t^2} = \boldsymbol{\omega} + \boldsymbol{\delta_1 log\sigma_t^2} + \boldsymbol{\alpha_1}\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \boldsymbol{\gamma_1}\left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right) \text{.----------------------(8)}$$

The exponential leverage effect is present if $\gamma < 0$ and the shock is asymmetric when $\gamma \neq 0$ .The shock persistence is δ.

In the equation (1), $\alpha_i$is the component of the return of asset i, that is independent of the market performance. $R_m$is the rate of return of the index market $\beta_i$is a value that measures the expected change in R_i given a change in Rm. This equation divides the returns on a stock in two parts, the part due to the market and the part

independent of the market. Here ε_i and $R_m$are random variables with volatility $\sigma_{\varepsilon_i}$and σ_{R_m}.
By definition the variance of ε_i is $\sigma_{\varepsilon_i}^2$and the variance of $Rm= \sigma_m^2$

Using (1) the mean return is $\bar{R}_i = \alpha_i + \beta_i R_m$ and the variance of the asset return is
$\sigma_i^2 = \beta_i^2 \sigma_m^2 + \sigma_{\varepsilon_i}^2$ .The covariance of the returns between stocks is $\sigma_{ij} = \beta_i \beta_j \sigma_m^2$.

Using the above, the expected return of a portfolio is

$$\bar{R}_p = \sum_{i=1}^{n} X_i \alpha_i + \sum_{i=1}^{n} X_i \beta_i \bar{R}_m \text{-----(9)}$$

The variance of a portfolio is

$$\sigma_p^2 = \sum_{i=1}^{n} X_i^2 \beta_i^2 \sigma_m^2 + \sum_{i=1}^{n} \sum_{\substack{j=1 \\ i \neq j}}^{n} X_i X_j \beta_i \beta_j \sigma_m + \sum_{i=1}^{n} X_i^2 \sigma_{\varepsilon_i}^2 \text{------------(10)}$$

Hence we have $\beta_p = \sum_{i=1}^{n} X_i \beta_i \; and \; \alpha_p = \sum_{i=1}^{n} X_i \alpha_i$
Therefore $\bar{R}_p = \alpha_p + \beta_p \bar{R}_m$-----------------------------(11)
Rearranging the terms

$$\sigma_p^2 = \beta_p^2 \sigma_m^2 + \sum_{i=1}^{n} X_i^2 \sigma_{\varepsilon_i}^2 \text{--------------------(12)}$$

Two alternative betas considered in this study are computed using Ordinary Least Squares(OLS) and GARCH models. Among GARCH models, the best model is selected as the one which corresponds to minimum AIC(Akaike Information Criteria). The calculation of a portfolio is based on the ratio called "excess on return to Beta". The numerator is the excess of return or the difference between the asset return and the risk free rate, and the denominator is the non diversifiable risk or the risk that we cannot get rid of. If the assets are ranked by this ratio from highest to lowest, the ranking presents a preference to be included in the portfolio. For a particular ratio all the assets over this particular ratio will be included in the portfolio, and all the assets with a ratio under this particular value are excluded from the selection. This particular ratio is called as cut- off ratio *C**. The stock selection for the portfolio is done by estimating the ratio of each stock under consideration and ranking the assets from highest to lowest based on the ratio. The portfolio consists of all stocks for with the ratio of excess of return to beta is greater than a particular C*.

C* is call the cut-off rate. All assets whose excess of return to beta is above C* are selected and whose ratios are below are rejected. To estimate the cut-off ratio it is necessary to rank the assets by the ratio of excess of return to beta and estimate the value of Ci, which is computed as

$$C_i = \frac{\sum_{j=1}^{n} \frac{\beta_j(\bar{R}_j - R_f)}{\sigma_{\varepsilon_j}^2}}{1 + \sigma_m^2 \sum_{j=1}^{n} \frac{\beta_j^2}{\sigma_{\varepsilon_j}^2}} \text{ . ------------(13)}$$

To weightage of each asset in the portfolio is

$$X_i = \frac{Z_i}{\sum_{i=1}^{n} Z_i} \text{----------(14)}$$

$$\text{Where } Z_i = \frac{\beta_i}{\sigma_{\varepsilon_i}^2} \left(\frac{\bar{R_i} - R_f}{\beta_i} - C^* \right) \text{---------(15)}$$

5. Analysis and Interpretation

5.1:Estimation of sensitivities due to macroeconomic factors:

The first step is to fit equations for the models considered in the study as specified in equations (1) and (3). The regression coefficients which are used to analyze the sensitivity of stock returns are given in table-1. The coefficient of the market index has the largest statistical significance for all stocks. Given that stocks used in analysis are from NIFTY 50 index, such results were expected. Positive signs on regression coefficients of NIFTY index indicate that the growth in NIFTY increases the stock returns. Results show that if NIFTY index rises by 1 percentage point, stock return increases by more than 1 percentage point on average for the majority of stocks. Inflation, that is, the change in CPI, shows significant t-statistics values for 13 stocks. The regression coefficients of stock return to the change in CPI for 7 stocks have negative signs, which mean that the inflation growth tends to decrease the stock return. This is justified because the inflation reduces the real payoff of investors during the holding period and hence the investment in stocks decreases. The negative sign on the inflation risk premium could indicate that investors are willing to take risk and hold stocks if they expect that economic expansion will increase the value of their stocks. The positive risk premium for inflation indicates that investors required a premium to compensate for the inflation risk which significantly increased during the year marked by strong inflationary pressures. The sensitivity of stock returns to changes in gold prices shows the significance for 28 stocks. The gold prices have a positive impact on stock prices as indicated by the positive regression coefficients. The growth of industrial production volume, as a measure of economic activity, has a positive effect on the stock return, since economic growth gives a positive signal to capital market. This macroeconomic factor shows statistical significance for 28 stocks from the sample. The Treasury bill rate is significant only in 3 stocks. The market price is significant except 2 stocks.

5.2: Estimation of risk premiums for macroeconomic factors:

After estimating sensitivities of stock returns to a change in each macroeconomic factor, the next step includes cross-sectional regression in which the estimated sensitivities are used as independent variables and stock returns in each month as dependent variables. This result in time series of risk premiums for each macroeconomic factor for the period from April 2008 to August 2016.Regression results are shown in Table-2. In Chen, Roll and Ross (1986), the results indicate that the most important factors affecting the expected stock returns on U.S. capital market are the industrial production, unanticipated changes in the risk premium, the unanticipated inflation, and, a somewhat weaker significance shows the unanticipated change in the term structure. The results showed that the market index doesn't have a significant influence on stock returns on the U.S. capital market, neither do the consumption and oil prices. In contrast, NIFTY 50 proved to be the most important factor in the Indian capital market. Differences in the results of the U.S. and the Indian capital market analysis could be explained by the fact that the U.S. capital market is one of the most developed markets in the world which responds quickly to every publicly disclosed information. On the other hand, the Indian capital market possibly is not yet sufficiently developed to identify all information affecting the stock prices movement; therefore, only the official stock market index NIFTY 50, as a representative variable of the Indian capital market, has emerged as a significant factor.

5.3: Comparative analysis of the APT and SIM:

The discrimination of the non-nested models is done based on the method suggested by Davidson and MacKinnon (1981). The regression model of average stock returns on the estimated values of SIM and APT is $\bar{R}_i = 0.984076R_{SIM} + 0.015924R_{APT}$. Here, SIM proves to be better since the coefficient of R_{SIM} is close to 1.

5.4: Construction of the portfolio using market betas:

Since the market index has emerged as a single most significant factor the following model for returns is formed. The calculation of a portfolio is based on the ratio called "excess on return to Beta" computed as $=\frac{R_i-R_f}{\beta_i}$.

Portfolio 1: After ranking the assets based on the Treynor's ratio which is computed using OLS betas, the cut-off value is identified as $C^* = \mathbf{0.083285}$**.** This cut-off value occurred after 8 stocks ranked based on the excess on return to beta ratio. The portfolio formed along with the weights is given in Table 3. The portfolio beta $\beta_{p=}$ 0.60415 and the portfolio return is 0.023431%.

Portfolio 2: After ranking the assets based on the Treynor's ratio which is computed using GARCH betas, the cut-off value is identified as $C^* = \mathbf{0.058682}$**.** This cut-off value occurred after 12 stocks ranked based on the excess on return to beta ratio. The portfolio formed along with the weights is in Table 4. The portfolio beta $\beta_{p=}$ 0.701017 and the portfolio return is 0.027188%.

6. Findings

We considered two alternative models APT and SIM to understand the movement of returns. It is found that for the Indian Capital market the Single Index model is the best alternative. To construct the SIM, betas are computed using two methods: OLS and Betas with intervening GARCH effects. Among these two betas, Betas with intervening GARCH effect results in the portfolio with maximum average return as compared to the portfolio constructed with OLS betas.

7. Limitation of the Study

- We have constrained the weight (X_i) for each asset to assume only positive values. Due to this if we wish to remove an inferior asset from the portfolio after a period of time, the entire computational process should be done with the updated data from the beginning.
- The duration for which the portfolio can be maintained should be decided based on the movement of the macroeconomic variables, the political situation and international happenings. The criterion for the duration is not specified in this paper.

III. CONCLUSIONS

This paper aims to investigate the relation between the stock return on Indian capital market and macroeconomic factors. The analysis included 37 stocks and seven macroeconomic factors: inflation, industrial production, interest rate, gold prices, currency in circulation and exchange rate. The cross sectional regression models of the mean returns of the stocks on the betas of the Single Index model and APT are then compared using the method suggested by Davidson and MacKinnon (1981). The Single Index Model with Market Index as the explanatory variable emerges as the best model and hence the portfolio is framed with this model as the base. The result that the market index is the most important factor in the Indian capital market, is in contrast to the results observed in countries like U.S. Differences in the results, could be explained by the fact that the U.S. capital market is one of the most developed markets in the world which responds quickly to every publicly disclosed information. But, the Indian capital market is not yet sufficiently developed to identify all information affecting the stock prices movement; therefore, only the official stock market index, has emerged as a significant factor. The betas are computed using two approaches: OLS and betas with the intervention of GARCH effects. The assets are ranked using Treynor's ratio. The OLS betas resulted in a portfolio of 8 stocks and the GARCH betas resulted in a more diversified portfolio of 12 stocks. Further the portfolio return due to OLS betas is 0.023431% and the portfolio return due to GARCH betas is 0.027188%. Hence it is concluded that the GARCH betas lead to a diversified portfolio with expected returns greater than that of the portfolio formed using OLS betas.

IV. FUTURE WORK

We have considered two alternative approaches to compute betas in this paper. We have proposed to recursively estimate the beta series from an initial set of priors and use these betas for the construction of the portfolio. We are trying to do this with the Kalman approach for computing the estimates of conditional risk. Also, we propose to frame a dynamic method which allows modifying the portfolio by removing or adding an asset without any necessity to carry out the calculation right from the beginning.

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VI. APPENDIX

TABLE 1: Sensitivities to the returns of the stock for the three models

	BETAS							
ASSETS	CAPM	RRM	GR	CIC	EXR	CPI	IIP	INT
JINDAL	1.03472	1.078149	0.544199	1.32089	-2.755736	1.779233	0.079665	0.011773
TATASTEEL	1.040202	1.133269	0.625943	0.451251	-3.220217	2.90544	0.223491	0.009755
AXISBANK	1.042882	1.112504	-0.454714	1.328436	-2.891052	2.901626	0.14819	-0.027225
GRASIM	0.990795	1.010082	0.236783	0.737767	-1.883717	1.73301	0.138452	0.036717
CIPLA	1.035074	**1.568758**	-3.924218	-2.465793	0.514292	5.208849	1.880405	-0.1319
AMBUJA	1.012695	0.934075	0.382342	0.961855	-1.443849	0.764043	0.328375	0.009153
DRREDDY	1.007711	0.931211	-0.229341	0.68996	-0.448926	0.862217	0.139196	-0.001621
ACC	1.030423	0.94321	0.30792	0.947771	-1.673601	1.210172	0.216849	-0.006995
GAIL	0.981577	0.833287	0.259284	0.502903	-0.143861	0.087706	0.267507	0.028492
HCL	1.00562	0.986861	-0.682503	-0.801901	-0.618153	3.047362	0.086906	-0.007865
WIPRO	0.995611	0.930738	-0.231581	-0.307759	-0.593221	1.72611	0.409403	0.004765
L&T	1.06003	1.082745	-0.104119	-0.065818	-2.51505	3.65513	0.062841	-0.032625
M&M	0.988161	1.002689	-0.083921	2.301082	-0.949724	-0.322061	0.014938	0.031044
INFY	1.000883	0.849065	-0.052128	-0.05196	-0.097315	0.76696	0.451846	-0.003137
NTPC	0.989541	0.872114	-0.019099	0.304709	-1.415918	2.045367	0.053123	0.021481
SUNPHARMA	1.018164	0.896274	-0.225552	0.447143	-0.714458	1.419757	0.104014	-0.013863
TATAMOT	1.013616	1.147878	0.003075	0.282532	-2.758712	3.655512	-0.190234	0.025209
TCS	0.999375	0.916899	-0.278158	-0.563217	-0.397885	2.089343	0.172955	0.002668
HEROMTR	1.019993	0.855573	0.344609	0.216109	-0.736062	1.19336	-0.007599	0.001521
HINDALCO	1.063019	1.095574	-0.032436	-0.309387	-2.548252	3.477176	0.465984	-0.041865
TATAPWR	0.99794	0.980187	0.090095	0.722772	-	2.111582	0.166205	0.02297

					2.123953			
BHARTIARTL	1.013039	0.91565	-0.256358	0.404775	-1.130328	1.853685	0.124116	-0.006666
IDFC	0.957301	0.82219	0.304684	0.807869	0.469295	-0.781547	0.143284	0.055133
SAIL	1.016788	1.043466	0.061771	1.385726	-2.63318	1.747483	0.423238	0.003199
RELINDUS	1.025798	0.949002	0.223649	0.931191	-1.669493	1.263519	0.245303	-0.004411
ONGC	1.023529	0.938905	0.153163	0.338949	-1.702784	2.186068	0.022628	-0.000471
BPCL	1.087962	0.912966	0.262202	-0.64191	-1.783672	3.277196	-0.026993	-0.061823
MARUTSUZ	1.002307	0.976714	-0.096201	0.18234	-1.73873	2.664567	-0.013187	0.015228
ITC	1.001001	0.861344	0.028967	0.618862	-0.891465	1.369542	-0.129597	0.013379
SIEMENS	1.027296	1.072443	0.12687	1.292318	-2.741819	2.013917	0.308541	-0.000725
RELINFRA	1.036447	1.158643	-0.296456	0.2385	-3.564651	4.68378	-0.070146	-0.005429
BHEL	1.036618	0.988427	-0.116545	0.632021	-2.278413	2.705568	0.060043	-0.017359
RCOM	1.06674	1.046764	-0.575459	0.167217	-2.808011	4.163519	0.092849	-0.056092
CAIRN	1.016574	0.940109	0.162455	0.418042	-1.14715	1.473684	0.074372	0.005995
DLF	1.020895	1.129923	0.168649	-0.816719	-3.636282	4.731397	0.528789	0.008837
PWRGRID	1.004177	0.870213	0.008491	0.783634	-1.011337	1.232432	-0.031813	0.009471
RELPWR	1.04812	1.052668	-0.220536	0.383829	-2.518696	3.31833	0.041003	-0.025365

TABLE 2: Risk premiums derived for the three models

Model		λ_0	λ_1	λ_2	λ_3	λ_4	λ_5	λ_6
SIM	Coefficient	92.7673	7.714909	-	-	-	-	-
	Standard Error	2.168765	2.158599	-	-	-	-	-
	Probability	0	0.001	-	-	-	-	-
R^2	0.96738							
APT	Coefficient	8.073528	90.76851	92.01576	91.52318	91.64573	92.2195	96.44627
	Standard Error	8.910938	8.844834	8.851372	8.730915	8.786353	8.768407	10.68135
	Probability	0.3721	0	0	0	0	0	0
R^2	0.938676							

TABLE 3: Portfolio of the stocks selected using OLS betas with the weights X_i

STOCKS	BETA	MEAN	ri-rf/beta	C_i	z_i	$Weight\ X_i$
grasim	0.704927	0.227507	0.236063	0.023814	0.011634	0.176227
bharatpetro	0.622573	0.189121	0.205632	0.031741	0.004767	0.07221
axisbank	1.307705	0.260806	0.152715	0.036147	0.001116	0.01691
sunpharma	0.479188	0.121633	0.126324	0.045163	0.005761	0.087267
infosys	0.701138	0.142658	0.116322	0.048633	0.00155	0.023479
HCL	0.905706	0.153869	0.102427	0.054455	0.00173	0.026203
drreddy	0.429245	0.103267	0.098235	0.057736	0.002134	0.032331
heromotor	0.560626	0.109099	0.085617	**0.083285**	0.037323	0.565372

TABLE 4: Portfolio of the stocks selected using GARCH betas with the weights X_i

STOCKS	beta	mean	ri-rf/beta	ci	zi	Xi
grasim	0.688173	0.227507	0.24181	0.002756	0.001468	0.033272
bharatpetro	0.61962	0.189121	0.206612	0.012399	0.005736	0.105665
axisbank	1.335834	0.260806	0.149499	0.018072	0.001491	0.027383
sunpharma	0.459751	0.115646	0.118642	0.028153	0.007699	0.141812
HCL	0.792396	0.153869	0.117074	0.036682	0.004604	0.084811
infosys	0.712445	0.142658	0.114476	0.040537	0.00266	0.048995
drreddy	0.440551	0.103267	0.095714	0.045286	0.005426	0.099942
heromotor	0.544309	0.109099	0.088183	0.049633	0.004584	0.084199
TCS	0.70935	0.115646	0.076896	0.054171	0.004279	0.078817
ITC	0.607313	0.107476	0.076363	0.055477	0.001824	0.033599
marutisuz	0.755521	0.117751	0.074983	0.058438	0.004108	0.075661
tatamtr	1.292045	0.138133	0.059621	**0.058682**	0.000237	0.004356