TRACKING NIFTY : A COINTEGRATION BASED APPROACH

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[This paper deals with formulation of Partially Replicating Index Tracking Portfolio with the use of cointegration. The paper is partly a replication of Christian L. Dunis & Richard Ho (2005) [published in Journal of Asset Management, Vol. 6, 1, page 33-52] with Indian stock market data. As NIFTY is an index based on free float market capitalization, a simple stock selection procedure of selecting stocks with highest market capitalization are used. Also progressively moving window portfolios are created and the dynamics of the portfolios are analyzed over a testing period of fourteen months. The essence of this study is to create a tracking portfolio in simple regression based approach which does not need any optimization. The resulting portfolio, as based on long-run cointegrating relationship, does not require frequent rebalancing and saves turnover cost.

Keywords: *Tracking, portfolio, nifty, cointegration]*

Introduction

In this age of increasing market volatilities, Tracking Portfolios have become extremely important. Not only this could set a benchmark return for the portfolio (and per se the portfolio manager), but also tracking a broad based index can enable an investor to hold the elusive Market Portfolio as described by CAPM.

Also to empirically test the multifactor asset pricing models (APT for example) tracking portfolios which track each factor of the market, are needed.

The tracking portfolio may be extensive (fully replicating), i.e. having all the stocks constituting the index or may have a smaller number of stocks (partially replicating) with optimized proportions to replicate the index returns. Goals of partially replicating portfolios are to minimize the tracking error between the portfolio and the index returns while having a less number of stocks than the benchmark index.

Traditionally, Index Tracking is viewed as a passive portfolio management

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technique where the portfolio manager tries to minimize the tracking error between the index and portfolio returns with minimal asset turnover so as to minimize the transaction cost. They believe that the market portfolio (a broad based index) is efficient and can't be beaten. Whereas the active portfolio managers constantly churn the assets in their portfolio to generate excess return than the index (so called alpha) which, if greater than the large transaction cost due to huge asset turnover, can create extraordinary returns.

Benchmark indices which are basically paper indices (portfolio created on paper and weights change every day) are based on a large number of stocks. If the indices are representative of any market then the index can be thought to be an approximation of market portfolio. Tracking a market portfolio is important for investors who want to expose themselves to a particular market.

This paper tries to formulate a method for tracking Indian market indices and follows it up with an extended out of sample testing period. The paper is organized in 6 sections. This section being the introduction, the next is motivation followed by Literature review in section 3. Section 4 summarizes the approach in view of cointegration in general with methodology and data used for the purpose. Section 5 is the analysis of results and observations while section 6 concludes.

Motivation for the Study

There are some established ways of developing index tracking portfolios as discussed in the following section, but in this paper it has been have tried to follow a method that would be simple enough to run and require less computing capacity. At the same time the model is expected to be powerful enough to even replicate a broad based index, enabling not only institutional investors but also individuals to replicate an index of their choice with acceptable errors.

As the portfolio is cointegration based, less periodic rebalancing of the portfolio will be needed and the transaction cost of asset turnover should be minimal.

Literature Review

Modern portfolio theories started with Harry M. Markowitz [1952], who revolutionized the idea of diversification by introducing the concept of covariance between assets in a portfolio. Resultant portfolio can have a variance less than that of individual assets if correlation between any two of them is less than perfect i.e. 1, while the mean return of the portfolio will be a weighted average of the mean returns of the individual assets in the portfolio. This resulted in formulation of an efficient frontier in the risk (X axis) return (Y axis) space, which denotes the set of minimum variance portfolios for specific returns.

Markowitz model uses a quadratic objective function for which the minimum variance criteria is fulfilled by a negative part having n(n+1)/2 quadratic terms making it hard to solve for a large number of assets. Further, as Markowitz's model assumes the correlation between asstes to remain constant over time, the model does not deal well with stock market data where variances and covariances are conditional. Chua David B, et al [2009] presented empirical results across a wide variety of assets, revealing that, unlike the theoretical conditional correlations, empirical correlations are significantly asymmetric, making it hard for the Markowian minimum variance portfolio to capture the true risk involved with covariance matrix. Thus it is best applied to allocation decisions across asset classes, for which the number of correlations is low, and the summary statistics are well estimated [See William N. Goetzmann, An Introduction to Investment Theory, 2000].

Even after assertion of an efficient frontier, the challenge was to select a particular portfolio from the all efficient ones depending upon investors' individual risk-return preferences. Short-fall criteria and Sharpe Ratio came as a solution, where the slope of the tangent drawn from the Expected Floor Return point on return axis (Y axis) to the efficient frontier denotes the t-statistic which in turn can be used to find the probability of actual return going below Floor Return. When the Floor Return is the risk free rate of return the tangent is called the security market line (SML) and the particular portfolio on the point of tangency on efficient frontier is called the Market Portfolio. Based on her preference each investor would hold a two-fund portfolio comprised of the market portfolio and the riskless asset and place herself on SML based on the relative weights allocated to the two funds [see William N. Goetzmann, An Introduction to Investment Theory, 2000].

Subsequently, the search for a market portfolio gave rise to Capital Asset Pricing Model (CAPM), which postulated that under some ideal & perfect environment, if an investor can hold or trade in world all available risky assets and one riskless rate existed at which all investors could borrow and lend, everyone in the world would want to hold precisely the same portfolio of risky assets, the market portfolio. An innovative approach of placing all the assets of world in a square cake and dividing it horizontally according to the size (market capitalization) of the assets and vertically according to wealth of all investors (as all of them hold the same portfolio, the market portfolio), indicated the market portfolio which was astonishingly close to the S&P 500 (A

capital-weighted portfolio of most of the U.S.'s largest stocks) in the 1960s [see William N. Goetzmann, An Introduction to Investment Theory, 2000].

Thus the belief that a broad based index can proxy for the elusive market portfolio led to the journey of Index Funds. Index Funds try to emulate the day to day return of the benchmark index that they are tracking. Generally for indices having fewer numbers of stocks (BSE Sensex 30 or NSE S&P NIFTY 50) a full replication is plausible, but for broad based indices like S&P 500 (NYSE & NASDAQ) or S&P CNX 500 (NSE India) a full replication may not be possible.

Even for a small based index, a full replication cannot get rid of the systematic risk of the market. Also, for indices like NSE S&P NIFTY, there is always some tracking error as weights of the index constituents change everyday depending on the free float methodology [See "Index Funds" by India Index Services & Products Limited, www.nseindia.com], which is very costly to eliminate due to presence of transaction costs.

The success of an Index Fund is measured by the tracking error which is computed by the standard deviation of the difference between day to day market return and portfolio return. Multiplying the standard deviation by square root of the number of trading days (typically 250 for NSE) gives the annual tracking error [see "Tracking Error" by India Index Services & Products Ltd, www.nseindia.com]. Tracking error is found to be significantly related to index revisions, share issuances, spin-offs, share repurchases, index replication strategy, and fund size. Furthermore, as Frino Alex, et al [2004] argued, index funds also exhibit a seasonal pattern in tracking error.

Typically, for large problems of index tracking involving mean return and covariance matrix, genetic algorithms are used as it becomes impossible for normal solvers to handle such an enormous problem. But Shapcott J. [1992] found it hard to find the global optima for the simple objective function and moreover the success of the portfolio depends upon the heuristics used by the model as well as the optimizer.

Another convenient way (return gap approach) of solving index tracking problem is by defining U_t as excess portfolio return over index at time t and D_t as the excess index return over portfolio at time t and solving the objective function Minimize {sum over t} $(U_t + D_t)$, that is minimizing the Mean Absolute Deviation of Portfolio and Index returns as tried by Rudolf M., Wolter H.J. and Zimmermann H. [1999]. Also there have been

applications of the Fuzzy logic by Yong Fang and Shou-Yang Wang [2005] in index tracking portfolio selection by allowing the upside excess return U_t while minimizing the average downside error D_t in a bi-objective model with maximizing expected return being the other objective.

Similar approach to minimize S_t (standard deviation of the difference between day to day market return and portfolio return over time t) has been postulated by Roll [1992]. In the same direction, Van Montfort Kees, et al [2008] has tried to track indices by solving the objective: MIN {sum over index creation period} sum squared error between index and tracking portfolio. They did not use binary variables to constrain the number of stocks in the portfolio, rather used heuristics to get the optimized solution.

Statman Meir and Scheid Jonathan [2008] indicated that the return gap approach as described in the previous paragraph is better than using correlations as the later is not a good indicator for two reasons. First, the benefits of diversification depend not only on the correlation between returns, but also on the standard deviation of returns, estimate of both are not robust. Second, correlation does not provide an intuitive measure of the benefits of diversification. To prove this, they have cited examples from historical data that there existed a substantial return gap although correlation is close to 1.

Since the seminal work of Engle and Granger [1987], cointegration has emerged as a powerful technique to see if two or more time series have common trends over a longer time period. Engle and Granger pointed out that a linear combination of two or more non-stationary series may be stationary and if such a stationary linear combination exists, the non-stationary time series are said to be cointegrated. As the individual series are non-stationary and thus have stochastic trend, stationarity of their linear combination will mean that those two series are having the same stochastic trend. Thus the cointegrating relationship is stronger than correlation relationship in the returns and may be interpreted as a long-run equilibrium relationship between the variables and can infer that the stochastic data generating process between the two series are same.

For only two series, simple regression and a subsequent check for stationarity of the error series is good enough. But for multivariate analysis, the well-documented Johansen [1988] test for multiple cointegrations is suitable.

For long run predictions at price level cointegration is good enough though for investigation of short run dynamics Vector Auto Regressive models with Error Correction vector (VECM) is the

proper one. Although models of cointegrated financial time series are now relatively common, their importance for quantitative portfolio optimization has remained limited because of mainly two reasons. First, although correlation can be empirically proved to be time varying, the pillars of portfolio construction (Markowitz), and asset pricing models (CAPM & APT) are based in risk return tradeoff rather than asset price data which cointegration deals with. Second, cointegration based approach does not have any endogenous asset selection procedure and can only assign appropriate weight to the chosen assets, which calls for an exogenous asset selection procedure, often heuristic, that can always be questionable.

Cointegration has recently been used in finding stock market linkages to see whether two or more stock markets share common stochastic trends. Kasa [1992] investigated whether there are any common stochastic trends in the equity markets of the US, Japan, the UK, Germany and Canada using monthly- and quarterly data for the period January 1974 to August 1990 and applied the Johansen [1988] test for multiple cointegration, The results indicate the presence of a single common trend driving these countries' stock markets.

Similar studies by Corhay et al. [1993] to find common long-run trend in different European countries' stock market; by Choudhury [1997] to analyze the long-run relationships between six Latin American stock markets and the US market use cointegration approach. Other studies looking at linkages across developing countries include Cheung and Mak [1992], Chowdhury [1994], Garrett and Spyrou [1994], Ng [2002] and Dunis and Shannon [2004].

While these papers focus primarily on stock market linkages, Cerchi and Havenner [1988] and Pindyck and Rothemberg [1992] underlined that as an equity index is by definition a weighted sum of its constituents stocks, provided index weights do not change radically over time, set of sufficiently large number of stocks should be cointegrated with the index. Based on this hypothesis, Alexander and Dimitriu [2002] built index tracking and market neutral cointegration portfolios for domestic US equities based on the Dow Jones Industrial Average index with daily data from January 1990 to December 2001. In parallel, Qiu [2002] using 12 years of daily data from January 1990 to March 2002, created a cointegration-based portfolio of international bonds from eight different countries to replicate the 13-country JP Morgan global government bond index. Burgess [2003], using EUROStoxx50 index daily data from September 1998 to

July 2002, developed cointegration-based strategies for hedging a given equity position or implementing statistical arbitrage trading opportunities.

Finally, Christian L. Dunis & Richard Ho [2005], using Dow Jones EUROStoxx50 index and its constituent stocks price data spanning from 4th January, 1999, to 30th June, 2003, devised a cointegration based tracking portfolio for European equities and also extended the model for long-short market neutral portfolios.

Methodology & Data

If Y and X are I(1) time series and $u = Y - \alpha - \beta X$ is I(0), then, in the long run, Y and X do not drift apart, since u has a zero mean. Hence, $Y = \alpha + \beta X$ can be interpreted as an equilibrium or long-run relationship between those series and depicted as cointegrating relationship while, u is referred to as the error-correction term (ECT), since it gives the 'error' value in the equilibrium which, in the long run, is zero.

In the current index tracking applications the choice of the dependent variable is completely obvious (the S&P CNX NIFTY Index level values) and undoubtedly one is looking for a cointegrating relation such as $Y = \alpha + X\beta + u$

where Y is index level column vector, X represents the stock price matrix.

Thus, Engel Granger method of regressing Y on X and then testing for stationarity of the residual series u seems robust enough. The only problem that may arise due to multicollinearity may cause the variance of estimated βs to be overestimated but in any case the estimates will remain unbiased.

Suppose X represents the stock price matrix of dimension (T×N) where each element x_{it} represent the price of ith stock at t^{th} time for all $i \in 1$ to N and for all $t \in 1$ to T

Let Y be the index level column vector of dimension (T×1) for the sample period of T trading days.

Then as index level are computed as weighted average of constituent stock prices, they should be cointegrated, which we can test by

I. Testing whether Y and X_is are all I (1)

II. Testing (Johansen test) whether there exists a cointegrating relationship between Y and X

III. Running a OLS regression $Y = \alpha + X\beta + U$ and testing whether the residual column vector U of dimension (T×1) is stationary i.e. I(0)

If all the tests are passed, then we can confer the $\beta = [\beta_1\ \beta_2\ \beta_3 \ldots\ldots \beta_N]^T$ to be the weight of the N stocks in the portfolio that tracks the index.

This simple regression does not restrict portfolio weights and signs. So a negative weight will mean that the future of the stock has to be shorted, as stock short selling overnight is not possible in India and it is easy to show that stock price and future price are cointegrated.

In this paper log normality of stock returns is taken for granted and thus a log transformed price series is used. Again it is trivial that if two series are cointegrated then their log transformed series will also be cointegrated.

After the regression the β values are obtained and normalized to get the weights of each stock in constituent portfolio so that the sum of weights is equal to ONE.

Stock selection is a major issue in this type of portfolio construction where stock selection is exogenous to the cointegration model. As NIFTY is a free float market capitalization Index, where the weights are proportional to the market capitalization, a simple model of picking the highest N capitalized stocks is used.

The number of stocks, N is varied from 5 to 10 to 20.

Data to formulate the model

S&P CNX NIFTY (NSE-India) which is a well diversified stock index comprising 50 stocks accounting for 24 sectors of the economy, has been taken as the benchmark index for this paper. The following statistics justify the selection…

- The total traded value for the last six months of all Nifty stocks is approximately 52.75% of the traded value of all stocks on the NSE.
- Nifty stocks represent about 63.94% of the Free Float Market Capitalization.

The closing price data is obtained from NSE website and cross checked for share split, bonus or rights issue adjustment with Bloomberg data sources.

For the initial estimation a period of 9Jan2007 to 31December2010 (total 985 time series data points) is taken. Five stocks are excluded from the estimation set namely: BajajAuto, CoalIndia, DLF, PowerGrid and Reliance Power as they are currently in the index but were newly listed (we need a longer estimation period for cointegration based approach) The reason for choosing 9Jan2007 as starting point is that CAIRN India, a stock with significant market capitalization was listed on that day.

The Initial portfolio P0 (P0_5 for 5 stocks, P0_10 for 10 stocks & P0_20 for 20 stocks) was created on data till 31st December 2010 and put into out of sample test from 1st January 2011.

Similarly, P1 (3 portfolios for N=5,10,20) was created on data till 31st January 2011 and put to out of sample test on 1st February 2011.

Thus for the data set lasting till 29th February 2012, a total 14 time-based portfolios (P0 to P13 with N=5,10,20 for each of them) were created and tested out of sample.

So a total of 42 portfolios created and named with convention PT_N (T=0 to 13, N=5,10,20).

For out of sample testing and analyzing the time dynamics of the tracking procedure developed, fourteen one month rebalancing portfolios could be taken. Similarly for a 3 month rebalancing mode twelve portfolios are analyzed. Further 9 portfolios for six month rebalancing and only 3 portfolios for the one year rebalancing strategy could be tested. The following table shows a summary of the portfolios and their testing methodology.

Table1: summary of the portfolios and their testing methodology

Month of the start of out of sample testing	1 Month rebalancing portfolio tested	3 Month rebalancing	6 Month rebalancing	12 Month rebalancing
Jan-2011	P0_5,P0_10,P0_20	P0_5,P0_10,P0_20	P0_5,P0_10,P0_20	P0_5,P0_10,P0_20
Feb-2011	P1_5,P1_10,P1_20	P1_5,P1_10,P1_20	P1_5,P1_10,P1_20	P1_5,P1_10,P1_20
Mar-2011	P2_5,P2_10,P2_20	P2_5,P2_10,P2_20	P2_5,P2_10,P2_20	P2_5,P2_10,P2_20
Apr-2011	P3_5,P3_10,P3_20	P3_5,P3_10,P3_20	P3_5,P3_10,P3_20	
May-2011	P4_5,P4_10,P4_20	P4_5,P4_10,P4_20	P4_5,P4_10,P4_20	
Jun-2011	P5_5,P5_10,P5_20	P5_5,P5_10,P5_20	P5_5,P5_10,P5_20	
Jul-2011	P6_5,P6_10,P6_20	P6_5,P6_10,P6_20	P6_5,P6_10;P6_20	
Aug-2011	P7_5,P7_10,P7_20	P7_5,P7_10,P7_20	P7_5,P7_10,P7_20	
Sep-2011	P8_5,P8_10,P8_20	P8_5,P8_10,P8_20	P8_5,P8_10,P8_20	
Oct-2011	P9_5,P9_10,P9_20	P9_5,P9_10,P9_20		
Nov-2011	P10_5,P10_10,P10_20	P10_5,P10_10,P10_20		
Dec-2011	P11_5,P11_10,P11_20	P11_5,P11_10,P11_20		
Jan-2012	P12_5,P12_10,P12_20			
Feb-2012	P13_5,P13_10,P13_20			

For the portfolios tested, Annual Return, Excess Return over the Index, Standard deviation of the return, Tracking Error, Sharpe Ratio (based on total risk given by standard deviation) and Treynor Measure (based on systematic risk given by beta) as well as Portfolio Beta are reported over the time as described above.

Results and observations

The normalized weighs of the entire set of 42 portfolios are provided in Exhibit 1 and the data sheets of portfolio performance measures and dynamics are provided in Exhibit 2.

For the whole estimation period the price levels moved as follows, showing visually the assumption that they are cointegrated is feasible.

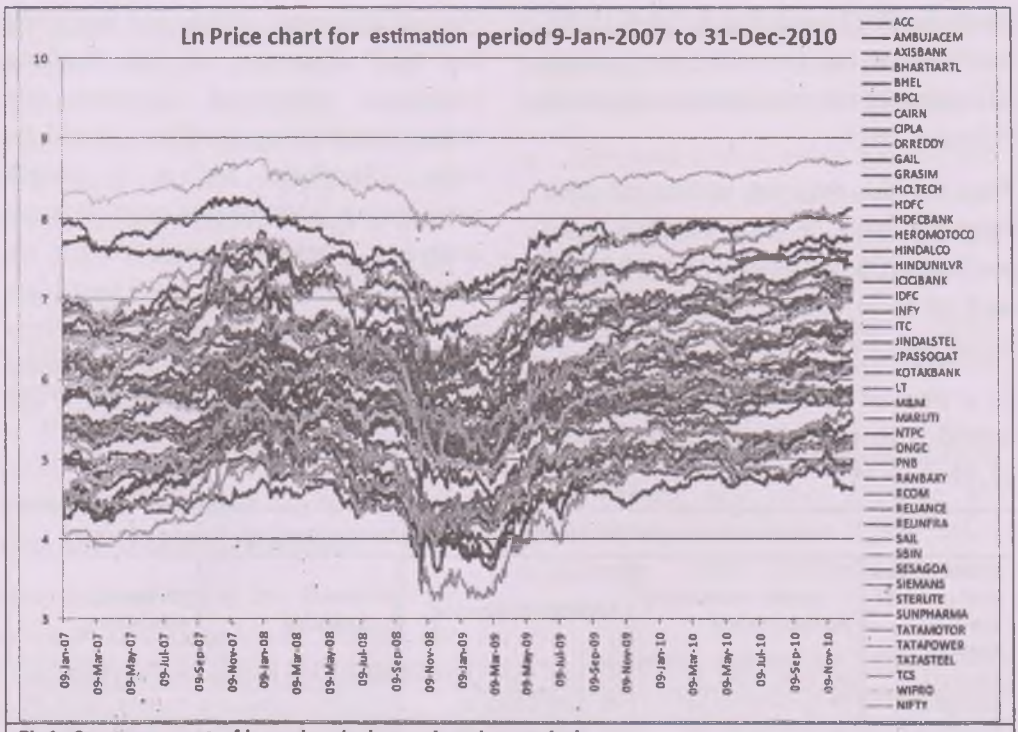


Fig1: Co-movement of log price during estimation period

Weights

The weights of 42 portfolios PT_N (T=0 to 13, N=5,10,20) vary as follows…

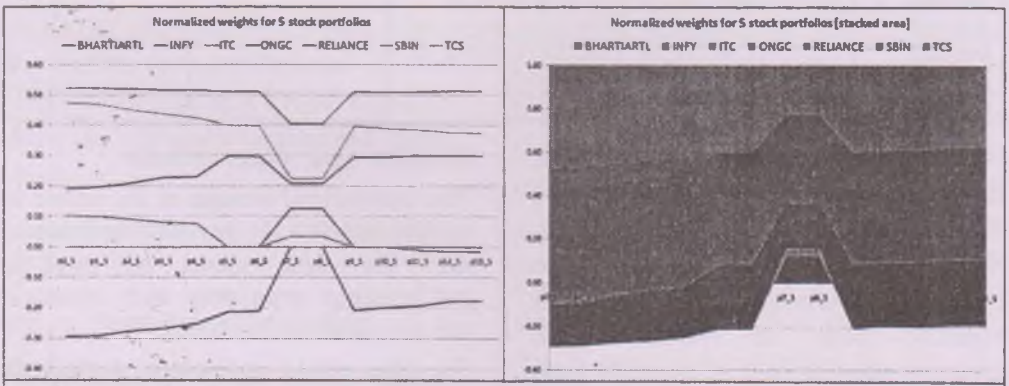


Fig2.1: weight dynamics for N=5 for all T in 0 to 13

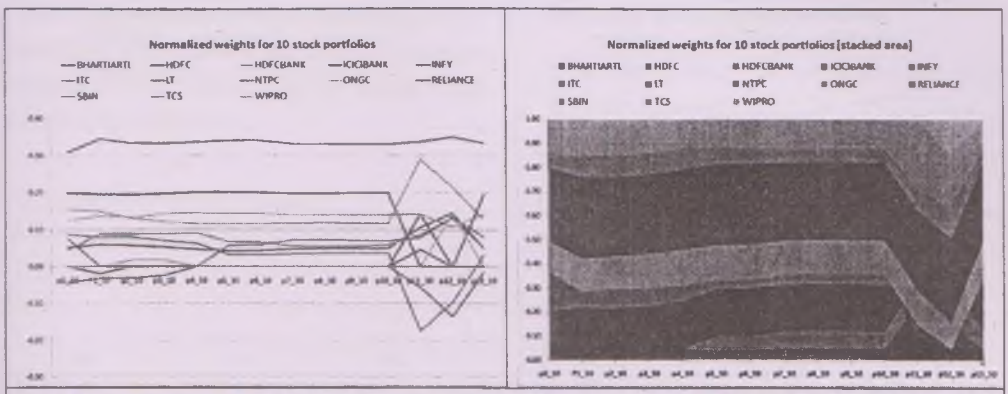


Fig.2.2: Weight dynamics for N=10 for all T in 0 to 13

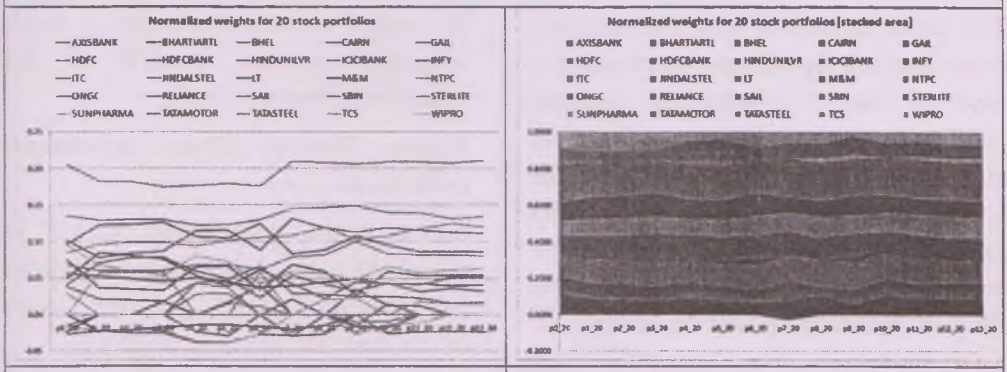
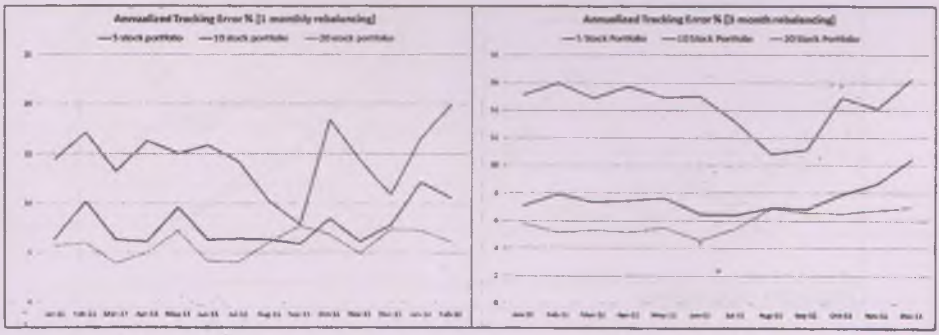


Fig.2.3: Weight dynamics for N=20 for all T in 0 to 13

The weights remain stable for lower N portfolios but vary a lot for N=20 portfolios. So the rebalancing, if done, will be costlier with increasing N.

Tracking Error

The tracking error for 5 stock portfolios remained higher than acceptable levels while that for 10 stock portfolios remain around below 10% pa. The tracking errors for 20 stock portfolios remained around 5-6% and were quite stable for all the rebalancing period. Tracking error evolved as follows…



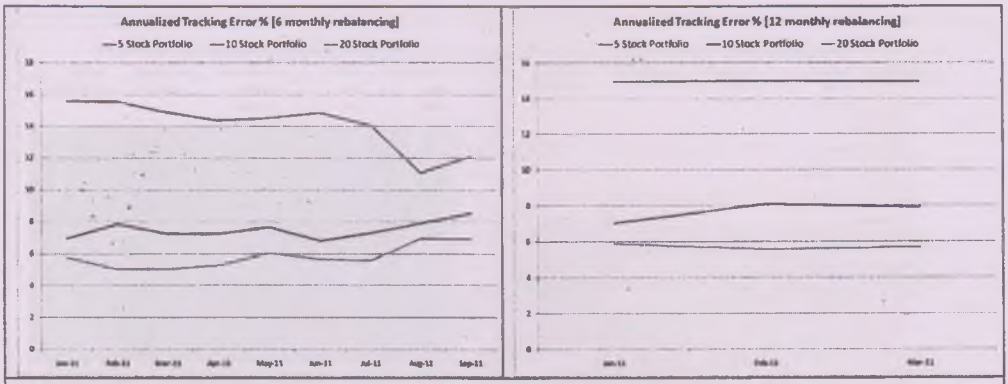


Fig3: Tracking error dynamics

The point to note is that: the tracking error does not deteriorate much even in case of larger rebalancing periods, confirming the conviction mentioned in motivation section. Thus although with correlation or return gap based approach, better tracking error can be managed on short term basis, more frequent rebalancing will be needed. So the cost of a crude tracking may be out weighted by the benefit of less rebalancing turnover cost.

Excess Return Over benchmark Index

Excess return generation was not the aim of the methodology and as expected the portfolios don't generate excess return over the index consistently.

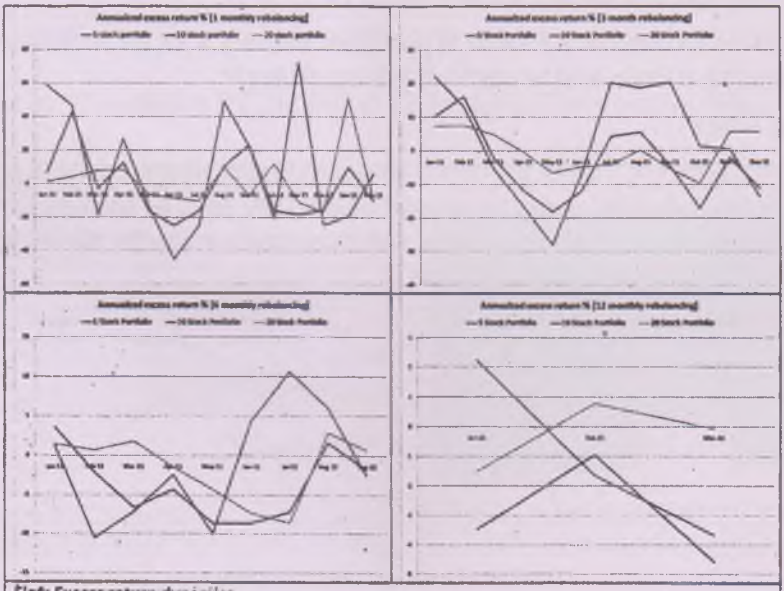
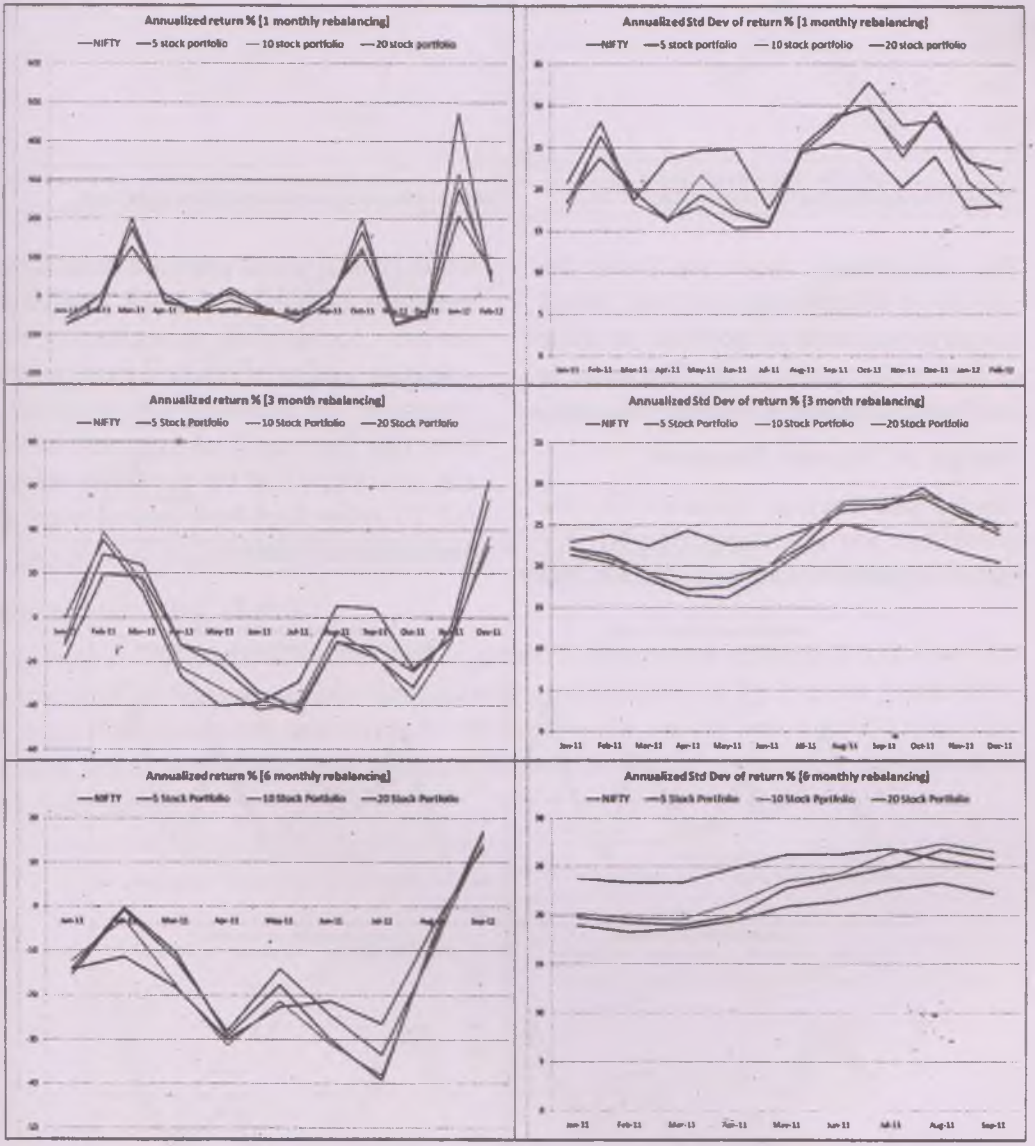


Fig4: Excess return dynamics

The observation is that the frequently rebalanced portfolios have better managed excess returns, especially for lower N (no of stocks) portfolios.

Return Dynamics

The following plots show the return dynamics of NIFTY vis-à-vis the generated tracking portfolios.



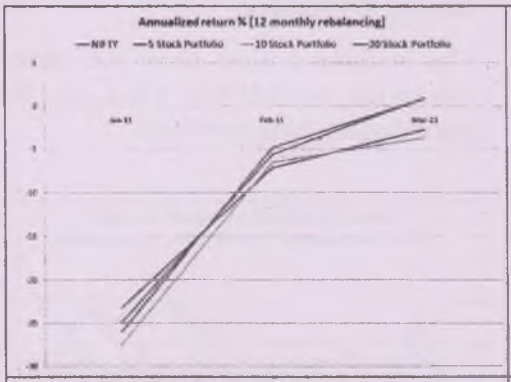


Fig5.1: Annualized return dynamics

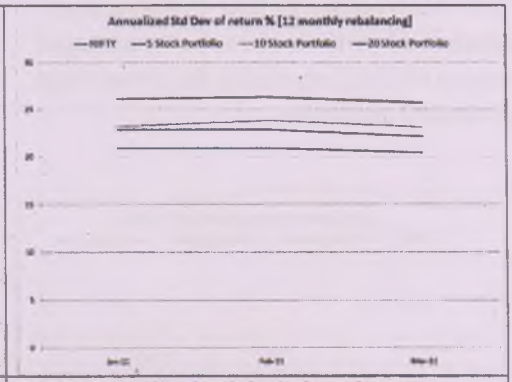
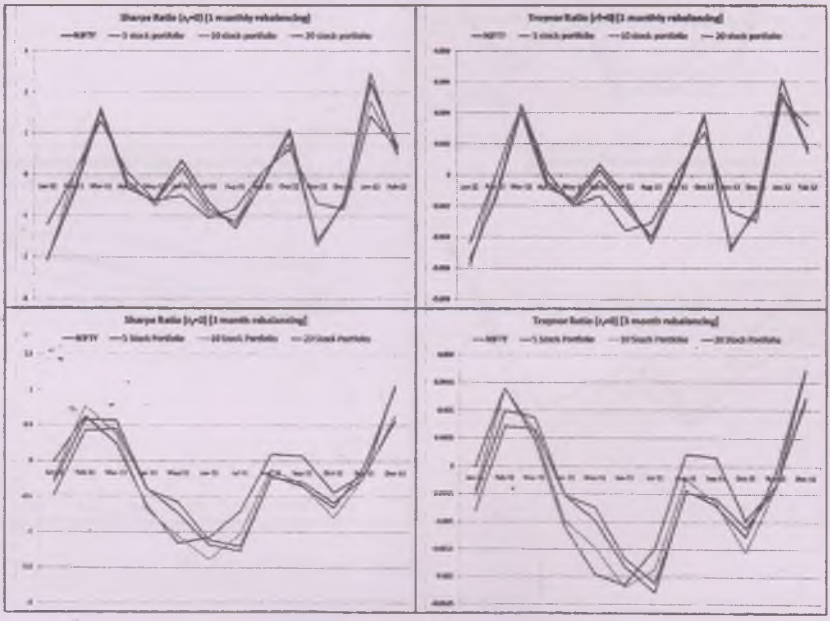


Fig5.2: Annualized std deviation of return

The plots clearly show that lower the number of stocks in the portfolio, worse the performance of the portfolio in terms of both risks and return. The same is confirmed in Sharpe & Treynor measures.

Sharpe & Treynor Measure

Sharpe and Treynor measure for the portfolios are identical with NIFTY indicating good tracking performance. But while 10 & 20 stock portfolio mimics the measures of NIFTY 5 stock portfolios deviate considerably, strengthening the point that number of stocks in an important parameter for cointegration portfolios. Here risk free rate is taken as zero as the aim is to show that the portfolios mimic NIFTY rather than their general usage as performance measure.



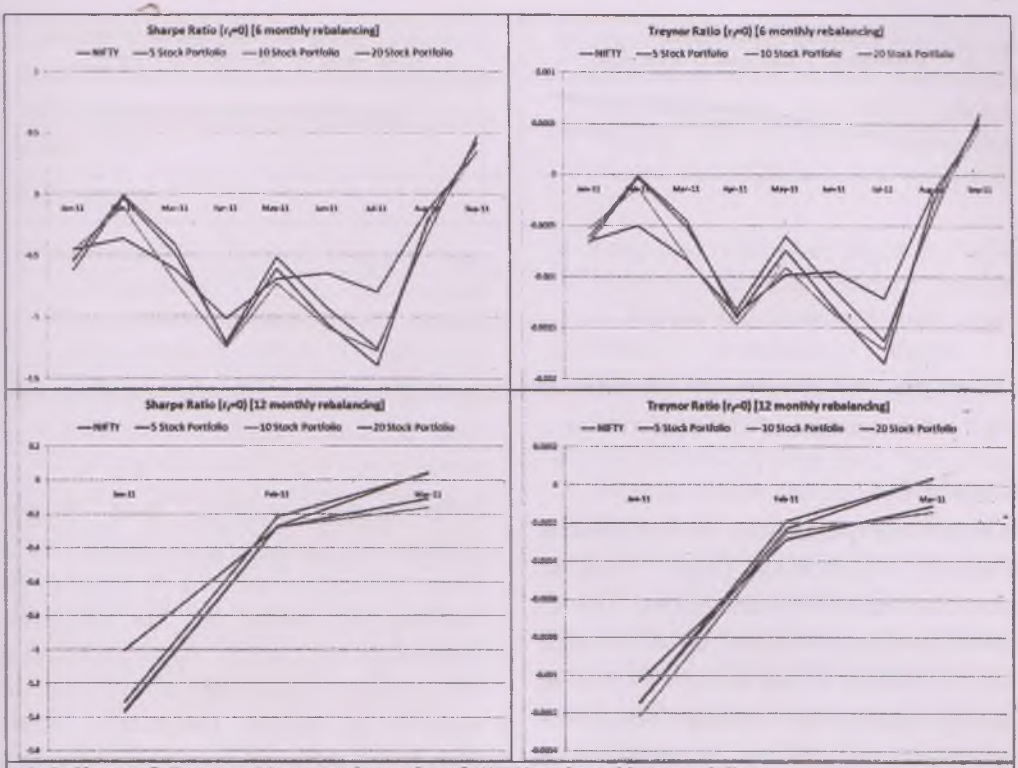
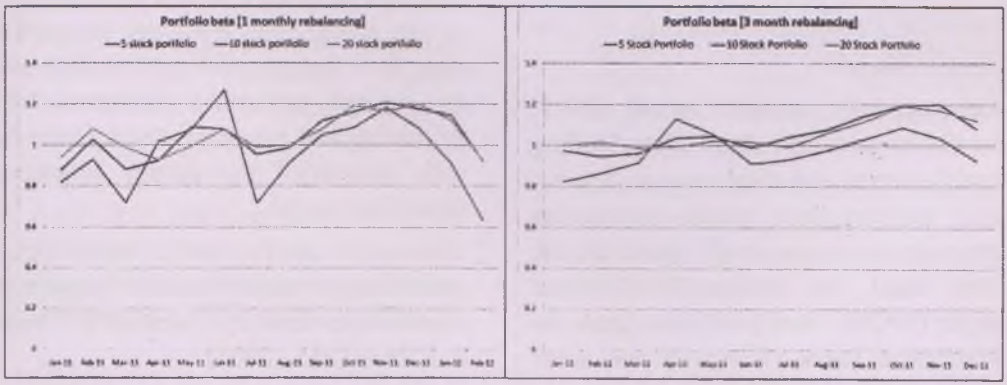


Fig6: Sharpe & Treynor Measure dynamics of NIFTY and tracking portfolios

Systematic Risk (beta)

The beta of the portfolios generated in general shows more systematic risk than the index itself in the out sample although being constrained to be 1 in the preparation sample. This does not pose any major problem as the excess beta is compensated by excess return and as discussed can always be synthetically reduced by derivatives or by short selling.



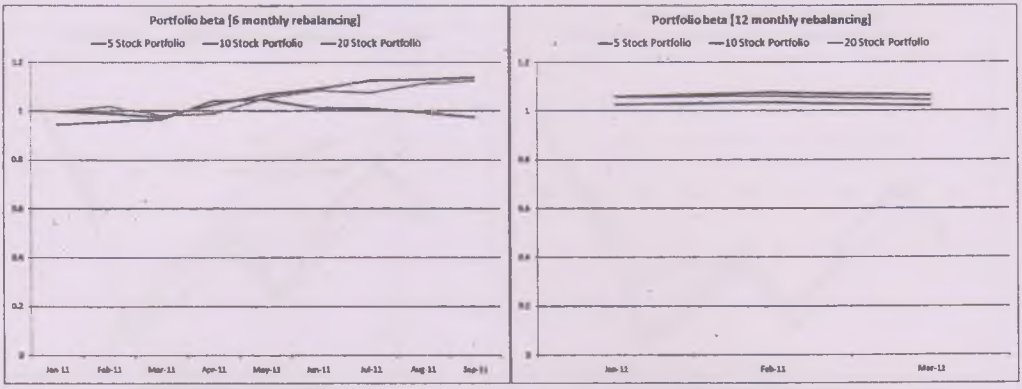


Fig.7 : Beta dynamics of tracking portfolios

Conclusion

Aim of this paper was to formulate a Partially Replicating Index Tracking portfolio based on cointegration. The 42 portfolios generated and tested through the 14 months of out of sample testing period shows that cointegration based approach can indeed be used as a method of tracking portfolio formulation. The time series data taken to formulate the model by estimation of model statistics as described above is a fairly good representative of the market behavior over the long run. This period exhibits both a downturn and an uptrend pitted with corrections and stabilizations. The returns also show both high and low volatile phases.

Although the smaller sized (N=5) portfolios does not show class leading tracking error and stable excess returns, their stability over longer rebalancing intervals was surprisingly good. On the other hand, the medium (N=10) and larger (N=20) sized portfolios track the benchmark index efficiently and show even better stability over longer rebalancing periods. It is evident that a larger testing period will be required to validate the model for the particular index it is built upon. Also, replicating the method prescribed above over a number of indices (especially broad based) and different economic indicators will be fruitful in the sense that it can be used as empirical testing of multifactor and arbitrage pricing models.

In this case as the stocks constitute the index cointegration was not a major problem. But, to track any other macro indicator the major problem lies in selection of stocks, which is exogenous to the model. So, a robust sequential algorithm to test cointegration between the desired economic indicators and individual and group of stocks, may be with automated computing heuristics would be helpful.

This model can be used to create alpha generating or market neutral long-short portfolios as done by Christian L. Dunis & Richard Ho (2005).

Creating a model in the same fashion as described in this paper, but including the transaction cost can be a fruitful future study.

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Exhibit 1: Weights of stocks in tracking portfolios

sl. no.	alphabetical list of relevant stocks	normalized weights [insignificant weights are set to ZERO with a significance level of 10%]																																							
		p0_5	p0_10	p0_20	p1_5	P1_10	p1_20	p2_5	p2_10	p2_20	p3_5	p3_10	p3_20	p4_5	p4_10	p4_20	p5_5	p5_10	p5_20	p6_5	p6_10	p6_20	p7_5	p7_10	p7_20	p8_5	p8_10	p8_20	p9_5	p9_10	p9_20	p10_5	p10_10	p10_20	p11_5	p11_10	p11_20	p12_5	p12_10	p12_20	p13_5	p13_10	p13_20
1	AXISBANK	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0298	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	BHARTIARTL	0.0000	0.0509	0.0564	0.0000	0.0594	0.0528	0.0000	0.0571	0.0482	0.0000	0.0526	0.0454	0.0000	0.0472	0.0504	0.0000	0.0423	0.0441	0.0000	0.0431	0.0375	0.1248	0.0487	0.0480	0.1249	0.0498	0.1048	0.0000	0.0500	0.0480	0.0000	0.0489	0.0421	0.0000	0.1070	0.0427	0.0000	0.1454	0.0399	0.0000	0.0500	0.0412
3	BHEL	0.0000	0.0000	-0.0140	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0236	0.0000	0.0000	-0.0287	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	CAIRN	0.0000	0.0000	0.0742	0.0000	0.0000	0.0372	0.0000	0.0000	0.0355	0.0000	0.0000	0.0337	0.0000	0.0000	0.0660	0.0000	0.0000	0.0668	0.0000	0.0000	0.0742	0.0000	0.0000	0.0641	0.0000	0.0000	0.0594	0.0000	0.0000	0.0279	0.0000	0.0000	0.0598	0.0000	0.0000	0.0542	0.0000	0.0000	0.0547	0.0000	0.0000	0.0542
5	GAIL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0220	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0146	0.0000	0.0000	0.0153	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	HDFC	0.0000	0.0000	0.0186	0.0000	0.0000	0.0239	0.0000	0.0000	0.0254	0.0000	0.0000	0.0185	0.0000	0.0000	0.0444	0.0000	0.0000	0.0482	0.0000	0.0000	0.0238	0.0000	0.0000	0.0540	0.0000	0.0000	0.0418	0.0000	0.0000	0.0338	0.0000	0.0000	0.0431	0.0000	0.1421	0.0419	0.0000	0.0000	0.0519	0.0000	0.0000	0.0529
7	HDFCBANK	0.0000	0.0000	0.0612	0.0000	0.0000	0.0873	0.0000	0.0000	0.0611	0.0000	0.0000	0.0763	0.0000	0.0000	0.0559	0.0000	0.0571	0.0397	0.0000	0.0509	0.0617	0.0000	0.0719	0.0425	0.0000	0.0741	0.0227	0.0000	0.0712	0.0453	0.0000	0.0680	0.0430	0.0000	0.0794	0.0322	0.0000	0.1351	0.0368	0.0000	0.0814	0.0328
8	HINDUNILVR	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0218	0.0000	0.0000	-0.0202	0.0000	0.0000	-0.0171	0.0000	0.0000	-0.0143	0.0000	0.0000	-0.0130	0.0000	0.0000	-0.0167	0.0000	0.0000	-0.0196	0.0000	0.0000	-0.0136	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	ICICIBANK	0.0000	0.1977	0.1359	0.0000	0.1954	0.1301	0.0000	0.1931	0.1320	0.0000	0.1974	0.1363	0.0000	0.2012	0.1235	0.0000	0.2008	0.1245	0.0000	0.2011	0.1304	0.0000	0.1990	0.1455	0.0000	0.1986	0.1470	0.0000	0.1954	0.1491	0.0000	0.2002	0.1402	0.0000	0.0000	0.1197	0.0000	0.0000	0.1322	0.0000	0.1940	0.1353
10	INFY	-0.2831	-0.0423	-0.0221	-0.2890	-0.0126	0.0000	-0.2740	-0.0126	0.0000	-0.2657	-0.0225	0.0035	-0.2531	0.0000	0.0000	-0.2526	0.0000	-0.0177	-0.2511	0.0000	0.0403	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.2869	0.0000	0.0351	-0.2966	0.0000	0.0110	-0.2909	-0.0540	0.0124	-0.1765	-0.1344	0.0000	-0.1754	-0.0134	0.0000
11	ITC	0.0000	0.0869	0.0411	0.0000	0.0796	0.0718	0.0000	0.0791	0.0715	0.0000	0.0765	0.0702	0.0000	0.0625	0.0530	0.0000	0.0626	0.0480	0.0000	0.0525	0.0570	0.0555	0.0554	0.0299	0.0556	0.0580	0.0274	0.0000	0.0768	0.0257	0.0000	0.0367	0.0252	-0.0180	-0.1744	0.0234	-0.0140	-0.0956	0.0159	-0.0152	0.0327	0.0171
12	JINDALSTEL	0.0000	0.0000	-0.0263	0.0000	0.0000	-0.0275	0.0000	0.0000	-0.0256	0.0000	0.0000	-0.0258	0.0000	0.0000	-0.0278	0.0000	0.0000	-0.0276	0.0000	0.0000	-0.0260	0.0000	0.0000	-0.0266	0.0000	0.0000	-0.0261	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0258	0.0000	0.0000	-0.0231	0.0000	0.0000	-0.0225	0.0000	0.0000	-0.0234
13	LT	0.0000	0.0749	0.1017	0.0000	0.0000	0.0786	0.0000	0.0000	0.0844	0.0000	0.0000	0.0871	0.0000	0.0000	0.1152	0.0000	0.0000	0.1162	0.0000	0.0000	0.0889	0.0000	0.0000	0.1128	0.0000	0.0000	0.1196	0.0000	0.0000	0.1112	0.0000	0.0000	0.1195	0.0000	0.0000	0.1196	0.0000	0.0000	0.1128	0.0000	0.0000	0.1122
14	M&M	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0161	0.0000	0.0000	-0.0267	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	NTPC	0.0000	0.0000	0.0848	0.0000	-0.0157	0.0967	0.0000	0.0000	0.0989	0.0000	0.0000	0.0985	0.0000	0.0000	0.0878	0.0000	0.0000	0.1019	0.0000	0.0000	0.1083	0.0000	0.0000	0.1083	0.0000	0.0000	0.1195	0.0000	0.0000	0.1038	0.0000	0.0000	0.1076	0.0000	0.2471	0.1179	0.0000	0.0000	0.1250	0.0000	0.0000	0.1206
16	ONGC	0.1967	0.1243	0.0971	0.1978	0.1360	0.1235	0.2111	0.1333	0.1242	0.2295	0.1427	0.1269	0.2353	0.1455	0.1075	0.2996	0.1430	0.1046	0.3005	0.1451	0.1256	0.2991	0.1395	0.1030	0.2991	0.1296	0.1090	0.2967	0.1245	0.1088	0.2561	0.1184	0.0956	0.3015	0.1424	0.0969	0.3011	0.1081	0.0860	0.3000	0.1432	0.0867
17	RELIANCE	0.5236	0.3985	0.2953	0.5231	0.3445	0.1821	0.5221	0.3336	0.1823	0.5171	0.3324	0.1754	0.5176	0.3363	0.1764	0.5130	0.3409	0.1303	0.5208	0.3780	0.1767	0.4048	0.3119	0.1265	0.4048	0.3257	0.1283	0.5108	0.3742	0.2062	0.5109	0.3301	0.1891	0.5730	0.3376	0.2042	0.5345	0.1686	0.2080	0.5150	0.3342	0.2115
18	SAIL	0.0000	0.0000	0.0294	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0282	0.0000	0.0000	0.0294	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	SBIN	0.1957	0.0414	0.0000	0.1887	0.0872	0.0000	0.0930	0.0879	0.0000	0.1021	0.0882	0.0000	0.0781	0.0905	0.0000	0.0000	0.0647	0.0154	0.0000	0.0657	0.0111	0.0000	0.0552	0.0000	0.0000	0.0535	0.0000	0.0000	0.0558	-0.0087	0.0000	0.0524	-0.0091	0.0000	0.0657	0.0000	0.0000	0.1327	0.0000	0.0000	0.0495	0.0000
20	STERLITE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0411	0.0000	0.0000	-0.0376	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	SUNPHARMA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0209	0.0000	0.0000	0.0225	0.0000	0.0000	0.0000	0.0000	0.0000	0.0188	0.0000	0.0000	0.0145	0.0000	0.0000	0.0136
22	TATAMOTOR	0.0000	0.0000	0.0673	0.0000	0.0000	0.0608	0.0000	0.0000	0.0622	0.0000	0.0000	0.0606	0.0000	0.0000	0.0685	0.0000	0.0000	0.0699	0.0000	0.0000	0.0623	0.0000	0.0000	0.0791	0.0000	0.0000	0.0829	0.0000	0.0000	0.1042	0.0000	0.0000	0.0813	0.0000	0.0000	0.0821	0.0000	0.0000	0.0817	0.0000	0.0000	0.0806
23	TATASTEEL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0542	0.0000	0.0000	0.0576	0.0000	0.0000	0.0542	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0586	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	TCS	0.4742	0.1556	0.0940	0.4642	0.1495	0.0604	0.4580	0.1305	0.0629	0.4170	0.1279	0.0545	0.4242	0.1164	0.0812	0.3959	0.1168	0.0771	0.3980	0.1272	0.0608	0.2257	0.1180	0.0593	0.2257	0.1101	0.0574	0.3975	0.1177	0.0404	0.3966	0.1162	0.0609	0.3067	0.3050	0.0578	0.3757	0.2164	0.0672	0.3748	0.1274	0.0643
25	WIPRO	0.0000	0.0000	-0.0154	0.0000	0.0000	-0.0252	0.0000	0.0178	-0.0194	0.0000	-0.0172	-0.0254	0.0000	0.0000	-0.0364	0.0000	0.0000	-0.0371	0.0000	0.0000	-0.0258	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0268	0.0000	0.0000	-0.0124	0.0000	0.0000	-0.0112	0.0000	0.1422	0.0000	0.0000	0.0000	0.0000

Exhibit 1.1: The constitutions of the portfolios generated number of stock wise

sl. no.	alphabetical list of relevant stocks	normalized weights for 5 stock portfolios [insignificant weights are set to ZERO with a significance level of 10%]													
		p0_5	p1_5	p2_5	p3_5	p4_5	p5_5	p6_5	p7_5	p8_5	p9_5	p10_5	p11_5	p12_5	p13_5
2	BHARTIARTL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1248	0.1249	0.0000	0.0000	0.0000	0.0000	0.0000
10	INFY	-0.2931	-0.2890	-0.2740	-0.2657	-0.2513	-0.2124	-0.2111	0.0000	0.0000	-0.2069	-0.1966	-0.1909	-0.1765	-0.1754
11	ITC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0355	0.0356	0.0000	0.0000	-0.0103	-0.0148	-0.0152
16	ONGC	0.1917	0.1970	0.2111	0.2295	0.2313	0.2996	0.3005	0.2093	0.2091	0.2967	0.2961	0.3015	0.3011	0.3008
17	RELIANCE	0.5236	0.5231	0.5221	0.5171	0.5176	0.5130	0.5120	0.4048	0.4048	0.5128	0.5109	0.5130	0.5145	0.5150
19	SBIN	0.1037	0.1007	0.0908	0.0821	0.0781	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	TCS	0.4742	0.4682	0.4500	0.4370	0.4242	0.3998	0.3986	0.2257	0.2257	0.3975	0.3896	0.3867	0.3757	0.3748

sl. no.	alphabetical list of relevant stocks	normalized weights for 10 stock portfolios [insignificant weights are set to ZERO with a significance level of 10%]													
		p0_10	P1_10	p2_10	p3_10	p4_10	p5_10	p6_10	p7_10	p8_10	p9_10	p10_10	p11_10	p12_10	p13_10
2	BHARTIARTL	0.0509	0.0594	0.0573	0.0526	0.0472	0.0423	0.0431	0.0487	0.0498	0.0500	0.0499	0.1070	0.1454	0.0500
6	HDFC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1421	0.0000	0.0000
7	HDFCBANK	0.0000	0.0000	0.0000	0.0000	0.0000	0.0571	0.0589	0.0719	0.0741	0.0712	0.0683	0.0794	0.1351	0.0814
9	ICICIBANK	0.1977	0.1954	0.1933	0.1974	0.2012	0.2009	0.2011	0.1990	0.1986	0.1994	0.2002	0.0000	0.0000	0.1948
10	INFY	-0.0423	-0.0328	-0.0328	-0.0228	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0560	-0.1344	-0.0134
11	ITC	0.0869	0.0796	0.0791	0.0701	0.0629	0.0320	0.0323	0.0354	0.0366	0.0368	0.0367	-0.1744	-0.0956	0.0327
13	LT	0.0743	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	NTPC	0.0000	-0.0187	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0471	0.0000	0.0000
16	ONGC	0.1243	0.1360	0.1331	0.1427	0.1455	0.1438	0.1433	0.1395	0.1396	0.1395	0.1394	0.1424	0.1081	0.1432
17	RELIANCE	0.3085	0.3445	0.3336	0.3324	0.3343	0.3409	0.3398	0.3319	0.3297	0.3302	0.3303	0.3378	0.3506	0.3343
19	SBIN	0.0434	0.0872	0.0879	0.0882	0.0905	0.0669	0.0657	0.0557	0.0535	0.0558	0.0584	0.0857	0.1322	0.0495
24	TCS	0.1556	0.1495	0.1305	0.1219	0.1164	0.1160	0.1158	0.1180	0.1181	0.1172	0.1168	0.2890	0.2164	0.1274
25	WIPRO	0.0000	0.0000	0.0178	0.0172	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1422	0.0000

sl. no.	alphabetical list of relevant stocks	normalized weights for 20 stock portfolios [insignificant weights are set to ZERO with a significance level of 10%]													
		p0_20	p1_20	p2_20	p3_20	p4_20	p5_20	p6_20	p7_20	p8_20	p9_20	p10_20	p11_20	p12_20	p13_20
1	AXISBANK	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0290	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	BHARTIARTL	0.0554	0.0528	0.0462	0.0456	0.0504	0.0441	0.0375	0.0400	0.0446	0.0483	0.0421	0.0427	0.0399	0.0412
3	BHEL	0.0149	0.0000	0.0000	0.0000	0.0236	0.0037	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	CAIRN	0.0743	0.0372	0.0355	0.0333	0.0666	0.0669	0.0343	0.0693	0.0594	0.0279	0.0598	0.0542	0.0547	0.0542
5	GAIL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0254	0.0000	-0.0546	0.0153	0.0000	0.0000	0.0000
6	HDFC	0.0386	0.0218	0.0204	0.0189	0.0444	0.0482	0.0238	0.0549	0.0418	0.0338	0.0431	0.0419	0.0519	0.0529
7	HDFCBANK	0.0512	0.0453	0.0818	0.0763	0.0714	0.0397	0.0617	0.0429	0.0227	0.0453	0.0430	0.0322	0.0368	0.0328
8	HINDUNILVR	0.0000	-0.0218	-0.0202	-0.0173	-0.0243	-0.0130	-0.0011	-0.0197	-0.0136	0.0000	0.0000	0.0000	0.0000	0.0000
9	ICICIBANK	0.1359	0.1301	0.1308	0.1303	0.1235	0.1245	0.1304	0.1455	0.1470	0.1493	0.1402	0.1397	0.1322	0.1353
10	INFY	-0.0221	0.0000	0.0000	0.0185	0.0000	0.0177	0.0403	0.0000	0.0000	0.0351	0.0133	0.0124	0.0000	0.0000
11	ITC	0.0411	0.0713	0.0785	0.0782	0.0597	0.0490	0.0670	0.0299	0.0279	0.0251	0.0252	0.0234	0.0159	0.0171
12	JINDALSTEL	-0.0263	-0.0225	-0.0250	-0.0250	-0.0378	-0.0376	-0.0260	-0.0284	-0.0261	0.0000	-0.0259	-0.0231	-0.0225	-0.0234
13	LT	0.1017	0.0786	0.0844	0.0871	0.1152	0.1162	0.0889	0.1120	0.1196	0.1132	0.1195	0.1156	0.1128	0.1122
14	M&M	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0161	-0.0167	0.0000	0.0000	0.0000
15	NTPC	0.0849	0.0967	0.0989	0.0985	0.0938	0.1019	0.1063	0.1083	0.1195	0.1030	0.1076	0.1179	0.1250	0.1206
16	ONGC	0.0973	0.1235	0.1242	0.1264	0.1075	0.1046	0.1256	0.0838	0.0886	0.1080	0.0956	0.0869	0.0868	0.0867
17	RELIANCE	0.2053	0.1831	0.1823	0.1756	0.1766	0.1800	0.1765	0.2103	0.2083	0.2062	0.2093	0.2092	0.2080	0.2115
18	SAIL	0.0294	0.0000	0.0000	0.0000	0.0282	0.0299	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
19	SBIN	0.0000	0.0000	0.0000	0.0000	0.0000	0.0150	0.0111	0.0000	0.0000	-0.0097	-0.0091	0.0000	0.0000	0.0000
20	STERLITE	0.0000	0.0000	0.0000	0.0000	0.0431	0.0370	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21	SUNPHARMA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0209	-0.0225	0.0000	0.0180	0.0145	0.0139
23	TATAMOTOR	0.0673	0.0608	0.0602	0.0606	0.0685	0.0689	0.0623	0.0791	0.0820	0.1002	0.0833	0.0821	0.0817	0.0806
22	TATASTEEL	0.0000	0.0582	0.0576	0.0592	0.0000	0.0000	0.0586	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
24	TCS	0.0948	0.0684	0.0609	0.0545	0.0812	0.0731	0.0439	0.0593	0.0574	0.0484	0.0669	0.0578	0.0622	0.0643
25	WIPRO	-0.0154	-0.0232	-0.0194	-0.0214	-0.0364	-0.0371	-0.0259	0.0000	0.0000	-0.0268	-0.0124	-0.0112	0.0000	0.0000

Exhibit 2: Performance & dynamics of portfolios (rebalancing period wise.

Dynamics of 1 month rebalancing portfolios over the out sample testing period Jan-2011 to Feb-2012

1 month portfolio start	Annualized return %				Annualized Std Dev of return %				Annualized Tracking Error %			Annualized excess return %		
	NIFTY	5 stock portfolio	10 stock portfolio	20 stock portfolio	NIFTY	5 stock portfolio	10 stock portfolio	20 stock portfolio	5 stock portfolio	10 stock portfolio	20 stock portfolio	5 stock portfolio	10 stock portfolio	20 stock portfolio
Jan-11	-74.111	-58.8202387	-72.34265297	-73.73446905	18.54106	20.78231	17.31889	18.38183	24.45119	6.364495	5.204888	59.06111	6.830587	1.360112
Feb-11	-33.85	-1.329990781	-4.542417546	-29.83771224	23.74043	23.67645	26.42295	26.32585	17.16303	16.16678	5.993015	46.65104	42.75187	4.356405
Mar-11	177.128	126.0434621	165.1896548	199.8594033	19.81564	18.72659	18.41724	19.54612	13.22058	6.29791	3.944297	-16.4339	-2.86451	7.913829
Apr-11	-18.294	3.856888834	-8.008479919	-11.39911988	16.56719	21.89585	16.40934	16.33164	16.33352	6.108189	5.037836	27.15951	12.54652	8.439853
May-11	-31.455	40.35891837	-42.56206548	-35.80042975	17.95439	24.85035	21.79137	19.31172	15.56096	5.513606	7.277903	-13.3855	-15.9636	-6.00096
Jun-11	19.3552	-34.12119174	-10.09304411	-9.239986008	15.39938	24.78807	17.66161	17.06769	15.88446	6.301501	4.176531	-44.972	-24.6723	-8.47539
Jul-11	-29.804	-47.1859101	-41.06990495	-36.85399808	15.52899	17.87151	16.15588	15.31806	14.23614	6.406536	4.108254	-24.7568	-16.0438	-9.91546
Aug-11	66.937	-49.8857298	-92.60537904	-93.14806022	24.48437	24.46482	24.99828	25.25082	10.22814	6.369918	6.075024	49.23585	10.75872	9.963343
Sep-11	-12.914	6.560185479	7.265121116	-18.62778345	25.54208	27.54056	28.99435	29.55435	7.502579	5.879571	7.744392	22.97169	21.17129	-6.56123
Oct-11	157.183	112.8278651	124.5006516	199.6409858	24.85081	32.88487	29.79129	30.52729	15.45242	8.480147	6.86368	-20.4187	-15.8252	12.14809
Nov-11	-70.419	-49.00592798	-75.75355437	-73.58619581	20.32952	22.71502	24.94681	23.96791	14.34909	6.102394	4.907608	77.3864	-28.0344	-33.7078
Dec-11	-80.735	-55.25551838	-49.84428615	-50.6388186	24.06434	28.27177	29.06982	29.39178	10.9537	7.858341	7.389731	-24.3482	-15.8041	-16.71
Jan-12	278.747	207.0660168	317.3568751	475.0030208	17.85365	23.37831	23.73858	21.81341	16.54545	12.14744	7.260424	-18.9182	10.19419	53.31038
Feb-12	35.5544	65.09931637	39.78225854	39.05154711	18.66069	22.47802	19.76279	17.75951	19.98672	10.55805	6.122929	6.409665	-3.90754	-20.3788

Risk Dynamics of 1 month rebalancing portfolios over the out sample testing period Jan-2011 to Feb-2012

1 month portfolio start	Sharpe Ratio (r_f=0)				Treynor Ratio (r_f=0)				Portfolio beta		
	NIFTY	5 stock portfolio	10 stock portfolio	20 stock portfolio	NIFTY	5 stock portfolio	10 stock portfolio	20 stock portfolio	5 stock portfolio	10 stock portfolio	20 stock portfolio
Jan-11	-2.0591	-1.11840277	-2.099299753	-2.061707138	-0.005425417	-0.004338795	-0.005895003	-0.005697834	0.817944	0.873597	0.939614
Feb-11	-0.4745	-0.015470903	-0.045286832	-0.341643125	-0.001592972	-6.607256E-06	-0.000154684	-0.001313964	0.929713	1.027585	1.081163
Mar-11	1.52472	1.29191726	1.594996472	1.620375984	0.004077237	0.004557253	0.004504004	0.004452018	0.715822	0.879435	0.908689
Apr-11	-0.3265	0.043289681	-0.136455477	-0.201672327	-0.000808174	0.000150391	-0.000361752	-0.000522079	1.016782	0.922994	0.927159
May-11	-0.6301	-0.630667545	-0.756882535	-0.680760734	-0.001522173	-0.00194491	-0.002040437	-0.001781872	1.077811	1.080954	0.99485
Jun-11	0.34083	-0.503141492	-0.178684367	0.153595583	0.000707715	-0.001234621	-0.000395094	0.000128434	1.294435	1.070048	1.076341
Jul-11	-0.6605	-1.046892546	-0.94867086	-0.836053559	-0.001415489	-0.001579478	-0.002221332	-0.001856036	0.751357	0.952254	0.989558
Aug-11	-1.2941	-0.821507978	-1.149019698	-1.145795474	-0.004372957	-0.003835537	-0.004720153	-0.003993907	0.912411	0.999077	0.999785
Sep-11	-0.1569	0.065994488	0.016787341	-0.209229007	-0.00055309	0.000242515	0.000256963	-0.000765757	1.045346	1.117829	1.076772
Oct-11	1.09198	0.632811649	0.756006215	1.007657755	0.003811059	0.002776105	0.002794315	0.003581879	1.068952	1.16024	1.192233
Nov-11	-1.6946	-0.6872934	-1.606457586	-1.571052514	-0.004872116	-0.002278707	-0.004693544	-0.004571123	1.18218	1.207428	1.164951
Dec-11	-0.6301	-0.822366458	-0.687971002	-0.696180846	-0.002092657	-0.002355649	-0.002349741	-0.002358032	1.084173	1.174561	1.197554
Jan-12	2.21898	1.423455677	1.785457083	2.466625534	0.00532679	0.004317523	0.004981163	0.006230655	0.932543	1.145733	1.12082
Feb-12	0.68866	0.630886653	0.479323343	0.525049073	0.001757003	0.001380549	0.001355334	0.001426105	0.830475	0.920518	0.924686

Dynamics of 3 month rebalancing portfolios over the out sample testing period Jan-2011 to Feb-2012

3 monthly portfolio start	Annualized return %				Annualized Std Dev of return %				Annualized Tracking Error %			Annualized excess return %		
	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio
Jan-11	-18.3473	-0.28042	-10.0287	-12.3131	21.38333	22.92575	21.96697	22.16804	15.09826	7.089334	5.775679	22.12655	10.18786	7.390119
Feb-11	19.76796	35.52088	39.04763	28.72625	20.40606	23.70267	20.85401	21.40232	15.94728	7.937466	5.133486	13.15286	16.09752	7.4797
Mar-11	18.29379	11.87918	15.81498	23.9131	18.38012	22.46113	19.15726	18.93965	14.84865	7.374211	5.336166	-5.42261	-2.09547	4.750297
Apr-11	-12.27	-26.6104	-22.54	-12.4008	16.44212	24.27688	18.60553	17.18575	15.7083	7.491309	5.136276	-16.3461	-11.7064	-0.14908
May-11	-16.7433	-40.093	-31.7871	-22.1412	16.16102	22.58167	18.48418	17.44479	14.9306	7.660227	5.48556	-28.0454	-18.0691	-6.48336
Jun-11	-33.9007	-38.6262	-41.8525	-37.0329	18.8944	22.81561	19.80711	19.76615	14.9861	6.509145	4.547043	-7.14902	-12.03	-4.73853
Jul-11	-41.0489	-29.1048	-38.5265	-43.4691	22.10029	24.41639	23.88402	22.64005	13.14792	6.436062	5.414009	20.26098	4.278657	-4.10553
Aug-11	-11.1176	5.406288	-6.1937	-10.802	25.11256	26.80482	27.90165	27.48095	10.80871	6.97171	6.377563	18.59073	5.539784	0.355094
Sep-11	-13.3416	4.270292	-17.2596	-17.9605	23.95924	27.12061	28.08402	27.48551	11.14019	6.853864	6.579299	20.32335	-4.52122	-5.32998
Oct-11	-24.2634	-23.2288	-37.2098	-31.5114	23.46301	29.51192	28.76102	28.37771	14.88494	7.902389	6.522747	1.366035	-17.094	-9.57006
Nov-11	-9.15603	-8.80378	-10.9357	-3.99705	21.6439	26.52009	27.05557	25.97914	14.07739	8.703676	6.780095	0.387751	-1.95908	5.678954
Dec-11	53.74018	32.75932	36.67755	62.55248	20.43887	24.93618	24.40126	23.86036	16.22756	10.44747	6.981409	-13.647	-11.0984	5.731944

Risk Dynamics of 3 month rebalncing portfolios over the out sample testing period Jan-2011 to Feb-2012

3 monthly portfolio start	Sharpe Ratio (r_f=0)				Treynor Ratio (r_f=0)				Portfolio beta		
	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio
Jan-11	-0.4720579	-0.0060999	-0.2395773	-0.2951797	-0.0008108	-1.365E-05	-0.0004348	-0.0005253	0.82315146	0.97222638	1.00052145
Feb-11	0.43306136	0.62822953	0.77439823	0.57801201	0.00072154	0.0014059	0.00139334	0.00099213	0.8648011	0.94634763	1.01808854
Mar-11	0.45518683	0.24887319	0.38167055	0.563767	0.000672	0.0004906	0.00061087	0.00086788	0.91519837	0.96140015	0.98820047
Apr-11	-0.3964865	-0.6346529	-0.6836276	-0.3836539	-0.0005236	-0.0010966	-0.0009862	-0.0005314	1.12858219	1.03590428	0.99665752
May-11	-0.578153	-1.156966	-1.055259	-0.7315339	-0.000733	-0.0019497	-0.0014669	-0.0009772	1.05120634	1.04308168	1.02443377
Jun-11	-1.1086652	-1.0826148	-1.3849941	-1.1840321	-0.001656	-0.0021462	-0.0021904	-0.0018177	0.90984441	0.99012547	1.01791931
Jul-11	-1.2003712	-0.7071897	-1.0226654	-1.2647063	-0.0021138	-0.0014764	-0.0018697	-0.0022946	0.9318879	1.04095229	0.99430439
Aug-11	-0.2318225	0.09702816	-0.1131945	-0.205472	-0.0004714	0.00021569	-0.0002372	-0.0004311	0.97642419	1.07814653	1.06063112
Sep-11	-0.2927952	0.07553563	-0.3304984	-0.3528571	-0.0005728	0.00016209	-0.0006616	-0.0007072	1.03193767	1.14544336	1.1197722
Oct-11	-0.5802611	-0.4388052	-0.7926852	-0.6534279	-0.0011116	-0.0009733	-0.0015578	-0.0012696	1.08640243	1.194915	1.19248044
Nov-11	-0.222719	-0.1744426	-0.2148807	-0.078821	-0.0003841	-0.0003559	-0.0003863	-0.0001394	1.03574265	1.19914832	1.17063454
Dec-11	1.05634683	0.57045421	0.64279814	1.02213495	0.00172038	0.00122534	0.00115661	0.00173158	0.92502569	1.08058233	1.12228596

Dynamics of 6 month rebalncing portfolios over the out sample testing period Jan-2011 to Feb-2012

6 monthly portfolio start	Annualized return %				Annualized Std Dev of return %				Annualized Tracking Error %			Annualized excess return %		
	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio
Jan-11	-15.3632	-14.2407	-12.2702	-14.1395	18.99709	23.76782	20.17198	19.82238	15.5706	6.946896	5.760157	1.326228	3.65448	1.445792
Feb-11	-0.86628	-11.3119	-2.97411	-0.2307	18.28283	23.39538	19.73519	19.29594	15.53014	7.861061	5.018966	-10.5369	-2.12625	0.641125
Mar-11	-11.9816	-18.2454	-17.8362	-10.4419	18.66015	23.37735	19.56771	18.99781	14.88101	7.255958	5.010278	-7.11642	-6.65152	1.749396
Apr-11	-28.1992	-29.9762	-31.2979	-29.2515	19.46268	24.87441	21.23818	19.96053	14.34114	7.233348	5.26052	-2.47494	-4.31567	-1.46564
May-11	-14.0657	-22.6125	-21.4535	-17.7391	20.89196	26.25886	23.54342	22.80361	14.51181	7.647742	6.031973	-9.94574	-8.59707	-4.27468
Jun-11	-24.6459	-21.4078	-31.1297	-30.1623	21.42303	26.30825	24.26568	23.8723	14.82857	6.820448	5.650039	4.297208	-8.60436	-7.32056
Jul-11	-33.385	-26.3345	-38.1557	-39.0992	22.69535	26.91859	26.39179	24.96545	14.04878	7.292679	5.564413	10.58401	-7.16163	-8.57789
Aug-11	-10.1263	-4.7406	-8.65502	-7.56347	23.31883	25.67552	27.35793	26.74432	11.06899	7.912185	6.954185	5.992575	1.637108	2.851648
Sep-11	16.23457	13.17925	14.06607	16.94659	22.20859	24.79914	26.5214	25.77981	12.08154	8.529976	6.922246	-2.62859	-1.86563	0.612566

Risk Dynamics of 6 month rebalncing portfolios over the out sample testing period Jan-2011 to Feb-2012

6 monthly portfolio start	Sharpe Ratio (r_f=0)				Treynor Ratio (r_f=0)				Portfolio beta		
	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio
Jan-11	-0.6183759	-0.4552143	-0.457045	-0.5416302	-0.0006672	-0.0006509	-0.0005255	-0.000611	0.9440446	0.9964252	0.9980556
Feb-11	-0.03365	-0.3628232	-0.1081784	-0.008464	-3.48E-05	-0.0005024	-0.0001221	-9.067E-06	0.9558005	0.9894395	1.0189669
Mar-11	-0.4855515	-0.611763	-0.7127534	-0.4121136	-0.0005105	-0.0008354	-0.0008069	-0.0004492	0.9645361	0.9738872	0.9819413
Apr-11	-1.2035654	-1.012956	-1.2498276	-1.225851	-0.0013251	-0.0013665	-0.0014637	-0.0013994	1.0430821	1.0258707	0.9890964
May-11	-0.5151071	-0.6930486	-0.7281585	-0.6079342	-0.0006063	-0.0009791	-0.0009046	-0.0007412	1.0472178	1.067803	1.0537623
Jun-11	-0.9302589	-0.6448844	-1.0824126	-1.0590974	-0.0011319	-0.0009516	-0.0013677	-0.0013222	1.0126103	1.0907584	1.085057
Jul-11	-1.2555347	-0.796404	-1.2771816	-1.3933418	-0.001625	-0.0012097	-0.0017097	-0.0018452	1.010633	1.1243027	1.0750393
Aug-11	-0.3224515	-0.1332166	-0.2330424	-0.2071077	-0.0004271	-0.0001957	-0.0003204	-0.0002827	0.9927196	1.1301908	1.1128873
Sep-11	0.4751441	0.3501675	0.3480706	0.4259396	0.0006018	0.0005083	0.0004623	0.0005567	0.9742958	1.1387007	1.1247594

Dynamics of 12 month rebalncing portfolios over the out sample testing period Jan-2011 to Feb-2012

12 month portfolio start	Annualized return %				Annualized Std Dev of return %				Annualized Tracking Error %			Annualized excess return %		
	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio
Jan-11	-24.8764	-23.1961	-27.485	-26.0163	20.89177	26.15923	23.17499	22.8146	14.95943	7.011566	5.861202	2.236781	-3.4724	-1.51733
Feb-11	-5.59121	-7.13591	-6.48533	-4.8587	20.9026	26.33591	23.83473	22.83669	14.97638	8.103278	5.552752	-1.63618	-0.94707	0.775887
Mar-11	0.978009	-2.72705	-3.65197	0.894628	20.46739	25.73939	23.13565	22.11679	14.95188	7.907066	5.662001	-3.66917	-4.58513	-0.08257

Risk Dynamics of 12 month rebalncing portfolios over the out sample testing period Jan-2011 to Feb-2012

12 month portfolio start	Sharpe Ratio (r_f=0)				Treynor Ratio (r_f=0)				Portfolio beta		
	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	NIFTY	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio	5 Stock Portfolio	10 Stock Portfolio	20 Stock Portfolio
Jan-11	-1.360893	-1.0028063	-1.378396	-1.3128092	-0.0011441	-0.0010284	-0.0012142	-0.0011406	1.0265366	1.0587701	1.0567698
Feb-11	-0.2747065	-0.2805482	-0.2807567	-0.2176645	-0.0002301	-0.0002858	-0.0002496	-0.0001877	1.0360204	1.0746722	1.0613852
Mar-11	0.0474564	-0.1072048	-0.1604828	0.0401897	3.893E-05	-0.0001081	-0.0001399	3.408E-05	1.0229144	1.0640454	1.0454159