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THE DUAL INDEX MODEL THAT ASTUTELY AUGURS STOCK PRICES USING SECTORAL INDICES – AN EMPIRICAL EVALUATION OF SECURITIES THAT ARE NOT CONSTITUENTS OF INDIA'S PREMIER STOCK EXCHANGE INDEX NAMELY BSE-SENSEX

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ABSTRACT

The concept of Single index model for pricing of assets has been widely used as a simple tool for forecasting returns of individual securities in tune with the movements of a general market index. The Capital Asset Pricing Model, a footing based on the fact that the alpha component and the residual risk tends toward zero as the number of securities are increased, reduces the single-index model equation to the market return multiplied by the risky portfolio's beta. The fundamental analysis and technical analysis have been the pillar stones on which asset pricing was based. However, no attempts have been made so far to augment technicals to fundamentals of a security. The dual index model, proposed in this paper, attempts to augment fundamental factors affecting security prices, such as company, industry and economy factors into the technical framework of regressing excess return on individual security with the fundamentals as regressors. While the company factors are decomposed into the expected excess return of the individual stock due to firm-specific factors that is commonly denoted by its alpha coefficient (α) or intercept or predictor constant, the industry factors and economy factors represented by excess returns on sectoral index and market index respectively are assumed to additional predictors in the multi regression, where the excess returns on security returns is the predictand dependent variable. The effectiveness of the dual index model in precisely predicting returns, in the case of securities that are not constituents of the market index, is brought under the scanner and it has been conclusively evidenced that when sectoral index and market index are not highly correlated the dual index model is much superior to single index model in forecasting returns, be it forecast for a short period or long.

Keywords: Dual Index, Multiple Regression, Sectoral Indices, Precision in prediction.

JEL Classifications: G120, G170

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1. Introduction

Identification of undervalued stocks to buy and attempts to predict market trends through fundamental or technical analysis could only be deemed to be futile exercises if the underlying intricacy of information effect is held valid. Traditionally the historical accounting caters information to fundamental analysts in the form of profit and loss statements, quarterly balance sheets and annual reports including dividend records and policies of companies. The dependence of fundamental analysis on accounting information is thus underlined, though it has been termed as a process built on quicksand (Edwards, R. D., Magee, J., & Bassetti, W. H. C, (2013)) since estimating company earnings for both the current year and next year for recommending stock cannot be ensured error free as is evidenced by Bernard, V. L., & Thomas, J. K. (1990).

The Harry Markowitz portfolio selection model that maximizes a portfolio's return for a given level of risk requires the estimation of expected returns and variances for each security and a covariance matrix calculated as the covariance between each possible pair of securities within the portfolio. The complexity of calculations of variances and co-variances is often beyond the potentials of a small investor, especially when his portfolio becomes diversified and consists of a number of securities. Though Sharpe with his single-index model comes to the rescue of such investors by simplifying calculation, it suffers an inherent limitation that all macroeconomic factors can be represented by the rate of return on a market index. The model presumes that all stocks have a positive covariance because they all respond similarly to macroeconomic factors. Though the slope of the simple regression model in Sharpe's Single Index Model can denote sensitivity of such factors when compared to other factors that are not considered macroeconomic, the firm specific variance compared to the market for one or more economic factors is only considered.

The Capital Asset Pricing Model, a footing based on the fact that the alpha component and the residual risk tends toward zero as the number of securities are increased, reduces the single-index model equation to the market return multiplied by the risky portfolio's beta. The decomposition of a stock's return into alpha and beta components allows an investor to profit from stocks with positive alpha while neutralizing the risk of the beta component.

On the other extreme the Fama-French Three-Factor Model not only reveals the primary factors that drive stock return but also provides a strategy for using those factors in your portfolio for a potentially higher expected long-term return. By incorporating the three-factors, such as, Beta – a measure of volatility of a stock in comparison to the market as a whole, Size – the extra risk in small company stocks and Value – the value in owning out-of-favor stocks that have attractive valuations, into asset allocations one can determine a theoretically appropriate required rate of return of any investment and compare the riskiness of an investment to the risk of the market.

This paper attempts to occupy an intermediate position between Sharpe's Single Index model and Fama-French Three factor model by postulating a dual index model which augments technical analysis to the fundamentals of a security. The model attempts to identify the power of sectoral indices, published by all major stock exchanges, in precisely predicting returns and future prices. This astute model that augurs stock prices across assorted sectors brings in the essentials of fundamental analysis namely company factors, industry factors and economy factors under the scanner of multiple regression analysis of the technicals of individual security prices, market index and the sectoral index to which the stock pertains. . While the company factors, as in the case of Sharpe's Single Index model, are decomposed into the expected excess return of the individual stock due to firm-specific factors that is commonly denoted by its alpha coefficient (α) or intercept or predictor constant in the regression, the industry factors are postulated to be represented by the sectoral index and all the other macroeconomic (systematic) uncertainties termed as economy factors that influence security prices are represented by the market index. Hence the excess return on the price of a security over a period is dependent on company specific factors which is a constant and the independent variables such as sensitiveness of the excess returns of sectoral index and market index which represents the industry factors and economy factors respectively. The model is explained in detail in the sections that follow, before being empirically tested, validated and used for forecasting future prices with a very high degree of precision.

2. Review of Literature

The extant literature was thoroughly surveyed before identification of the research gap. The role of sectoral indices though has been subjected to studies has been preemptively scanned from the macroeconomic influence, but never from its capability to represent an industry as a whole.

King (1966) was the first one who found that industry factors have a significant impact on the stock price. He studied factor analysis by applying observed co-variance matrix of a large set of a series of monthly changes in closing price to discover and explain the degree of cross sectional interdependence exhibited the set of series. By separating large set of individual series into smaller sets of clusters of security price changes that tend to move as homogeneous groups concludes by drawing agreement between familiar methods of classifying the securities and suggesting classification resulting from statistical analyses

Bae and Duvall (1996) applied multi-index CAPMs to explore the relationships of U.S. aerospace company stock returns to selected market and industry variables. They found that the market returns represented by the S&P 500 index and Department of Defense expenditures are significantly positively related to aerospace stock returns. The regression results on other variables such as S&P 500 index, Consumer Price Index, Treasury bill yields and Industrial Production Index are mixed; in particular, aircraft shipments are positively related to aerospace stock returns, but the relations are not significant. Additional regression analysis of employing unanticipated changes in independent variables provides confirmatory evidence. The results of this paper suggest that a multi index CAPM using selected economic and industry variables provides additional power in explaining the variability of U.S. aerospace stock returns over a single index model using the market index alone.

Fiess & MacDonald (2002) investigated the time series properties and the informational content of Open, High, Low and Close prices in forecasting the mean and volatility of exchange rates. These different prices are assigned a special importance in technical analysis. They used range and co-integration methods to a high frequency data set and observed that the existence of stable structural relationships and asymmetric information flows is supportive of certain predictions of market microstructure models of the foreign exchange market. They conclude that a technical analysis of High, Low and Close prices is a useful way of learning about latent Granger causality in high frequency exchange rates.

Malkiel (2003) examined the attacks on the efficient market hypothesis and the belief that stock prices are partially predictable. While he makes no attempt to present a complete survey of the purported regularities or anomalies in the stock market, he describes the major statistical findings as well as their behavioral underpinnings, where relevant, and also examines the relationship between predictability and efficiency. He also describes the major arguments of those who believe that markets are often irrational by analyzing the "crash of 1987," the Internet "bubble" of the turn of the last century and other specific irrationalities often mentioned by critics of efficiency. He concludes that the collective judgment of investors will sometimes make mistakes. Undoubtedly, some market participants are demonstrably less than rational. As a result, pricing irregularities and even predictable patterns in stock returns can appear over time and even persist for short periods. Moreover, the market cannot be perfectly efficient, or there would be no incentive for professionals to uncover the information that gets so quickly reflected in market prices, a point stressed by Grossman and Stiglitz (1980), are of the opinion that undoubtedly, with the passage of time and with the increasing sophistication of our databases and empirical techniques, we will document further apparent departures from efficiency and further patterns in the development of stock returns. They are of the opinion that our stock markets are far more efficient and far less predictable than some recent academic papers would make us believe. Moreover, the evidence is overwhelming that whatever anomalous behavior of stock prices may exist, it does not create a portfolio trading opportunity that enables investors to earn extraordinary risk adjusted returns.

Cao, D., Long, W., & Yang, W. (2013), examined the relationship between the stock market sector indices from the micro and macro level, by dividing the periods into two stages representing drastic shock periods in 2007 and 2008 as well as the general ups and downs periods. They observed that in the first stage when the market experiences drastic ups and downs, the sector indices tend to rise or fall together, and exhibit very close correlations between each other. However, in the second stage, much smaller correlations appear, and the stock price indices reflect the cyclical characteristics of the real sector economy. Though related to sectoral index and market index in terms of correlation between each other, the study remains aloof from analysis of implications or correlations between individual security returns and market indices or sectoral indices.

Kumar, P. V. V., & Singh, P. K. (2011) attempted to understand the movement of sectoral returns and their contribution towards the Sensex returns and found that the sensex returns could be explained with the help of the selected sectoral index returns only. They also found that there is significant difference between the different sectors contribution to the final sensex returns and that the forecasting of the sensex returns with help of differenced first order regressive method provides better results. The liquidity measured on the basis of Market efficiency coefficients showed that certain sectors like health care, consumer durables and the auto sectoral indices have high long term variance in the returns where as it was lower in the oil and gas sector. Though their study finds the variance in all sectoral indices and the market index (BSE) return and illustrates the significance of the individual sector performance and their impact upon on the market index returns, it fails to look into the volatility in individual security returns that can be attributable to vacillant returns from market changes (economy factors) represented by market index BSE and sectoral changes (industry factors) represented by sectoral indices. The paper in spite of finding that the sensex returns can be explained with the help of selected sectoral index returns, neglects the option to explain individual security returns in the light of variations in returns of market index and sectoral index.

Though various aspects of predicting returns and association of returns on security to industrial factors as well as influence of macroeconomic factors on either market index or sectoral index has been explored by researchers, the attempts of incorporating fundamental analysis of variations in company, industry and economy factors on variations in returns of securities has never been attempted. It is in this back drop the gap was observed and this paper attempts to bridge the gap by augmenting technicals to fundamentals of asset pricing so as to augur security returns and prices across assorted sectors with a very high degree of precision.

3. Proposed Model

The Dual Index Model postulated here uses multiple regression with independent variables namely excess returns on market index and sectoral index representing economy factors and industry factors respectively with the company factors as intercept/ predictor constant on the dependent variable defined as the excess return on individual security. The Ordinary Least Square regression representation for the proposed Dual Index model will thus be,

$$R_i = \alpha + \beta_1 R_m + \beta_2 R_s + \varepsilon \qquad (1)$$

Where, R_i = excess return on individual security i.e. the dependent variable, R_m= excess return on market index and R_s= excess return on concerned sectoral index, α = intercept term or predictor constant representing company factors, β_1= slope of the independent variable namely excess return on market index representing economy factors, β_2= slope of the independent variable namely excess return on sectoral index representing industry factors and ε = error term.

4. Research Questions

The basic research questions addressed through the model proposed in this paper are:

i. Is it possible to develop, empirically test and validate a model which explains the variations in excess returns over risk free returns of securities that are not constituents of the market index BSE-Sensex, through variations in company factors, industry factors and economy factors?
ii. To what extent can the dual index model be superior to Sharpe's single index model in explaining sensitivity of vacillant returns of securities that are not constituents of the market index BSE-Sensex?
iii. To what higher degree of precision can the dual index model be used to forecast returns and prices of securities that are not constituents of the market index BSE-Sensex, than the single index model whether it be the general market index or sectoral index representing the industry?

5. Research Method

As stated earlier in the research question, this paper examines the feasibility of a model which incorporates company, industry and economy factors as predictors into the multiple regressions with excess return on individual securities as predictand. The dependant variable is defined as the excess return on securities computed as the excess of raw returns over the average risk free return prevailing in the economy. The intercept of the equation is assumed to be the firm dependent company factors and independent variables are taken to be the industry factors represented by excess return (raw return – risk free return) on sectoral index to which the security belongs and economy factors represented by the excess return (raw return – risk free return) on general market index.

6. Sample

This model considers two securities that are not constituents of the market index BSE- Sensex but are constituents of BSE- Sectoral indices BSE - Consumer Discretionary products and BSE - Power. The historical daily data pertaining to a period of 1667 trading days spanning over 1st July 2009 to 31st March 2016 in the form of close price of selected securities, Sensex and sectoral indices Consumer Discretionary products as well as Power were made available from the official website of Bombay Stock exchange (www.bse.in). Besides, the daily data for 62 trading days spread between 1st April 2016 to 30th June 2016 was also obtained as out of sample data for the purpose of forecasting and comparing with actual, so as to arrive at the precision level of predictions using the model.

7. Procedure

The data relating to the close prices obtained were first subjected to a cleaning process for date mismatches and then the raw returns and excess returns were computed using spreadsheet.

$$\text{Raw Return } Rr = (P_t/P_{(t-1)}) - 1 \quad (2)$$

Where, P_t = Price on day t, P_{t-1}= Price on previous day t-1 and Excess Return = Raw return – Risk free Return. For this purpose the risk free rate in India was taken as 6.72%, being the average bond yield rate obtained for the last 22 years from 1994[1].

The normal distribution nature of data sets were tested using descriptive statistics especially Jarque-Bera p values. The pre-requisites of avoiding spurious regressions such as stationary nature of observations and linear relationships between variables were tested group unit root tests and correlation coefficients before validating the model before running regression equation independently for each of them under scrutiny.

The OLS regression equations for each security were subjected to coefficient diagnostics using Variance inflation factors. The residual diagnostics in terms of correlogram of squared residuals were analyzed before testing heteroskedasticty of residuals using ARCH test.. The forecast values for excess returns were obtained for an out of sample period of four months after validating regressions, which were then converted to predicted prices as follows. The forecasted excess returns were added to the risk free return in the market to arrive at the predicted raw returns of the securities. The predicted prices of the securities were then computed as follows.

$$\text{Raw return, } R_r = R_i + R_f$$

[1] http://www.tradingeconomics.com/india/government-bond-yield

$$R_r = \left(\frac{P_t}{P_{t-1}}\right) - 1 \text{ , Therefore } P_t = R_r P_{t-1} + P_{t-1} \quad (3)$$

Where R_r= Predicted Raw Return, P_t= Price at time period t and $P_{(t-1)}$ = Price at previous time period t-1. The predicted prices P_t were then compared with actual prices of time period 1 and the absolute differences between predicted and actual prices as well as percentage change of difference over predicted prices were computed. The minimum, maximum and average percentage differences between predicted and actual prices were used to determine the degree of precision of the model in predicting prices.

8. Experimental Results

The empirical testing of the model was conducted using the above mentioned measures for each of the 2 securities that are not constituents of the market index sensex but are constituents of sectoral indices namely consumer discretionary products and power. The two securities that are analyzed in this paper are Mahindra Holidays Limited and Crompton Greaves Limited. Initially, the dual index model is experimented with followed by Sharpe's single index model using market index and then using sectoral index.

8.1 Dual Index Model

As explained earlier, the dual index model considers the fundamentals of valuation of security prices namely company factors, industry factors and economy factors. While company factors are considered to be the intercept term, the excess returns on sectoral index and market index representing industry and economy factors respectively are taken as predictors to explain the variations in predictand variable namely excess return on individual securities that are not constituents of the market index Sensex.

8.1.1 Descriptive Statistics

The excess return data relating to the above mentioned two individual securities namely Mahindra and Crompton, BSE-Sensex and sectoral index namely BSE-Consumer Discretionary products and BSE- Power were first tested for normality. With that objective, the descriptive statistics of the series under analysis were obtained for common samples. Table 1 shows the descriptive statistics of common samples of the 2 dependent and 2 independent variables.

Table 1 Descriptive Statistics (Common Samples)

	ER_Mahindra	ER_Sensex	ER_CDISP	ER_Crompton	ER_Sensex	ER_Power
Mean	-0.068672	-0.066774	-0.072047	-0.067496	-0.066797	-0.06738
Median	-0.068173	-0.066673	-0.066246	-0.0672	-0.066678	-0.06685
Maximum	0.053258	-0.029472	-0.024857	0.068991	-0.029472	0.034303
Minimum	-1.0672	-0.126562	-1.0672	-0.783974	-0.126562	-0.14838
Std. Dev.	0.047172	0.010725	0.074391	0.033271	0.010729	0.013235
Skewness	-17.11372	-0.071072	-13.01017	-7.467334	-0.071154	-0.14964
Kurtosis	364.2001	4.313226	Jun-00	150.0882	4.299127	6.576651
Jarque-Bera	9088438	120.4617	2069143	1517309	118.5625	894.2254
Probability	0	0	0	0	0	0
Sum	-113.7896	-110.6449	-119.382	-112.449	-111.2836	-112.255
Sum Sq. Dev.	3.684906	0.190473	9.164394	1.843064	0.191648	0.291641
Observations	1657	1657	1657	1666	1666	1666

A high Jarque-Bera values with probability less than 0.05, rejects the null hypothesis, at 5% significance level, that the distribution is normal, in the case of all the variables.

8.1.2 Unit Root Tests

The pre-requisites of multiple regression analysis such as multi variate normality and linear relationship of variables are tested using unit roots test and correlation before proceeding with the OLS estimation. Table 2 shows the results of unit root tests on the group of variables in the first category relating to consumer discretionary products sector.

Table 2 Group unit root test: Summary

Series: ER_MAHINDRA, ER_SENSEX, ER_CDISP				
Sample: 7/17/2009 3/31/2016				
Exogenous variables: Individual effects				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 0				
Newey-West automatic bandwidth selection and Bartlett kernel				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.8498	0.0000	3	4971
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-38.505	0.0000	3	4971
ADF - Fisher Chi-square	291.863	0.0000	3	4971
PP - Fisher Chi-square	275.164	0.0000	3	4971
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

In the case of Mahindra Holidays, the probability values of Levin, Lin & Chu t statistic in common unit root process and Im, Pesaran and Shin W-stat, ADF - Fisher Chi-square as well as PP - Fisher Chi-square statistics in individual unit root process are lesser than 0.05, which rejects the null hypothesis of unit root presence. In the absence of unit root, all the data series representing excess returns on the Mahindra security, Sensex and Sectoral index BSE-Consumer Discretionary Products are found to be stationary at level.

Table 3 depicts the results of unit root tests on the group of variables in the second category relating to power sector.

Table 3 Group unit root test: Summary

Group unit root test: Summary				
Series: ER_CROMPTON, ER_SENSEX, ER_POWER				
Sample: 7/17/2009 3/31/2016				
Exogenous variables: Individual effects				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 0				
Newey-West automatic bandwidth selection and Bartlett kernel				
Balanced observations for each test				
Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-88.777	0.0000	3	4995
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-75.978	0.0000	3	4995
ADF - Fisher Chi-square	206.263	0.0000	3	4995
PP - Fisher Chi-square	202.955	0.0000	3	4995
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				

As in the case of consumer discretionary products, all the relevant test statistics, both in common unit root process and individual unit root process, revealed a probability of lesser than 0.05, which rejects the null hypothesis of a unit root. Thus, the regressors namely excess returns on market index sensex as well as sectoral index power and regressand namely excess returns on individual security called Crompton were found to be stationary at level without any differencing of any order.

8.1.3 Correlation

Collinearity is the association, measured in terms of correlation between two independent variables (Hair F., Jr., Black C., Babin J., & Anderson E. (2015)). The ability of an additional independent variable to improve the prediction of the dependent variable is related not only to its correlation to the dependent variable but also to the correlations of the additional independent variable to the other independent variable. Before conducting regression analysis the linear relationship between dependent and independent variables in terms of Pearson's correlation are examined, the results of which are tabulated in table 4.

Table 4 Correlation between variables

	ER_MAHINDRA	ER_SENSEX	ER_CDISP
ER_MAHINDRA	1.0000		
ER_SENSEX	0.16139	1.0000	
ER_CDISP	0.534469	0.115514	1.0000
	ER_CROMPTON	ER_SENSEX	ER_POWER
ER_CROMPTON	1.0000		
ER_SENSEX	0.375824	1.0000	
ER_POWER	0.462867	0.781536	1.0000

It is obvious from the above that, the Mahindra security had a relatively low correlation with market index Sensex (0.16) and a relatively high correlation with sectoral index consumer discretionary products (0.53). A very low correlation (0.12) existed between the independent variables market index sensex and sectoral index consumer discretionary products.

In the case of the other security under review namely Crompton, a sufficiently high correlation of 0.38 and 0.46 was observed to each of the independent variables market index sensex and sectoral index power respectively. Among the independent variables market index sensex and sectoral index power a very high coefficient of correlation (0.78) was observed.

8.1.4 OLS Regressions (Dual Index Model)

As stated earlier, with company factors as intercept term and the excess returns on market index and sectoral index as predictors, the ordinary least squares method of regression was applied to analyze the sensitivity of the predictand namely excess returns on individual security. Table 5 summarizes the OLS regression results of both the securities under review.

The probability of t-statistics being lesser than 0.05 rejects the null hypothesis, at 5% significance level, that the coefficient is zero, in the case of intercept 'C' and the regressor namely sectoral index in both the cases. Hence the company factors represented by intercept and industry factors represented by excess returns on sectoral indices are found to be significant. In the case of the yet another regressor namely the market index Sensex representing economy factors, the null hypothesis of a zero coefficient could be rejected at 5% significance level only in the case of Mahindra. In the case of Crompton, since the probability of t –statistic, for the regressor sensex, exceeds 0.05, the null hypothesis that the coefficient is zero fails to get rejected, at 5% significance level. Hence the only insignificant coefficient is that of the economy factors represented by market index Sensex in the case of Crompton.

Table 5 Regression Results- Mahindra & Crompton

Method: Least Squares				
Sample: 7/17/2009 3/31/2016				
Dependent Variable: ER_MAHINDRA			Included obs: 1657	
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ER_SENSEX	0.444239	0.091373	4.86181	0.0000
ER_CDISP	0.331512	0.013173	25.1661	0.0000
C	-0.015124	0.006143	-2.46197	0.0139
Dependent Variable: ER_CROMPTON			Included obs: 1666	
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ER_SENSEX	0.112164	0.108016	1.0384	0.2992
ER_POWER	1.092533	0.087562	12.4773	0.0000
C	0.013611	0.004566	2.98069	0.0029

	Mahindra	Crompton
R-squared	0.29572	0.214755
Adjusted R-squared	0.29487	0.21381
S.E. of regression	0.03961	0.0295
Sum squared resid	2.5952	1.447258
Log likelihood	3000.18	3507.457
F-statistic	347.252	227.4047
Prob(F-statistic)	0.0000	0.0000
Durbin-Watson stat	1.23032	2.161373

In both the cases, the R squared and adjusted R squared was not insignificant though not substantial and standard error of regression was significantly low. With probability of F-statistic being lesser than 0.05, the null hypothesis that the fit of the intercept only model is as good as the specified model could be rejected, at 5% significance level, in both the cases. A near two Durbin Watson statistic in the case of Crompton indicated the non vulnerability to first order auto correlation, while in the case of Mahindra it cannot be ruled out.

The following representations of regression equations were obtained.

ER_MAHINDRA = 0.444239*ER_SENSEX + 0.331512*ER_CDISP - 0.015124

ER_CROMPTON = 0.112164*ER_SENSEX + 1.092533*ER_POWER + 0.013611

8.1.4.i. Coefficient Diagnosis

The multicollinearity among independent variables were diagnosed using variance inflation factors, the results of which are tabulated as table 6.

Table 6 Variance Inflation Factors

Mahindra	Included observations: 1657		
Variable	Coefficient Variance	Uncentered VIF	Centered VIF
ER_SENSEX	0.008349	40.32702	1.01352
ER_CDISP	0.000174	1.964753	1.01352
C	0.00	39.85194	NA
Crompton	**Included observations: 1666**		
Variable	Coefficient Variance	Uncentered VIF	Centered VIF
ER_SENSEX	0.011667	102.2263	2.56937
ER_POWER	0.007667	69.20639	2.56937
C	0.00	39.91707	NA

The multicollinearity among independent variables in both the cases were not a concern as is obvious from the centered VIF values which were lesser than 5.

8.1.4. ii. Correlogram of Squared Residuals

The autocorrelation and partial auto correlation that might exist between residuals was subjected to examination using Correlogram of squared residuals as is shown in table 7.

Table 7 Correlogram of Squared Residuals

	Mahindra				Crompton			
Lags	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	-0.004	-0.004	0.0306	0.861	0.011	0.011	0.2081	0.648
2	0.007	0.007	0.1123	0.945	-0.001	-0.001	0.2104	0.900
3	-0.005	-0.005	0.162	0.983	-0.002	-0.002	0.2164	0.975
4	0.012	0.012	0.3974	0.983	0.008	0.008	0.328	0.988
5	0.003	0.004	0.4168	0.995	-0.002	-0.002	0.3318	0.997
6	-0.012	-0.012	0.6469	0.996	-0.001	-0.001	0.3334	0.999
7	-0.016	-0.016	1.0674	0.994	-0.003	-0.002	0.3442	1.000
8	0.023	0.023	1.9667	0.982	-0.002	-0.002	0.352	1.000
9	0.014	0.014	2.2719	0.986	-0.002	-0.002	0.3598	1.000
10	-0.019	-0.02	2.8982	0.984	-0.001	-0.001	0.3625	1.000
11	-0.024	-0.024	3.8664	0.974	-0.001	-0.001	0.3634	1.000
12	-0.023	-0.023	4.7193	0.967	0.003	0.003	0.3755	1.000

The probability of Q statistics greater than 0.05 at all lags, fails to reject the null hypothesis of no autocorrelation, at 5% significance level, in both the cases.

8.1.4. iii. Heteroskedasticity Test – ARCH

The absence of Heteroskedasticity in residuals is tested using ARCH heteroskedasticty test of residual diagnosis and the results are tabulated as table 8.

Table 8 Heteroskedasticity Test – ARCH

	Mahindra	Crompton		Mahindra	Crompton
F-statistic	0.01101	0.2074	Prob. F	0.9165	0.6489
Obs*R-squared	0.01102	0.2076	Prob. Chi-Square	0.9164	0.6486

With the probability of F statistic and Observation times R squared greater than 0.05, the null hypothesis that there is no heteroskedasticty present in residuals fails to get rejected, at 5% significance level, in both the cases.

8.1.4. iv. Forecasts

The forecasts of raw returns for 1 month and 3 months out of sample starting from 1st April 2016 was made to forecast prices and find difference between forecasted and actual price, both in absolute and relative terms. Table 9 shows the results of predicted prices and the variance from actual prices of both the securities during the forecasted out of sample period of 1 month staring from 1st April 2016.

Table 9 Forecasts – 1 month starting 1st April 2016

Date	Forecasted ER		Forecasted RR = Forecasted ER+Rf		Forecasted Price		Actual Price		Variation =(Forecasted Price- Actual Price)		Variation % = (Variation/ Forecast Price) *100	
	Mahindra	Crompton	Mahindra	Crompton	Mahindra	Crompton	Mahindra	Crompton	Mahindra	Crompton	Mahindra	Crompton
1-Apr-16	-0.06814	-0.05926	-0.00094	0.00794	386.4864	49.590648	386.7	48.85	-0.213639	0.740648	-0.055277	1.4935235
4-Apr-16	-0.06201	-0.057902	0.00519	0.009298	388.707	49.304207	396.2	49.85	-7.493027	-0.5457927	-1.92768	-1.10699
5-Apr-16	-0.08261	-0.092517	-0.01541	-0.025317	390.0946	48.587948	404.95	49.1	-14.85544	-0.5120524	-3.808164	-1.053867
6-Apr-16	-0.065393	-0.061472	0.001807	0.005728	405.6817	49.381245	403.2	50	2.481745	-0.6187552	0.6117467	-1.253017
7-Apr-16	-0.074382	-0.070093	-0.007182	-0.002893	400.3042	49.85535	404	51.1	-3.695782	-1.24465	-0.923243	-2.496522
8-Apr-16	-0.066045	-0.050127	0.001155	0.017073	404.4666	51.97243	401.4	50.7	3.06662	1.2724303	0.7581886	2.4482794
11-Apr-16	-0.056979	-0.042765	0.010221	0.024435	405.5027	51.938855	410.2	52.3	-4.697291	-0.3611455	-1.158387	-0.695328
12-Apr-16	-0.061774	-0.06136	0.005426	0.00584	412.4257	52.605432	416.55	52.95	-4.124255	-0.344568	-0.999999	-0.655005
13-Apr-16	-0.051104	-0.050274	0.016096	0.016926	423.2548	53.846232	416.55	53.95	6.704789	-0.1037683	1.5841023	-0.192712
18-Apr-16	-0.061722	-0.059847	0.005478	0.007353	418.8319	54.346694	419.55	55.2	-0.718139	-0.8533057	-0.171462	-1.570115
20-Apr-16	-0.066482	-0.055547	0.000718	0.011653	419.8512	55.843246	421.05	58.9	-1.198763	-3.0567544	-0.285521	-5.473812
21-Apr-16	-0.069467	-0.079097	-0.002267	-0.011897	420.0955	58.199267	415.35	59.85	4.74548	-1.6507333	1.1296193	-2.836347
22-Apr-16	-0.066823	-0.065016	0.000377	0.002184	415.5066	59.980712	407.35	58.05	8.156587	1.9307124	1.9630464	3.2188887
25-Apr-16	-0.071424	-0.083654	-0.004224	-0.016454	405.6294	57.094845	400	59.25	5.629354	-2.1551547	1.3878073	-3.774692
26-Apr-16	-0.057642	-0.05704	0.009558	0.01016	403.8232	59.85198	397.7	59.9	6.1232	-0.04802	1.5163071	-0.080231
27-Apr-16	-0.065051	-0.072545	0.002149	-0.005345	398.5547	59.579835	389.65	59.35	8.904657	0.2298345	2.2342374	0.3857589
28-Apr-16	-0.079603	-0.091293	-0.012403	-0.024093	384.8172	57.92008	387.25	58.05	-2.432829	-0.1299195	-0.632204	-0.224308
29-Apr-16	-0.067905	-0.057134	-0.000705	0.010066	386.977	58.634331	398.15	57.7	-11.17301	0.9343313	-2.887255	1.5934885
									Max		2.2342374	3.2188887
									Min		-3.808164	-5.473812
									Average		-0.092452	-0.681834

While the maximum variation ranged between 2.23% to 3.22%, the minimum of variation in forecasted prices ranged over -3.81% to -5.47%. However, the average variation in the case of Mahindra was only -0.09% and that of Crompton was a meager -0.68%.

The maximum, minimum and average variation for a three month forecast period of 1st April 2016 to 30th June 2016 is shown in table 10.

Table 10 Variation (%) in Forecasts 3 month starting 1st April 2016

	Mahindra	Crompton
Maximum	2.234237	4.6889004
Minimum	-3.808164	-12.932862
Average	-0.026838	-0.485558

The average variation between forecasted and actual prices of a 3 month period in the case of Mahindra was only -0.02% while that of Crompton was -0.48. Though both of them are significantly low, it may be inferred that the dual index model is ideal for forecast of securities that are not constituents of market index, especially when there exists a low correlation between independent variables namely market index and sectoral index. The degree of precision achieved by the dual model is now compared with that of Sharpe's Single Model, using market index and sectoral index as the independent variable separately.

8.2. Single Index Model – Simple OLS with Market index as Predictor

The results of forecasts made by Sharpe's single index model with one regressor namely market index, using the same data as in dual index model are tabulated in table 11.

Table 11 Variation (%) in Forecasts
1 month and 3 months starting 1st April 2016

	Mahindra		Crompton	
	1 month	3 months	1 month	3 months
Maximum	2.002971	2.650263	2.748051	4.7828411
Minimum	-3.886666	-3.8866658	-6.65064	-13.14715
Average	-0.38092	-0.2139528	-0.856131	-0.6465198

Comparison of results of dual index model and Sharpe's single index model with one regressor, the market index revealed that while dual index model showed an average variation of -0.09% and -0.02% between forecasted and actual prices for 1 month and 3 months forecast respectively in the case of Mahindra, the single index model showed an average of -0.38% and -0.21% respectively for 1 month and 3 months forecast.

In the case of Crompton, while dual index model showed an average variation of -0.68% and -0.48% for 1 month and 3 months forecast respectively, the single index model showed relatively higher average variation of -0.85% and -0.65%.

Thus irrespective of the correlation between market index and sectoral index, both the securities showed a higher degree of precision in forecast by dual index model than the counterpart single index model. This is a conclusive evidence of the capability of dual index model in predicting stock returns and prices precisely than the established single index model at least when it comes to those securities that are not constituents of the market index.

8.3. Single Index Model – Simple OLS with Sectoral index as Predictor

The results of forecasts made by Sharpe's single index model with one regressor namely sectoral index, using the same data as in dual index model are tabulated in table 12.

Once again comparison of results of dual index model and Sharpe's single index model with one regressor, the sectoral index revealed that while dual index model showed an average variation of -0.09% and -0.02% between forecasted and actual prices for 1 month and 3 months forecast respectively in the case of Mahindra, the single index model showed a relatively higher average of -0.14% and -0.03% variations respectively for 1 month and 3 months forecast.

Table 12 Variation (%) in Forecasts
1 month and 3 months starting 1st April 2016

	Mahindra		Crompton	
	1 month	3 months	1 month	3 months
Maximum	2.164142	2.978008	3.257887	4.5919782
Minimum	-2.872019	-3.3340113	-5.401194	-12.930276
Average	-0.137112	-0.0342517	-0.57053	-0.4779981

In the case of Crompton, while dual index model showed an average variation of -0.68% and -0.48% for 1 month and 3 months forecast respectively, the single index model showed relatively lower average variation of -0.57% and -0.47%.

Thus irrespective of the correlation between market index and sectoral index, both the securities showed a higher degree of precision in forecast by dual index model than the counterpart single index model, when the correlation between market index and sectoral index is low as is evident from the case of Mahindra. However, in the case of Crompton which belongs to a sector whose excess returns on sectoral index are highly correlated to excess returns on market index, the precision attained by dual index model is not as high as single index model with sectoral index as the lone regressor. This is a conclusive evidence of the capability of dual index model in predicting stock returns and prices precisely than the established single index model when market index and sectoral index are not highly correlated.

9. Conclusion

Experimentation of data on excess returns of securities that are not constituents of market index revealed that a dual index model that incorporates fundamentals of a security by augmenting technicals to fundamentals is quite effective in forecasting returns and prices with a high degree of precision. In the case of a security that belongs to a sector, whose sectoral indices are not highly correlated to the market index, the dual index model can predict the security return and prices with a high degree of precision than Sharpe's single index model, whether computed with market index or sectoral index as the lone predictor, be it a forecast for a shorter period of one month or a longer period of three months. However, if the security belongs to a sector whose sectoral index is highly correlated to market index movements, then dual index model is superior only to single index model, computed with market index as the lone regressor, in predicting returns and prices whether it be for 1 month or 3 months. . In the case of such securities, single index model computed with sectoral index as the lone regressor is found to have a slighter advantage in forecasting security returns and prices over the dual index model.

Hence an investor who wishes to invest in small cap or mid cap securities that are not constituents of the market index, he can rely upon the dual index model that uses sectoral index and market index movements to predict returns and prices with a reasonably high degree of precision at least in the cases where sectoral index movements and market index movements are least correlated.

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