Predictive Analysis of Mutual Fund Investment Using Sustainability Index Evidence from Indian Stock Market

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ABSTRACT: This study is an attempt to predict the price movement between S & P BSE GREENEX and selected open ended equity mutual fund categories traded at stock exchanges in India. Daily data over the last 5 years were taken and the sample period is from January 1, 2016 to January 1, 2021. The authors use a set of econometric models such as dynamic lag vector auto regression stochastic process model, Cointegration, Granger causality test and Variance Decomposition to substantiate the existence of long run and short run association between the dependent and independent variables selected. The study shows clear evidences of cointegration between S & P BSE GREENEX and selected mutual fund categories, which is an indication of the existence of long run equilibrium relationship between the variables. The empirical investigation also proved the traces of bi-directional and uni-directional Granger- casual effect between the variables. The findings of the study show that S & P BSE GREENEX and large cap mutual fund categories have strong price movement relationship compared to mid-cap funds, which shows a marginal relationship and relatively very weak relationship with small cap funds.

Keywords: S & P BSE GREENEX, Mutual Funds, Vector Auto-regression, Cointegration, Granger Causality

1. Introduction

The growth of mutual fund industry over the past few decades has changed the face of financial services sector tremendously. These changes can be witnessed in the increasing number of investors year by year largely because of the government's role in cultivating savings habit among the people. RBI initiatives for financial education and financial literacy programmes have paved way for varied investment opportunities among the investors. The constant effort of the mutual fund managers in identifying the optimum portfolio mix has also added advantage to the best investment in the secondary market. Evidently, Asset under Management (AuM) of mutual fund industry's in India shows a steady increase from Rs. 6.26 trillion in December 31, 2010 to Rs.31.02 in December 31, 2020 representing a complete paradigm shift in the development of Indian capital market.

Today, investors are witnessing a plethora of innovative indices and are often confused with the criteria of selecting the best funds. The longitivity and sustainability of Indian companies is an inevitable factor in this regard. Stakeholders in the capital market are more interested in those stocks of the companies which are environmentally and socially responsible. Developed countries like USA and European nations already have such Socially Responsible Indices (SRI) like Dow Jones Sustainability Index (DJSI), FTSE4GOOD index etc. The sustainability of leading companies captioned with green terminologies is a trending scenario in India and investment in these funds demands more return. India is in its infancy stage for developing such socially responsible indices and as a new start to promote investments in Green India, an innovative benchmark sustainability index, S & P BSE GREENEX was hosted on Bombay Stock Exchange teamed up with IIM, Ahmedabad in February 2012. S & P BSE GREENEX, a weighted index is a constituent of 25 leading green companies from BSE 100 and it evaluates the companies in terms of their carbon emission practices, free float

market capitalization and liquidity. Past few studies reported the performance of Socially Responsible Indices and concluded that it performs better than other ordinary indices (Moskowitz, 1972; Luck, & Pilotte, 1993; Derwall, Guenster, Bauer, & Koedijk, 2005; Edmans, 2011).On the other hand, Roy (2019) reveals that there is no significant difference between the returns from socially responsible indices and returns from other conventional indices unless multi factor measures are used.

The rationale of the paper is to understand the price movements between S & P BSE GREENEX and selected open ended equity mutual fund categories by applying dynamic regression models. Further, this paper supplements the literature by examining the long run and Granger-causality relationship between variables. Authors have also explored the predicting power of exogenous and endogenous variables by applying Forecast Error Variance Model.

The rest of the paper is designed as follows: Section 2 covers review of literature pertaining to the S & P BSE GREENEX and cointegration and causality studies using daily NAV, Section 3 presents data and methodology applied, Section 4 shows the result and analysis and section 5 includes the conclusion, limitation and scope for further research.

2. Literature Review

The methodology and theoretical framework adopted in this study will be substantiated by comparing to the previously published models on interrelationships and dynamic linkages among variables pertaining to the topic selected. Authors have included reviews related to performance of S & P BSE GREENEX and stock price movements using stochastic models in order to validate the objectives of the study.

Eugene Fama (1970) proposed the efficient market hypothesis stating that current stock prices reflect all available information. The hypothesis is that abnormal returns cannot be made from trading information by incorporating information quickly and efficiently into asset prices at any given point of time. Muth, J. F. (1961) and Lucas (1978) postulates the theory of rational expectations that the optimum prediction of equilibrium price of any security's using all available information are determined by a statistically acceptable model. The rational expectations theory is based on the supposition that the market is always efficient, there exist systematic investor expectations and for predicting future price investors use all relevant information. Shawky (1982) used the ratios of Treynor, Sharpe, and Jensen to measure the performance US mutual funds with the support of monthly NAV value collected for a period of four years from 1973 to 1977 and the result shows there is no significant difference between the three performance measures.

Diltz (1995) examine that improvement in environmental performance has significant impact on performance of portfolio. White (1996), points out that green equity portfolio had significant positive Jensen's alpha compared to brown equity portfolios. Yamashita et al. (1999) study environmentally ranked stocks performed better compared to other stocks. Statman, M. (2000) examine that the Domini Social Index and socially responsible mutual funds performs better than the S&P 500 Index and conventional mutual funds. Derwall et.al (2005) evaluates that eco efficiency portfolio preforms better than other tailored portfolios. Brammer et al. (2006) reveals that stock returns have negative relationship with corporate sustainable performance. Dunn (2009) said in his paper that better earnings of the firms are the result of better environmental efficiency of the firm.

Rakowski & Wang (2009) applied the VAR model to study the relationship between mutual fund returns and daily mutual fund flows. They concluded that past flows have a positive impact on future returns with an information effect when compared to the Price Pressure theory. Chu (2010) investigates cointegration and

causality to test the long and short run relationship between equity funds in Hong Kong and local stock market index using monthly fund price for 101 mandatory provident funds. Evidence shows that 56.43% of the equity funds have unidirectional short run relationship with local stock market index. Chu (2011) examines the relationship between net asset values of 15 equity funds and the local stock market index with evidence from Hong Kong for a period of nine years. Engle- Granger cointegration and Johansen cointegration tests are applied to determine the long term relationship while Granger-causality and VECM are used to determine the short term relationships. Result reveals the presence of 10 unidirectional short run relationships with local stock market index. Tripathi & Bhandari (2012) study the performance of green stocks portfolio against non-green stocks portfolios during pre and post crisis periods and found that green stocks portfolio outperforms non-green stocks portfolio in both periods. Bammi, R., (2013) examines the existence of semi strong form efficiency in Indian capital market by analysing the impact of announcement of firms name in BSE GREENEX. Event study methodology is applied by using daily stock return of 20 companies belonging to BSE GREENEX. Result shows negative returns during the event window and concluded that investors do not pay much heed to the green image of the companies. Bhattacharya (2013) investigates about BSE GREENEX against BSE SENSEX regarding financial rewarding and established that over a period of time BSE GREENEX performed superior and have higher predictability. Kaur, R. (2018) pointed out that, pioneering footsteps marking environment protection and there by setting up of indices like BSE GREENEX has a significant positive impact on stocks of firms which has adopted environment sustainability practices. Dinesh, K et al. (2020) examines the volatility performance of stocks of BSE-GREENEX using monthly stock returns. Result shows that 85% of the stocks of BSE GREENEX have no significant difference on the stock returns and indicate no variations in the monthly returns.

As far as S & P BSE GREENEX is concerned, existing studies show results based on its performance with other indices and also return based performance of the index. However, the growth momentums of this index need further insights into other areas of financial services, especially mutual funds. There are many studies related to price linkages between stock market index, stocks and mutual funds and macro-economic variables. It is evident from the literature that price linkage between S & P BSE GREENEX and equity mutual funds has not been considered for the study. Hence, we found it as a gap to extend our study to examine how far S & P BSE GREENEX could be utilised for tailoring mutual funds using dynamic econometric models.

3. Data and Methodology

The study uses open ended equity mutual funds traded in Indian stock exchanges for a period of 5 years from January 1, 2016 to January 1, 2021. The multivariate time series data used for the study comprises of daily NAV closing price of S & P BSE GREENEX and selected equity mutual fund categories consisting a total of 1227 observations. The open ended equity mutual funds consist of 3 Large Cap Funds (Axis Blue Chip, ICICI Blue Chip, SBI Blue Chip) 3 Mid Cap Funds (Axis Mid Cap, DSP Mid Cap, KOTAK Emerging Equity Fund) and 3 Small Cap Fund (DSP Small Cap, HDFC Small Cap, Nippon India Small Cap). All the data were sourced from the trusted website of Bombay Stock Exchange Limited and The Association of Mutual Funds in India (AMFI).

Investment in stock market requires careful investigation of funds floated in the market. This paper aims to explore price linkages between S & P BSE GREENEX and selected open ended equity mutual funds. The study applies Granger- causality test, Johansen and Juselius cointegration model and variance decomposition to examine the long run and short run relationship between the variables. Authors have chosen a sample period of 5 years with no clear evidences of structural breaks by applying Quandt-Andrews Test (Quandt, 1998; Andrew, 1993). Since data and prices are skewed over time it is relevant to convert all the time series data into natural logarithms so as to give a better reflection of reality of prices (Harrington, 1987).

Unit root Test

Stock market using time series data are always in trend and have a tendency to remain non stationary. Hence, we have conducted Unit root Test, the most suited empirical model to check whether the time series data is non stationarity and possesses unit root. For this purpose, Augmented Dickey Fuller (ADF) (Dickey and Fuller, 1979, 1981) and the Phillips-Perron (PP) (Phillips and Perron, 1988) unit root tests are applied. This is specified in equation (1) and (2)

I. Augmented Dickey Fuller (ADF)

$$\boldsymbol{\Delta Y_t} = \beta_1 + \delta Y_{(t-1)} + \sum_{i=1}^{m} \Delta\alpha_1 Y_{(t-1)} + \mu_t \quad (1)$$

II. Phillips-Perron (PP)

$$\boldsymbol{Y_t} = \alpha_0 + \alpha Y_{(t-1)} + \mu_t \quad (2)$$

Δ = first difference operator; Y_t= variable tested for stationary; $Y_{(t-1)}$ = lagged variable tested for stationary; t= linear time trend; μ_t= covariance stationary random error; δ,α= unit root coefficients

Vector Autoregressive (VAR)

The dynamic linkages are studied with Vector Autoregressive (VAR) models as it allows multivariate modelling of time series data. To enable the presence of optimum lag length, vector autoregression lag selection method is applied. Likelihood Ratio (1999), Akaike (1969) Final Prediction Error (FPE), Akaike (1974) Information Criterion (AIC), Schwarz (1978) Information Criterion (SIC) and Hannan- Quinn (1979) Criterion (HQ) are widely used estimators of the optimum lag length 'p'. Our VAR is specified in equation (3)

$$\boldsymbol{Y_t} = \beta_0 + \sum_{i=1}^{p} \beta_1 Y_{(t-1)} + \varepsilon_t \quad (3)$$

$\boldsymbol{Y}$= {B_GRNX, LcAX, LcIC, LcSB, McAX, McDS, McKO, ScDS, ScHD, ScNI}

Y_t = Vector of non-stationary variables at I (1); β_0 = Vector of constants; β_1 = Matrix coefficient
$Y_{(t-1)}$ = Vector of non-stationary variables at lag periods; p = number of lags of variables in the system; ε_t = Error term of the regression at time't'

Johansen's Cointegration Test

The theory of cointegration states that when two or more variables are integrated, there exist long run equilibrium and the prices cannot drift from each other for an unspecified period of time. This method is applied to determine the long term relationship between variables and the acceptance of hypothesis is based on the values of Trace statistics and Maximum Eigenvalue statistics propounded by Johansen and Juselius (1998) as specified in equation (4) and (5)

$$\boldsymbol{\lambda_{trace}}(r) = -T \sum_{i=r+1}^{n} ln(1-\widehat{\lambda_1}) \quad (4)$$

$$\boldsymbol{\lambda_{max\,(r,r+1)=-Tln(1-\widehat{\lambda_{r+1}})}} \quad (5)$$

T=Size of the sample; $\widehat{\lambda_1}$ = i[th] largest canonical correlation; r, r+1= cointegration vectors

Authors used Johansen and Juselius (1990) co-integration test within the Vector Error Correction Model (VECM) framework to find out the presence of long term equilibrium relationship among variables. The error correction term (ECT) in the VECM explains the speed of adjustment of variables to long run equilibrium as well as identifies the weak exogeneity. The following equation (6) is the functional formula representing VECM:

$$\begin{aligned}\boldsymbol{\Delta B\_GRNX} = \mu_t \sum_{k=1}^{r} \alpha_{1,k}\ ECT_{k,t-1} + \sum_{s=1}^{p} \delta_{1,s}\,\Delta B_{GRNX\,t-s} + \sum_{s=1}^{p} \delta_{2,s}\,\Delta LcAXI_{t-s} + \sum_{s=1}^{p} \delta_{3,s}\,\Delta LcIC_{t-s} \\ + \sum_{s=1}^{p} \delta_{4,s}\,\Delta LcSB_{t-s} + \sum_{s=1}^{p} \delta_{5,s}\,\Delta McAX_{t-s} + \sum_{s=1}^{p} \delta_{6,s}\,\Delta McDS_{t-s} + \sum_{s=1}^{p} \delta_{3,s}\,\Delta ScDS_{t-s} \\ + \sum_{s=1}^{p} \delta_{4,s}\,\Delta ScHD_{t-s} + \sum_{s=1}^{p} \delta_{5,s}\,\Delta ScNI_{t-s} + \varepsilon_t\end{aligned} \quad (6)$$

μ_t = intercept; Δ = first difference operator; δ= information on the speed of adjustment coefficient to long-run equilibrium; ECT= error correction term derived from the long-term cointegrating relationship; P = number of optimal lags of variables in the system

Engle- Granger Causality/Block Exogeneity Test

For short run causality, we have adopted VECM based bi-directional Engle and Granger (1987) Causality/Block Exogeneity Test. Finally, authors applied Forecast Error Variance Decomposition (FEVD) analysis to understand how own and cross shocks drive the variables at each time horizon

4. Empirical Result

Unit Root Test

Table No:1 Unit Root Test.				
Period From: January 1, 2016 to January 1, 2021				
	Augmented Dickey –Fuller Test		**Phillips Perron Test**	
Variables	**Level**	**1st Difference**	**Level**	**1st Difference**
B_GRNX	-1.280186	-35.91643*	-1.383034	-35.91706*
LcAX	-0.076810	-12.20322*	-0.362298	-36.26963*
LcIC	-0.767781	-12.01031*	-0.766485	-36.11233*
LcSB	-1.219616	-11.84777*	-0.716276	-35.74531*
McAX	-0.136184	-11.77445*	-0.563634	-33.12518*
McDS	-1.150301	-10.93825*	-0.734159	-33.28058*
McKO	-1.384379	-10.75745*	-1.039883	-31.84777*
ScDS	-1.677614	-11.77445*	-1.402217	-28.43111*
ScHD	-1.365622	-19.98639*	-1.406548	-29.76914*
ScNI	-0.918987	-29.35830*	-1.133376	-29.86402*

Note: * indicates statistical significance of data at 5% level. The variables include the daily closing price of S & P BSE GREENEX (*B_GRNX*), Axis Blue Chip (*LcAX*), ICICI Blue Chip (*LcIC*), SBI Blue Chip (*LcSB*), Axis Mid Cap (*McAX*), DSP Mid Cap (*McDS),* KOTAK EEF Mid Cap (*McKO*), DSP Small Cap (*ScDS),* HDFC Small Cap (*ScHD*) and Nippon India Small Cap (*ScNI*)

Initially, for examining the nature of relationship between S & P BSE GREENEX and selected mutual fund categories, the stationarity properties were scrutinized. The null hypothesis (H01) is that the data is non-stationary. The Augmented Dickey – Fuller (ADF) and Phillips Perron (PP) test result presented in Table -1 clearly indicates the acceptance of null hypothesis in levels i.e., all the series are non-stationary because the critical t- value is greater than ADF and PP critical values. The same test is then applied in their first differences, I (1). The outcome shows the stationarity of the variables at 5% level of significance because the ADF and PP critical values are greater than t - critical value. Hence, we reject the null hypothesis and accept the alternative hypothesis that all the data are stationary at first difference I (1).

Vector Autoregression Model

Table No: 2 VAR Result.

Period From: January 1, 2016 to January 1, 2021

Exogenous Variable (C)	**Endogenous Variables**									
	B_GRNX	**LcAX**	**LcIC**	**LcSB**	**McAX**	**McDS**	**McKO**	**ScDS**	**ScHD**	**ScNI**
R-squared	0.9888	0.9971	0.9946	0.9927	0.9972	0.9956	0.9955	0.9954	0.9970	0.9968
Adj. R-squared	0.9886	0.9970	0.9945	0.9926	0.9972	0.9955	0.9954	0.9953	0.9969	0.9967

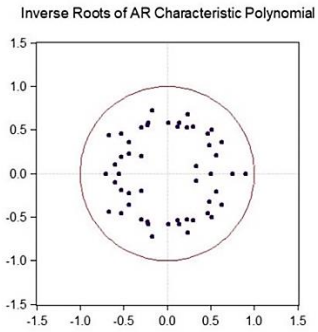
Note: The variables include S & P BSE Greenex (*B_GRNX*), Axis Blue Chip (*LcAX*), ICICI Blue Chip (*LcIC*), SBI Blue Chip (*LcSB*), Axis Mid Cap (*McAX*), DSP Mid Cap (*McDS),* KOTAK EEF Mid Cap (*McKO*), DSP Small Cap (*ScDS),*HDFC Small Cap (*ScHD*) and Nippon India Small Cap (*ScNI*)

The study utilized specific lagged endogenous multivariate VAR model as shown in Table-2 , since there is a possibility of long run and short run relationship between S & P BSE GREENEX and selected equity mutual fund categories at first difference. The endogenous variables are analysed with the default lag interval of 2. The result shows that the R-squared and adjusted R-squared values of all the endogenous variables are greater than 0.99 and it can be concluded that VAR model is good fit for estimating all endogenous variables.

VAR Stability Model

The graphical representation of VAR stability is exhibited in Figure -1. It proves that none of the roots are out of the circle during the study period.

Figure1. VAR Stability Model.



Optimum Lag-Length selection

Table No: 3 VAR Lag Order Selections.					
Period From: January 1, 2016 to January 1, 2021					
Lag	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	NA	84008.74	39.71745	39.75917	39.73315
1	45238.26	6.48e-12	2.616902	3.075822	2.789598
2	662.1654	4.40e-12	2.230196	3.106316	2.559888
3	273.5164	4.12e-12	2.164386	3.457705	2.651074
4	136.5937	4.33e-12	2.212285	3.922804	2.855968
5	148.0273	4.49e-12	2.249462	4.377181	3.050142
6	405.9008	3.73e-12*	2.064016*	4.608934	3.021691
7	148.4981*	3.87e-12	2.098600	5.060718	3.213271
8	120.0621	4.10e-12	2.156916	5.536233	3.428583

Note: * indicates lag order selected by the test

Johansen (1991), mentioned that VAR lag order selection is inevitable for the accurate outcome of cointegration. The Table- 3 shows different information criteria's adopted in our study i.e., Likelihood Ratio (1999), Akaike (1969) Final Prediction Error (FPE), Akaike (1974) Information Criterion (AIC), Schwarz (1978) Information Criterion (SIC) and Hannan- Quinn (1978) Criterion (HQ). The choice of the most appropriate lag interval one to six is identified using Akaike Information Criteria (2.064016) for the purpose of conducting cointegration and causality based on the VAR.

Cointegration

Table No: 4 Number of Cointegrating Relations by Model.					
Period From: January 1, 2016 to January 1, 2021					
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	4	3	3	3	3
Max-Eigen	1	1	1	2	2

Note: Critical value is based on MacKinnon-Haug-Michelis (1999) selected at 5% level of significance

The next step involves identifying the presence of cointegration between selected variables which is inevitable prior to the execution of Vector Error Correction Model (VECM). Authors use Johansen Cointegration Test to model the long term relationship between S & P BSE GREENEX and selected equity mutual fund categories. The Table- 4 shows the cointegration test result which clearly indicates the existence of one cointegration vector, thereby satisfying the valid condition for VECM. In this case, we reject the null hypothesis of no cointegrating vectors (r = 0) and accept the alternative hypothesis of the existence of one cointegrating vector.

Vector Error correction Model (VECM)

Table No 5: Result of Error Correction Term.										
Period From: January 1, 2016 to January 1, 2021										
Exogenous	**D(B_GRNX)**	**D(LcAX)**	**D(LcIC)**	**D(LcSB)**	**D(McAX)**	**D(McDS)**	**D(McKO)**	**D(ScDS)**	**D(ScHD)**	**D(ScNI)**

Error	-0.0776	-0.0404	-0.0851	-0.0507	-0.0001	-0.0305	-0.0605	-0.0003	-0.0002	-0.0005
Standard	0.0126	0.0132	0.0322	0.0205	0.0001	0.0150	0.0210	0.0003	0.0001	0.0003
t-statistics	-6.0408*	-3.0058*	-2.6416*	-2.0472*	-0.7051	-2.0321*	-2.8826*	-1.1781	-1.6516	-1.7834
R-squared	0.4425	0.2224	0.1881	0.1477	0.0775	0.1459	0.2161	0.1157	0.0890	0.1019
Adj. R-	0.4183**	0.2239**	0.1885*	0.1481*	0.0375	0.1454**	0.2177**	0.1191	0.0494	0.0629

Note: * indicates statistical significance of data at 5% level. The variables include S & P BSE GREENEX (*B_GRNX*), Axis Blue Chip (*LcAX*), ICICI Blue Chip (*LcIC*), SBI Blue Chip (*LcSB*), Axis Mid Cap (*McAX*), DSP Mid Cap (*McDS),* KOTAK EEF Mid Cap (*McKO*), DSP Small Cap (*ScDS),*HDFC Small Cap (*ScHD*) and Nippon India Small Cap (*ScNI*).
** denotes the funds with higher explanatory power.

The Table- 5 shows the adjustment coefficient in the VECM within a lag period of one to six. It is evident from the result that the coefficients of Axis Mid Cap (McAX), DSP Small Cap (ScDS), HDFC Small Cap (ScHD) and Nippon India Small Cap (ScNI) are weakly exogenous. The coefficient of Error Correction Term for BSE GREENEX (B_GRNX, -0.076609), Axis Blue Chip (LcAX, -0.040433), ICICI Blue Chip (LcIC, -0.085144), SBI Blue Chip (LcSB, -0.050680), DSP Mid Cap (McDS,-0.030543) and KOTAK EEF Mid Cap (McKO, -0.060536) shows the correction of the previous period volatility of price in the short run dynamic process at 7.6%, 4.04%, 8.51%, 5.06%, 3.05% and 6.05% respectively. This means that the ECT values of variables (LcAX, LcIC, LcSB, McDS, and McKO) will adjust to restore the disequilibrium caused by the weakly exogenous variables, when these variables are treated endogenous. Adjusted R-squared reveals that S & P BSE GREENEX (41.8%) has greater explanatory power than LcAX (22.3%), LcIC (18.85%), LcSB (14.81%), McDS (14.54%), and McKO (21.77%). The interest of the study fundamentally focuses on long run and short run relationship with specified VECM.

Johansen Cointegration Test

Table No.: 6 Johansen Cointegration.
Period From: January 1, 2016 to January 1, 2021

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical	Max-Eigen	0.05 Critical
r = 0	0.163914	446.3044	239.2354*	220.1988	64.50472*
r ≤ 1	0.046072	226.1055	197.3709	58.01496	58.43354
r ≤ 2	0.037150	168.0906	159.5297	46.56501	52.36261
r ≤ 3	0.029778	121.5256	125.6154	37.18352	46.23142
r ≤ 4	0.024359	84.34206	95.75366	30.33201	40.07757
r ≤ 5	0.019491	54.01005	69.81889	24.21099	33.87687
r ≤ 6	0.013836	29.79906	47.85613	17.13679	27.58434
r ≤ 7	0.007604	12.66227	29.79707	9.388527	21.13162
r ≤ 8	0.002657	3.273742	15.49471	3.272639	14.26460
r ≤ 9	8.97E-07	0.001103	3.841466	0.001103	3.841466

Note: * Trace test and Max-Eigenvalue test indicates one cointegrating vector at 5% level of significance

The Johansen's cointegration test is being considered to trace out the presence of cointegrating vectors by using VAR based maximum likelihood test. The null hypothesis (H02) is that there exists no long term equilibrium relationship between S & P BSE GREENEX and equity mutual fund categories. Table 6 illustrates the result of Johansen-Juselius cointegration test within a lag of six and one unit root in each series.

The test revealed that trace statistics (446.3044) is greater than the critical value (239.2354) and the Maximum Eigenvalue statistics (220.1988) is greater than the critical value (64.50472) at 5% which is significant for rejecting null hypothesis and accepting the alternative hypothesis i.e,. There exist long term equilibrium

relationship between S & P BSE GREENEX and selected open ended equity mutual fund prices. The result obtained from the Johansen's Cointegration test is essential to find out the optimal forecast using all available information, the so-called 'Theory of rational expectations'.

Granger Causality /Block Exogeneity Wald Test

Authors have attempted to explore short run unidirectional and bi-directional causality between the variables and tests a) Whether the current value of S & P BSE GREENEX 'Granger-cause' the selected equity mutual fund categories b) Whether selected equity mutual fund categories 'Granger- cause' S & P BSE GREENEX c) Whether particular mutual fund categories Granger causes other mutual fund categories under study. The optimum lag structure (p = 6) is selected based on the Akaike Information Criterion (AIC). The null hypothesis (H_{03}) states there is no short term exogenous relationship between S & P BSE GREENEX and selected equity mutual fund categories. The present study also examines the short run exogenous relationships under the null hypothesis (H_{04}) that there is no Granger causal relationship between the selected equity mutual fund categories.

Table No: 7 Multivariate Causality- Chi-Square Statistics

Period From: January 1, 2016 to January 1, 2021

Excluded	Dependent Variables									
	D (B_GRNX)	D (LcAX)	D (LcIC)	D (LcSB)	D (McAX)	D (McDS)	D (McKO)	D (ScDS)	D (ScHD)	D (ScNI)
D(B_GRNX)		19.06*	15.61*	17.32*	3.01	13.48*	13.66*	6.79	5.16	5.85
D(LcAX)	15.44*		13.04*	2.52	0.88	3.06	2.68	9.24	5.41	9.32
D(LcIC)	13.21*	16.30*		12.32*	8.00	7.88	8.18	7.66	3.38	13.25*
D(LcSB)	16.86*	5.40	15.01*		8.51	15.54	12.47*	4.21	12.84*	25.22*
D(McAX)	16.75*	5.91	4.35	4.90		5.50	6.65	9.70	7.62	21.97*
D(McDS)	5.70	8.53	8.92	11.88*	25.22*		10.18	8.95	11.96*	6.42
D(McKO)	15.25*	5.55	4.83	5.08	19.09*	4.40		5.15	4.79	1.30
D(ScDS)	4.88	7.73	4.21	5.53	2.24	2.84	2.68		15.01*	14.91*
D(ScHD)	8.85	8.57	2.62	5.12	9.70	16.46*	17.15*	14.24*		13.62*
D(ScNI)	4.66	3.53	4.70	5.00	1.82	7.54	6.62	16.60*	12.07*	
All	87.09*	87.27*	82.38*	78.48*	75.35*	95.26*	92.80*	52.40*	65.44*	73.61*

Note: * indicates statistical significance of data at 5% level. The variables include the daily closing price of S & P BSE GREENEX (*B_GRNX*), Axis Blue Chip (*LcAX*), ICICI Blue Chip (*LcIC*), SBI Blue Chip (*LcSB*), Axis Mid Cap (*McAX*), DSP Mid Cap (*McDS)*, KOTAK EEF Mid Cap (*McKO*), DSP Small Cap (*ScDS)*,HDFC Small Cap (*ScHD*) and Nippon India Small Cap (*ScNI*).

The Table- 7 exhibits VECM based Granger/ Block Exogeneity Wald Test with a chi-square statistics at 5% level of significance. The presence of 7 bi-directional and 14 uni-directional causal relationships provide strong evidence to deny both null hypothesis, (H_{03}) and (H_{04}) and accept the alternative hypothesis. To conclude, we can say that short term exogenous relationship exist not only between S&P BSE GREENEX and selected mutual fund categories but also between selected equity mutual fund categories under study.

Variance Decomposition

Table No: 8 Variance Decomposition.

Period From: January 1, 2016 to January 1, 2021

VDC	DAY	Percentage Of Forecast Error Variance Explained By Innovation In:

	S	D (B_GRN	D (LcA	D (LcI	D (LcS	D (McA	D (McD	D (McK	D (ScD	D (ScH	D (ScNI
D (B_GRN	**1**	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	15	67.028	56.52	19.32	11.15	4.511	1.602	11.268	0.386	0.425	0.669
	30	61.758	62.26	20.96	17.35	10.705	1.605	11.872	1.309	0.588	0.988
D (LcAX)	**1**	8.337	98.66	44.25	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	15	18.161	97.32	55.96	0.207	0.697	0.091	0.460	0.034	0.592	0.398
	30	21.294	96.61	56.14	0.228	1.003	0.095	0.559	0.044	0.573	0.513
D (LcIC)	**1**	11.220	54.47	85.19	0.000	0.000	0.000	0.000	0.000	0.000	0.213
	15	13.385	51.85	81.53	0.456	1.064	6.710	0.246	0.034	0.720	0.317
	30	17.789	51.86	79.67	0.493	1.664	10.18	0.288	0.036	0.699	0.916
D (LcSB)	**1**	6.266	3.382	4.233	83.13	0.000	3.984	0.000	0.000	0.000	0.000
	15	10.532	4.700	9.302	82.09	1.203	7.435	0.290	0.035	1.071	0.336
	30	15.527	4.423	11.86	79.87	1.911	10.47	0.338	0.053	1.058	0.476
D (McAX)	**1**	0.460	0.883	0.325	0.026	18.602	10.49	11.686	0.103	0.030	0.054
	15	0.071	0.804	0.229	0.620	25.018	14.52	14.378	0.175	1.923	0.033
	30	0.172	0.856	0.133	0.641	24.816	14.65	14.984	0.118	1.928	0.025
D (McDS)	**1**	0.000	0.000	0.007	0.014	0.000	21.55	0.000	0.000	0.000	0.000
	15	8.077	0.328	0.425	0.807	0.604	24.85	2.070	0.014	6.602	0.044
	30	11.850	0.678	0.714	0.849	1.102	23.96	2.179	0.078	7.605	0.084
D (McKO)	**1**	0.000	0.000	0.000	0.000	0.000	0.000	30.262	0.000	0.000	0.000
	15	5.459	0.601	0.353	7.605	0.889	0.196	28.662	0.018	7.125	0.092
	30	8.625	0.672	0.671	12.73	1.575	0.249	27.037	0.138	8.123	0.176
D (ScDS)	**1**	0.653	0.000	0.018	0.001	0.000	0.000	0.000	28.21	1.415	1.249
	15	0.206	0.859	0.612	0.922	0.678	0.609	1.479	34.17	7.848	0.615
	30	0.768	0.864	0.894	0.980	1.099	0.793	1.498	33.04	8.663	0.402
D (ScHD)	**1**	0.862	0.004	0.773	0.132	0.000	0.429	0.890	0.000	21.70	25.01
	15	0.401	0.665	1.131	9.720	0.595	0.409	0.202	0.077	24.86	16.93
	30	0.311	0.735	1.663	9.736	1.077	0.470	0.094	0.210	23.92	15.78
D (ScNI)	**1**	0.839	0.000	0.001	0.000	0.000	0.958	0.102	0.000	14.39	39.45
	15	0.444	0.969	1.385	5.077	4.985	1.209	0.677	9.507	6.645	27.10
	30	0.481	0.141	1.883	4.850	5.650	1.295	0.743	10.78	5.007	26.16

Note: Ordering for Cholesky test**: B_GRNX, LcAX, McKO, LcIC, LcSB, McDS, ScNI, ScHD, ScDS, McAX**.

VDC indicates Variance Decomposition. D represents difference operator. The variables include S & P BSE GREENEX (*B_GRNX*), Axis Blue Chip (*LcAX*), ICICI Blue Chip (*LcIC*), SBI Blue Chip (*LcSB*), Axis Mid Cap (*McAX*), DSP Mid Cap (*McDS),* KOTAK EEF Mid Cap (*McKO*), DSP Small Cap (*ScDS),*HDFC Small Cap (*ScHD*) and Nippon India Small Cap (*ScNI*).

The Variance decomposition is employed to understand the percentage of movement in S & P BSE GREENEX that are caused by its own shock versus shocks from selected equity mutual funds. Table 8 displays variance decomposition analysis of S & P BSE GREENEX and selected equity mutual funds by applying a 30 days forecast error variance of the dependent variables. This is done by imparting one standard deviation shock in the endogenous variable and measuring its impact on exogenous variables. Authors have applied Cholesky Decomposition Method within the VECM framework to obtain the result.

The findings from Table 8 reveal the following conclusions. First, the result clearly indicates almost 61.75% of S & P BSE GREENEX, 96.61% of Axis Blue Chip, 79.67% of ICICI Blue Chip, 79.87% of SBI Blue Chip, 24.81% of Axis Mid Cap, 23.96% of DSP Mid Cap, 27.03% of KOTAK EEF, 33.04% of DSP Small Cap, 23.92% of HDFC and 26.16% of Nippon India Small Cap are explained by its own shock after 30 days. Second, the large cap funds selected for the study viz. Axis Blue Chip (21.29%), ICICI Blue Chip (17.78%) and SBI Blue Chip (15.52%) shows more predictability power over S & P BSE GREENEX when compared to Mid Cap Funds and Small Cap Funds after 30 days. Third, movements in S & P BSE GREENEX does explain the

forecast error variance in large cap funds with 62.26% in Axis Blue Chip, 20.96% in ICICI Blue Chip and 17.35% in SBI Blue chip when compared to Axis Mid Cap (10.71%) and Kotak EEF (11.87%) after 30 days. The result shows that small cap funds are weak in predicting the price co-movements of S & P BSE GREENEX after 30 days.

Normalised Cointegration Coefficient

The results of Johansen cointegration tests show significant long run relationship of the variables. Table Table -9 shows the normalised cointegration coefficients to study the price relationship of S & P BSE GREENEX with other funds. It is clearly evident that the large cap funds such as LcAX, LcIC and LcSB have a strong positive effect on S & P BSE GREENEX price at 5% significance level. The S & P BSE GREENEX price will increase at 1.91% and 3.82% when there is 1% price increase in LcIC and LcSB. But in the case of LcAX, 1% increase in price will decreases the green index price to 2.91%. The result of McDS and McKO are statistically significant at 2.86%, but 1% increase in the price movement of McDS and McKO will lead to 1.05% and 0.42% decrease in the price movement of S & P BSE GREENEX. The coefficient of small cap funds price (ScDS, ScHD and ScNI) shows very weak relationship with S & P BSE GREENEX.

Table No: 9 Normalized Cointegration Coefficients			
Period From: January 1, 2016 to January 1, 2021			
Cointegrating Vector	**Coefficient**	**Standard Errors**	**t-statistics**
B_GRNX(-1)	1.000000		
LcAX(-1)	2.91580	0.89141	3.27103*
LcIC(-1)	-1.91463	0.78311	-2.44493*
LcSB(-1)	-3.82712	0.82556	-4.63578*
McAX(-1)	-1.84334	11.8586	-0.15544
McDS(-1)	1.05086	0.36692	2.86400*
McKO(-1)	0.41827	2.18800	2.22484*
ScDS(-1)	-0.97732	17.9804	-0.05435
ScHD(-1)	-0.80699	5.52883	-0.14596
ScNI(-1)	0.61519	10.2790	0.05984
C	-12.85492		

Note: The variables include S & P BSE GREENEX (*B_GRNX*), Axis Blue Chip (*LcAX*), ICICI Blue Chip (*LcIC*), SBI Blue Chip (*LcSB*), Axis Mid Cap (*McAX*), DSP Mid Cap (*McDS),* KOTAK EMF Mid Cap (*McKO*), DSP Small Cap (*ScDS),*HDFC Small Cap (*ScHD*) and Nippon India Small Cap (*ScNI*).

5. Conclusion

Studies on stock market variables and behaviour of share prices have gathered momentum in the past several years. In this paper authors have attempted to explore the price movements of S & P BSE GREENEX and selected open ended equity mutual funds using time series data from January 1, 2016 to January 1, 2021. Our study uses various statistical time series models such as Vector Autoregression, Vector Error Correction Model, Johansen cointegration and Granger- causality/Block exogeneity Wald test for finding out the long run and short run association between S & P BSE GREENEX and selected mutual fund categories. In order to validate the short run relationship between the variables, error correction term examination and Cholesky variance decomposition is applied.

The Augmented Dickey Fuller (ADF) and Philipp Perron unit root test shows that all the variables are stationary at first difference I(1). The VAR stability test satisfies the condition that none of the roots are outside the circle.

Optimum lag length was determined using Akaike Information Criterion (p=6). Since there is an evidence of one cointegration vector, our study has applied Johansen cointegration within VECM framework thereby explaining the long run relationship between the variables. The study finds that S & P BSE GREENEX have a highly significant relationship with large cap funds, marginal relationship with mid cap funds and relatively very weak relationship with small cap funds. Our study proves that there is a long run price linkage between selected mutual fund categories and S & P BSE GREENEX in large cap funds. Since there is a long run equilibrium relationship, the mutual funds cannot diverge from the movement of S & P BSE GREENEX. This is clear evidence that S & P BSE GREENEX can be used to predict short and long run price behaviour of mutual funds as per the Theory of Rational expectation. The Granger-causality/Block Exogeneity Wald test clearly indicates bi-directional and uni-directional relationship exist between selected equity mutual fund categories and S & P BSE GREENEX. There is no significant causal relationship between small cap funds and S & P BSE GREENEX, if considered independently. This has been supported by the evidence from the variance decomposition.

Suffice to say, this study is useful for tailoring mutual funds in future by considering the S & P BSE GREENEX as a best fit for reaping profits in the long run. As a matter of fact, mutual funds always publicize the past performance of the funds accompanied by a disclaimer that past performance cannot be guaranteed.

The major limitation of the study relates to the sample size which comprised funds from selected categories only. The non-availability of sufficient number of funds was another limitation of the study. In addition the types of funds and study period chosen for the research were short.

Research can be further extended to study price linkages between S & P BSE CARBONEX and mutual fund investment in Indian stock market. A comparative study can be undertaken using Global Sustainability Indices as a variable. Further exploration in this area can be done using NIFTY 100 ESG Index and mutual fund investment.

References

1. Eugene Fama .1970. “Efficient capital markets: A review of theory and empirical work”. *Journal of Finance* 25 (2): 383-417.
2. Lucas, R. E., Jr. 1978. “Asset prices in an exchange economy”. *Econometrica* 46 (6): 1429-1445.
3. Muth, J. F. 1961. “Rational expectations and the theory of price movements”. *Econometrica* 29 (3): 315-335.
4. Shawky, H. A. 1982. “An update on mutual funds: Better grades”. *Journal of Portfolio Management* 8 (2): 31-36.
5. Diltz, J.D. 1995. “The Private Cost of Socially Responsible Investing.” *Applied Financial Economics*, 5(11): 69-77.
6. White, Mark A. 1996. “Corporate Environmental Performance and Shareholder Value.” *Working Paper WHI002*, McIntire School of Commerce.
7. Yamashita, Miwaka, SwapanSen, and Mark C. Roberts. 1999. “The Rewards for Environmental Conscientiousness in the U.S. Capital Markets.” *Journal of Financial and Strategic Decisions*, 12(1): 73–82.
8. Statman, M. 2000. “Socially Responsible Mutual Funds”, *Financial Analysts Journal*, Vol. 56(3):30-39.
9. Derwall, J., Guenster, N., Bauer, R., and Koedijk, K. (2005). “The Eco-Efficiency Premium Puzzle.” *Financial Analysts Journal*, 61(1):51-63.
10. Brammer, S., Brooks, C., & Pavelin, S. 2006. “Corporate Social Performance and Stock Returns: UK Evidence from Disaggregate Measures”. *Financial Management*, 35 (3): 97-116.

11. Rakowski, D., and X. Wang. 2009. "The dynamics of short-term mutual fund flows and returns: A time-series and cross-sectional investigation". *Journal of Banking & Finance,* 33 (11): 2102-2109.
12. Chu, P. K. K. 2010. "The price linkages between the equity fund price levels and the stock markets: Evidences from cointegration approach and causality analysis of Hong Kong Mandatory Provident Fund (MPFs)". *International Review of Financial Analysis,* 19 (4): 281-288.
13. Bammi, R. 2013. "BSE GREENEX Impact on Indian Stock Market Performance: An Event Study", International Journal of Research Excellence in Management, 2(1):7-12.
14. Tripathi, et al. 2012, "Green is good in Indian Stock Market". Colombo Business Journal, 3(12):27-45.
15. Bhattacharya. 2013, "Effect of Going Green on Stock Prices: A Study on BSEGREENEX", International Journal of Computer Applications, 174(2):32-37.
16. Kaur, R.2018. "BSE GREENEX: Adding Greenness To Indian Stock Market". *Journal of Management (JOM),*5(5):24-31.
17. Dinesh, K et al. 2020. "Measuring Volatility Among Green Stock Prices". *Our Heritage,* 68(2): 623-632.