A Study of Co-movement Among Indices of Bombay Stock Exchange

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Abstract

In the last decade, financial reforms have led to creditable growth in the Indian stock market. Even every day, it is touching new highs and the predications are all above from the current level. Interestingly, experts link market decline with correction of stock prices. Researchers and practitioners evaluate exceptional positive hit or negative shock through fundamental and technical analysis gap. Market behavior is very uncertain as it is related to investor sentiments. However, sentiment must be backed by calculation. This paper attempted to evaluate the performance of and mutual relationships among various Bombay Stock Exchange (BSE) indices. The study will certainly contribute towards accurate estimation of returns. A secondary data based study was conducted to cross assess the co-movement of BSE indices namely BSE SENSEX, BSE100, BSE200, BSE500, BSE Mid Cap, and BSE Small Cap for a period from 1st April 2008 to 31st March 2014. Daily closed series values were taken for all the indexes. Various econometric tools such as ADF unit root, Johnson co-integration, VAR model, Granger causality, and Vector decomposition and so forth were employed to analyze data and evaluate findings so as to shed light on the critical relationships among BSE indices.

Keywords: **indices, comovement, econometrics, stock exchange, financial reforms, BSE**

JEL Classification : C2, O16

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The last 2 decades have witnessed significant growth of the Indian economy. Globalization led India to make radical policy changes and open up to foreign investment (FIIs). As a result, FIIs increased their investment in India which led to great momentum in the Indian stock market. Financial reforms (LPG in 1993) resulted in expansion rates that were higher than those in last four decades. Undoubtedly, the Indian stock market has performed over the years, and its contribution to the Indian economy is unquestionable. However, whether the stock market is a true barometer of economic growth has been a moot point. Nevertheless, many researchers including Sinha and Macri (2001), Levine and Zervos (1996), Bhattacharya, Sarkar, and Mukhopadhyay (2003), Arestis and Demetriades (1997) argued that there was a positive association between stock market performance and growth of economy.

Usually stock market performance is taken as an index of industry or corporate performance only but globalization has turned it into an indicator of economic development. It has now become a way to attract new and valuable financial sources for faster development. Paramati and Gupta (n.d.) asserted that the new economic policy of 1991 positively affected the Indian stock market and significantly contributed to the economic transformation. Financial management is a theory of funds allocation and effective utilization thereof so that remaining funds can either be retained and/or distributed to investors. Till the year 2000, Indian economy faced

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liquidity constraints but in the last 10 years, things have changed and impressive growth rates have been recorded at the stock market. This made the Indian economy one of the fastest developing markets.

Advanced financial management takes stock market theory as a concept of wealth maximization. This is evident by the past performance and exceptional growth of many corporations. Further, it is noteworthy that wealth maximization also contributes to profit maximization, if an organization raises its capital (equity or debt) for expansion, it might lead to a positive sentiment in the market raising the value of the organization's shares, thus increasing wealth without necessarily earning profits. This raises the question: What kind of analysis would correctly explain such behavior, technical or fundamental?

Post financial reforms the Indian stock market has been driven more by foreign investment rather than domestic investment. Researchers such as Mukherjee and Coondoo (2002), Mangesh and Rao (2011), Murthy and Singh (2013) verified the statement. The question raised here is: Why domestic investors don't invest more in the stock market? A possible answer to this question might be that the erratic and unstructured return behaviors of Indian indices are not able to gain the trust of investors. The absence of scientific study or established tools to provide true estimation of set returns further compounds the problem. For investors, various indices are available at Indian stock exchanges including BSE and NSE, but a method of rational estimation of these indices does not exist, which increases the risk factor. Karmakar (2005) also emphasized on the necessity of a framework that offered inter linkage among Indian stock market indices as they operate under different cultural, institutional and regulatory functions as compare to developed countries. This warrants a study of co-movement between indices to shed light on ways to calculate risk and return.

This paper is an attempt to assess the performance of the prominent indices of the Bombay Stock Exchange (BSE), and determine the mutual relationship shared among them. This study offers a deeper understanding of the co-movement between the selected series during 2010-2014 and also offers an approach to compare individual performances of select indices of the BSE.

Review of Literature

Poshkwale (1996) studied efficient market hypothesis and market sentiment reaction on return at BSE and observed variance in returns. Findings further revealed that returns on Fridays (weekend) were always higher as compared to other weekdays. Aggarwal (1999) found that high volatility in emerging stocks was the result of various economical, political and social issues, and these issues varied from country to country. Bandivadekar (2003) revealed that futures and options reduced the volatility effects for all indices of BSE and Nifty 50 of NSE. A decline in uncertain trends increased rational behavior of investors which in turn reduced market volatility. Findings further showed that BSE Sensex volatility declined due to the lessening of overall market volatility, but NSE Nifty recorded effects of market as well as and futures.

Razdan (2002) explained that static relationship existed between BSE index and market returns, and asserted that in case of constant market, future returns will consequently be lower and show a declining trend. (Hussain, Hamid, Akash, & Khan, 2011) studied volatility effects on daily returns for KSE 100 index, and investigated day of week effect in the Pakistani Stock Market. Findings saw constant returns for the whole week (based on 5 days working) except Tuesday. It validated efficient market theory assumption. But high volatility converted Tuesday to higher return day. Thus, Karachi stock market found that Tuesdays significantly affected weekly performance.

Pandey (2005) analyzed various volatility models and their estimators for BSE Sensex and NSE Nifty listed companies, and proved recognition of time-varying volatility for market co-integration. The study argued that based on efficiency criteria, conditional volatility model seemed fit for estimating long term volatility and stock market return relationship. On the other hand, based on extreme value estimators, weekly and monthly volatility was forecasted.

Karim, Kassim, and Arip (2010) studied the impact of the financial global crisis on co-movement of Islamic stock indices. No long-term cointegration or inter-linkage among the indices during the pre and post global recession period was found. However, they did suggest using international diversification to get higher returns from Islamic indices.

Chandra (2012) explored the relationship between FII trade volumes and Indian stock market reactions. It was realized that FII investment pushes trade volume and increases market cap of companies. Interestingly, increased trade volume caused stock market returns to fluctuate (increased trade volume gave higher returns and vice-versa). Thus, a positive relationship exists between trade volume and market returns. Maditinos, Šević, and Theriou (2007) studied analysis techniques used by Greek investors for portfolio designs. Analyses were categorized for individual and institutional investors. It was found that individual investors were more dependent on voice analysis based on media reports as compared to fundamental and technical analysis. On the other hand, professional investors used both fundamental and technical analyses for portfolio design and diversification.

Kumar (2012) examined the effects of Indian volatility index on Indian stock market, and revealed a relationship between Indian volatility index and stock markets in developed countries. Findings proved that volatility index return and stock market return are adversely correlated and in the long run the US market would impact volatility index. Interestingly, in case of sharp rises in stock prices liquidity index decreases, but when market decreases sharply, volatility index shows a slow upwards index. Valadkhani and Chancharat (2007) found no long run relationship or inter-linkages between Thailand stock market indices and other leading trading countries such as Australia, Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, UK and United States of America during 1997 to 2005. However, short run cointegration was seen with Hong Kong, Philippines and UK.

Meric, Gulser, Niranjan Pati, and Ilhan Meric, 2011) researched on Indian stock market integration with selected thirteen countries and results indicated that Indian stock indices follow U.S., Hong Kong, New Zealand, and Australia. Besides stocks of Malaysia, Indonesia, South Korea, Taiwan, and German stock follows Indian stock indices. It proved the long run relationship between countries and Indian stock indices which can produce investors' rational ground for investment diversification among the selected countries.

Priscilla (2013) found that the Chinese stock market performance was strongly influenced by the performance of the American stock market. Moreover, the Chinese market was also found to be cointegrated with stock markets of Russia, Germany, Japan, South Korea, Mexico and India. It was further observed that macro-economic issues such as exchange rate and interest rates were driving forces behind the performance of the Chinese stock market. Masih & Masih (1997) found that the stock markets of Honk Kong, Singapore, Taiwan and South Korea had inter-linkages with stock markets of United States of America, Japan, United Kingdom and Germany. Gentzoglanis (2007) observed cointegration between economic growth and performance of stock market indices in high income countries of The Middle East and North Africa (MENA). Financial openness, privatization, regulation and competitiveness were missing in lower income countries of the MENA region and as a result, strong cointegration with stock market performance did not exist.

Dadhich, Chotia, and Chaudhry (2015) proved that Indian stock market volatility is strongly related to flow of foreign institutional investment as Indian economy is emerging and expending. Study has explained the volume of FIIs for the duration of before & after global recessionary period with a comparison of gross purchase and gross sales.

Antoniou, Petmezas, and Zhao (2007) studied cointegration of the UK stock markets with stock markets of Europe and United States of America. Results showed that a comparatively strong mutual performance relationship existed between UK stock markets and European stock markets. Prasad and Verma (2013) explain that stock returns are not different compare to their market level i.e. small or large of S&P CNX 500. It was found that returns of small stocks were quite similar with large stocks returns. Research manuscript established a Cointegration or mutual relationship between the small and large stocks. Seth and Sharma (2015) observed long

run cointegration between Asian stock markets and stock markets of United States. Although between 2008 and 2010 (global financial crisis period), a comparatively weaker mutual financial relationship was recorded. (Shabri Abd. Majid, Kameel Mydin Meera, Azmi Omar, & Abdul Aziz, 2009) found strong inter linkages among stock market performances of ASEAN countries in the post global recession period. However, Indonesian stock markets were found to perform weakly in the long run.

Joshi (2013) revealed Cointegration or mutual relationship among the stock indices of BRICS countries and established that Indian indices are correlated with Brazil, Russia and China between the years 2002 to 2007. But Interestingly Indian stock indices were not long run associated with Brazil and South Africa during global recession crisis. EI Hedi Arouri & Khuong Nguyen (2009) found small co-movements between indices of stock markets of the Gulf and the world market. Also, a positive relation was found to exist between these co-movements and stock performance of crude oil companies.

Research Methodology

This study examines the relationship among the various indices of the Bombay Stock Exchange, popularly known as BSE. Daily closing values of the selected indices - S&P BSE 30, S&P BSE 100, S&P BSE 200, S&P BSE 500, S&P BSE Mid cap, S&P BSE Small cap were taken for the purpose of this study. The period considered for this study is 1st April, 2008 to 31st March, 2014. Therefore, data for a total of 6 years (24 quarters) is taken for the purpose of the study, and has been analyzed using econometric tools.

Econometric analysis can be performed on series of stationary nature. In order to check stationary nature of all series, a line graph and correlogram is prepared for each of the data series. For final confirmation, whether series are stationary or not the Augmented Dickey-Fuller test under the unit root test has been performed. Afterwards with the stationary log series of all the selected variables, we carry out the Granger's causality model in order to understand: whether any selected indices or variable Granger causes other variable or variables.

Afterwards Granger we apply VAR model. It is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system.

Finally, we apply the variance decomposition analysis in order to finally quantify the extent to which the six indices are influenced by each other. While impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VAR, but variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR.

Analysis and Results

We undertake the statistical methods as mentioned in Section 3 of this paper and present the findings in this section. The used analysis methodology is similar with previous studies on same subjective approach either for inter sector study, intra sector study, studies between selected countries and studies of group of countries to evaluate the mutual long run relationship between the stock prices or series values. Hence this finding support the results of similar studies conducted in the past.

We start by computing basic statistics for the six series of selected indices to get an insight into the data. For performing the econometric analysis, it is very essential for the researcher to make sure that the series under reference are stationary, otherwise study will provide the results for the consideration period only. Besides non stationary time series will lead to nonsense regression results. In order to make the series stationary, we take log of

Table 1. Descriptive Statistics of the Returns on BSE Sensex, BSE 100, BSE 200, BSE 500, BSE Mid Cap, and BSE Small Cap

	BSE Sensex	BSE100	BSE 200	BSE 500	MID CAP	SMALL CAP
Mean	17083.29	5177.429	2095.617	6554.457	6129.982	6956.900
Median	17540.97	5353.420	2172.570	6819.260	6347.295	6847.515
Maximum	22386.27	6707.280	2681.350	8405.660	8730.300	11243.99
Minimum	8160.400	2413.050	963.4100	2983.020	2553.490	2866.680
Std. Dev.	3001.087	918.0510	376.2302	1175.682	1198.350	1671.438
Skewness	-1.19852	-1.326702	-1.36808	-1.41961	-1.17659	-0.138274
Kurtosis	4.165935	4.374921	4.420773	4.561548	4.589790	3.087525
Jarque-Bera	441.1159	554.4636	590.1093	651.8477	500.6956	5.223658
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.073400
Sum	25454104	7714369.	3122470.	9766141.	9133673.	10365782
Sum Sq. Dev.	1.34E+10	1.25E+09	2.11E+08	2.06E+09	2.14E+09	4.16E+09
Observations	1490	1490	1490	1490	1490	1490
Year wise Return(%)	2628.2	796.5	322.4	1008.38	943.07	1015

the six series on which further analysis shall be performed. Log of the six series gives the daily return of the six indices under study.

Table 1 presents the descriptive statistics of all selected indices for the period of 6 years (2008-2014). All the counted figures are varying due to input volume differences of all selected indices. Whereas mean shows the return of each variable and other side standard deviation shows the inherent risk factor.

Table 1 shows that the average daily return at the BSE 30, BSE 100, BSE 200, BSE 500, BSE Mid cap, BSE Small cap happens to be 17083.29, 5177.429, 2095.617, 6554.457, 6129.982, and 6956.900, respectively based on a total of 1490 observations. Hence, the annual returns over a period of six and a half years can be computed by dividing the mean daily return with 6.5. Thus, calculated returns are 2628.2, 796.5, 322.4, 1008.38, 943.07, and 1015 for BSE 30, BSE 100, BSE 200, BSE 500, BSE Mid cap, and BSE Small cap, respectively. It is clear that on an average, BSE 30 returns were highest among all 6 indices, followed by BSE 500, BSE Small cap, BSE Mid cap, BSE 100, and BSE 200. On the other hand, higher standard deviation indicates higher risk factor at the BSE Sensex followed by BSE Small cap, BSE Mid cap, BSE 500, BSE 100, and BSE 200. Certainly it provides high returns but comes with high risk fundamentals.

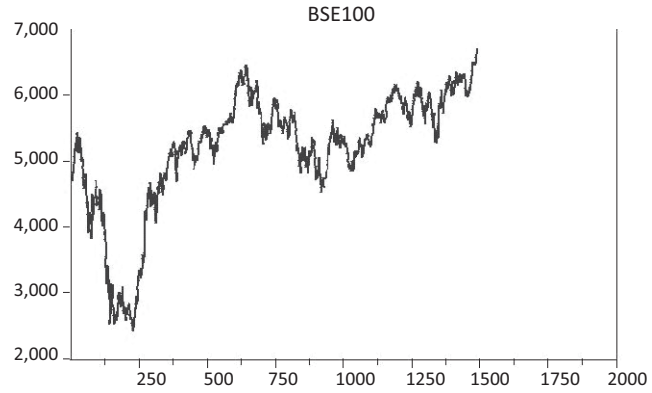
Figures 1-6 show the individual line graphs of the annual volume of all selected indices (BSE 30, BSE 100, BSE 200, BSE 500, BSE Mid cap, BSE Small cap). Figure 7 shows common line graphs for all the variables under study. It is indicated from the figures that volumes at all the 6 variables are stationary in nature.

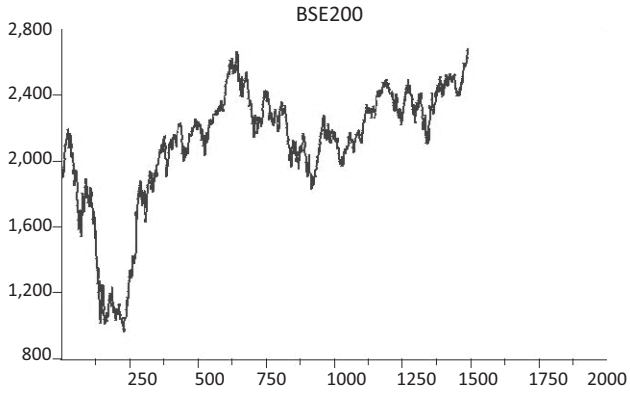
In order to further check the stationarity of all series, we perform the correlogram and the unit root test. Tables 2-7 summarizes auto correlation, partial auto correlation, Q stat and the probability of return on all selected six variables. Here correlogram analysis has been done with ten legs for all the variables.

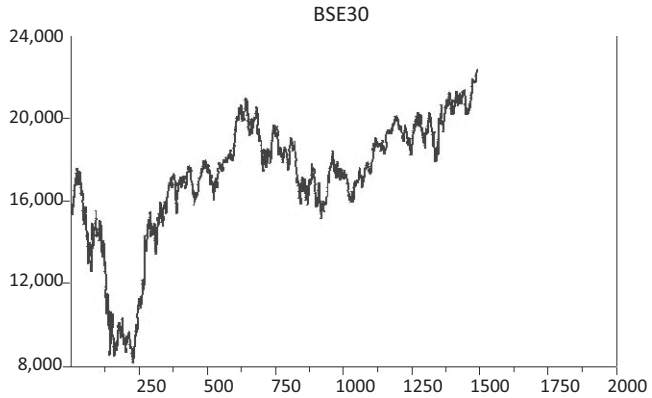
It is evident from Table 2 that the auto correlation of log BSE 30 is very low from lag 2 and onwards. In case of BSE 100, BSE 200, BSE 500 afterwards leg 2, received values were very low. This explained from Tables 3 to 5. This explains that BSE 30, BSE 100, BSE 200 and BSE 500 are stationary in nature. Here all explained variables were calculated on 1st difference. In case of BSE Mid cap and BSE Small cap received values of Auto correlation from first leg onwards recorded the negative values as showed in Tables 6 and 8. This estimation has been calculated on IInd difference and which indicates the stationary nature of the series.

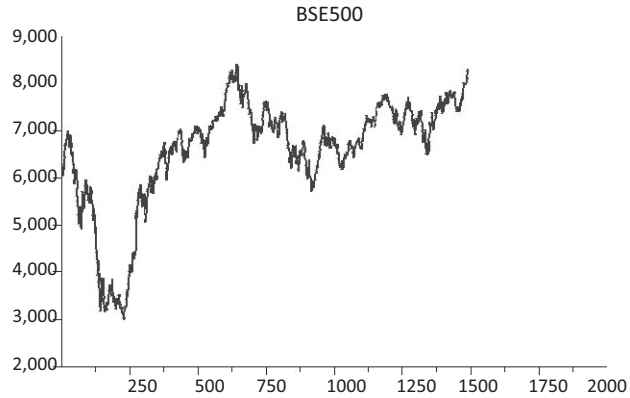
Further, the unit-root test is performed on all the series in order to test the null hypothesis that the series has a unit

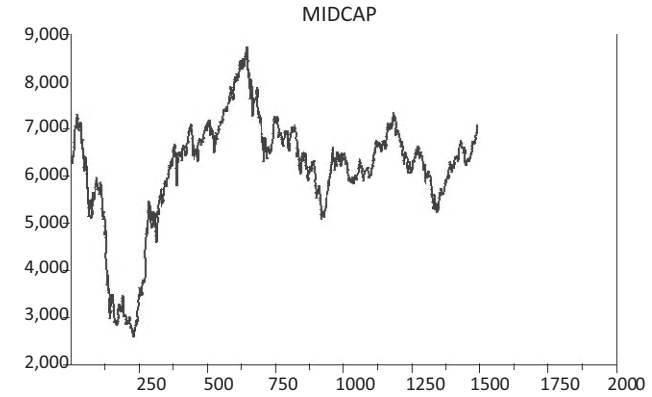
Figures 1 to 6

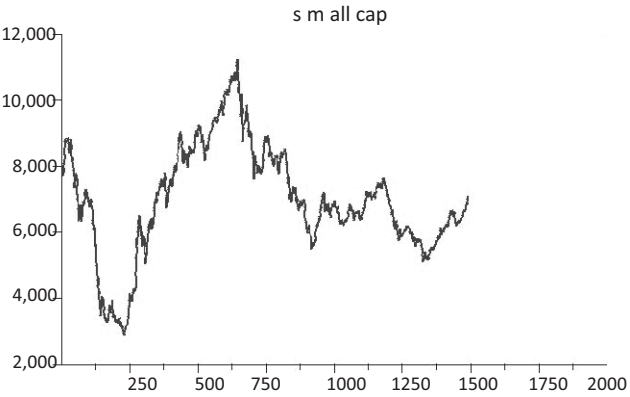












root. The findings of the unit-root test and the augmented Dickey-Fuller test are shown in Tables 8 to 13. Acceptance or rejection of Null hypothesis was based on received P value (less than or more than .05 respectively). We have found all selected indices have recorded .0000 *p* -values which is clearly less than .05. Hence we have to acknowledge or accept all null hypotheses, which validates that all series don't have a unit-root. Accordingly it certifies that all series are stationary.

After confirming that all six series are stationary in nature, we performed the Johnson cointegration test to check the long run association between all the indices. This test deals with the mutual relationship among a group of variables. Table 14 shows Johnson cointegration test analysis for all the variables. Here, Trace test and Max-eigenvalue test represent *p* - values to estimate co-integration among the series. Received all *p*- values for both

Table 2. Auto Correlation and Partial Autocorrelation of Returns of BSE 100

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
| |	| |	1	0.075	0.075	8.2889	0.004
| |	| |	2	0.011	0.005	8.4615	0.015
| |	| |	3	-0.017	-0.019	8.9130	0.030
| |	| |	4	-0.018	-0.015	9.3752	0.052
| |	| |	5	-0.017	-0.015	9.8316	0.080
| |	| |	6	-0.020	-0.018	10.446	0.107
| |	| |	7	0.042	0.045	13.151	0.069
| |	| |	8	0.028	0.021	14.318	0.074
| |	| |	9	0.036	0.031	16.297	0.061
| |	| |	10	0.022	0.017	17.014	0.074

Table 3. Auto Correlation and Partial Autocorrelation of Returns of BSE 200

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
| |	| |	1	0.085	0.085	10.782	0.001
| |	| |	2	0.022	0.015	11.525	0.003
| |	| |	3	-0.011	- 0.014	11.691	0.009
| |	| |	4	-0.019	- 0.017	12.204	0.016
| |	| |	5	-0.017	-0.013	12.624	0.027
| |	| |	6	-0.021	-0.018	13.262	0.039
| |	| |	7	0.045	0.049	16.352	0.022
| |	| |	8	0.027	0.020	17.479	0.025
| |	| |	9	0.040	0.034	19.900	0.019
| |	| |	10	0.024	0.017	20.745	0.023

Table 4. Auto Correlation and Partial Autocorrelation of Returns of BSE 500

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
| |	| |	1	0.099	0.099	14.624	0.000
| |	| |	2	0.033	0.023	16.213	0.000
| |	| |	3	-0.001	-0.006	16.214	0.001
| |	| |	4	-0.017	-0.017	16.640	0.002
| |	| |	5	-0.015	-0.011	16.968	0.005
| |	| |	6	-0.019	-0.016	17.528	0.008
| |	| |	7	0.049	0.053	21.082	0.004
| |	| |	8	0.030	0.021	22.392	0.004
| |	| |	9	0.042	0.034	25.046	0.003
| |	| |	10	0.025	0.016	25.983	0.004

Table 5. Auto Correlation and Partial Autocorrelation of Returns of BSE Sensex

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
| |	| |	1	0.060	0.060	5.4278	0.020
| |	| |	2	-0.014	-0.018	5.7360	0.057
| |	| |	3	-0.032	-0.030	7.2743	0.064
| |	| |	4	-0.016	-0.013	7.6794	0.104
| |	| |	5	-0.018	-0.018	8.1892	0.146
| |	| |	6	-0.021	-0.020	8.8597	0.182
| |	| |	7	0.035	0.036	10.675	0.153
| |	| |	8	0.025	0.019	11.597	0.170
| |	| |	9	0.024	0.021	12.461	0.189
| |	| |	10	0.020	0.019	13.043	0.221

Table 6. Auto Correlation and Partial Autocorrelation of Returns of BSE Mid Cap

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
| |	| |	1	-0.435	-0.435	282.87	0.000
| |	| |	2	-0.031	-0.273	284.33	0.000
| |	| |	3	0.010	- 0.168	284.47	0.000
| |	| |	4	-0.047	- 0.172	287.76	0.000
| |	| |	5	0.011	-0.138	287.95	0.000
| |	| |	6	-0.067	-0.210	294.58	0.000
| |	| |	7	0.072	-0.125	302.33	0.000
| |	| |	8	-0.021	-0.125	303.00	0.000
| |	| |	9	0.028	-0.075	304.15	0.000
| |	| |	10	0.003	-0.054	304.16	0.000

Table 7. Auto Correlation and Partial Autocorrelation of Returns of BSE Small Caps

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
| |	| |	1	-0.405	-0.405	245.02	0.000
| |	| |	2	-0.042	-0.247	247.67	0.000
| |	| |	3	-0.004	-0.160	247.70	0.000
| |	| |	4	-0.046	-0.166	250.82	0.000
| |	| |	5	-0.002	-0.145	250.83	0.000
| |	| |	6	-0.057	-0.203	255.61	0.000
| |	| |	7	0.075	-0.104	264.12	0.000
| |	| |	8	-0.033	-0.123	265.73	0.000
| |	| |	9	0.047	-0.053	269.00	0.000
| |	| |	10	-0.018	-0.060	269.46	0.000

Table 8. Unit-Root Test and Augmented Dickey-Fuller Test for Returns at BSE 100

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
D(BSE100(-1))	-0.925459	0.025868	-35.77627	0.0000
C	1.182125	1.798255	0.657374	0.5110
R-squared	0.462751	Mean dependent var		-0.007339
Adjusted R-squared	0.462389	S.D. dependent var		94.58985
S.E. of regression	69.35512	Akaike info criterion		11.31770
Sum squared resid	7147858.	Schwarz criterion		11.32483
Log likelihood	-8418.369	Hannan-Quinn criter.		11.32036
F-statistic	1279.941	Durbin-Watson stat		2.000855
Prob(F-statistic)	0.000000			

Table 9. Unit-Root Test and Augmented Dickey-Fuller Test for Returns at BSE 200

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
D(BSE200(-1))	-0.914984	0.025847	-35.40051	0.0000
C	0.453543	0.710932	0.637955	0.5236
R-squared	0.457505	Mean dependent var		-0.001680
Adjusted R-squared	0.457140	S.D. dependent var		37.21471
S.E. of regression	27.41944	Akaike info criterion		9.461725
Sum squared resid	1117213.	Schwarz criterion		9.468855
Log likelihood	-7037.523	Hannan-Quinn criter.		9.464382
F-statistic	1253.196	Durbin-Watson stat		2.002619
Prob(F-statistic)	0.000000			

Table 10. Unit-Root Test and Augmented Dickey-Fuller Test for Returns at BSE Sensex

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
D(BSE30(-1))	-0.939684	0.025892	-36.29243	0.0000
C	4.187464	6.050372	0.692100	0.4890
R-squared	0.469880	Mean dependent var		-0.052070
Adjusted R-squared	0.469524	S.D. dependent var		320.3831
S.E. of regression	233.3472	Akaike info criterion		13.74428
Sum squared resid	80914061	Schwarz criterion		13.75141
Log likelihood	-10223.74	Hannan-Quinn criter.		13.74693
F-statistic	1317.141	Durbin-Watson stat		1.997952
Prob(F-statistic)	0.000000			

Table 11. Unit-Root Test and Augmented Dickey-Fuller Test for Returns at BSE 500

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
D(BSE500(-1))	-0.900983	0.025814	-34.90319	0.0000
C	1.275514	2.172238	0.587189	0.5572
R-squared	0.450491	Mean dependent var		0.000175
Adjusted R-squared	0.450121	S.D. dependent var		112.9832
S.E. of regression	83.78135	Akaike info criterion		11.69564
Sum squared resid	10430701	Schwarz criterion		11.70277
Log likelihood	-8699.557	Hannan-Quinn criter.		11.69830
F-statistic	1218.233	Durbin-Watson stat		2.004543
Prob(F-statistic)	0.000000			

Table 12. Unit-Root Test and Augmented Dickey-Fuller Test for Returns at BSE Mid Cap

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
D(MIDCAP(-1))	-0.792058	0.025372	-31.21805	0.0000
C	0.380551	1.958340	0.194323	0.8459
R-squared	0.395913	Mean dependent var		0.070712
Adjusted R-squared	0.395507	S.D. dependent var		97.19282
S.E. of regression	75.56659	Akaike info criterion		11.48925
Sum squared resid	8491231.	Schwarz criterion		11.49637
Log likelihood	-8551.745	Hannan-Quinn criter.		11.49190
F-statistic	974.5665	Durbin-Watson stat		2.026432
Prob(F-statistic)	0.000000			

Table 13. Unit-Root Test and Augmented Dickey-Fuller Test for Returns at BSE Small Cap

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
D(SMALL_CAP(-1))	-0.665653	0.031031	-21.45111	0.0000
D(SMALL_CAP(-1),2)	-0.072480	0.025889	-2.799574	0.0052
C	-0.309826	2.303402	-0.134508	0.8930
R-squared	0.362227	Mean dependent var		0.097344
Adjusted R-squared	0.361367	S.D. dependent var		111.1435
S.E. of regression	88.81981	Akaike info criterion		11.81311
Sum squared resid	11707215	Schwarz criterion		11.82381
Log likelihood	-8780.049	Hannan-Quinn criter.		11.81710
F-statistic	421.4226	Durbin-Watson stat		2.002380
Prob(F-statistic)	0.000000			

Table 14. Johansen Cointegration Among BSE Sensex, BSE 100, BSE 200, BSE 500, BSE Mid Cap, BSE Small Cap

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None	0.025019	85.46597	95.75366	0.2065
At most 1	0.011142	47.83945	69.81889	0.7283
At most 2	0.010093	31.20027	47.85613	0.6557
At most 3	0.005677	16.13580	29.79707	0.7027
At most 4	0.004058	7.680937	15.49471	0.5001
At most 5	0.001106	1.643250	3.841466	0.1999

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) *p*-values

test are more from .05, which proves that we cannot reject the null hypotheses. Hence we accepted the Null hypothesis and it means all variable are not co-integrated, which proves that all indices have no long run association. It also validates that selected variables eventually don't move together.

Pair wise relationship is also significant to examine for verifying the mutual or reciprocal relationship among series. It provides a justification to understand actual behavior of one series into mutual relationship. Further this examination can lead to overview the impact of one series on another and vice-versa. To evaluate the pairwsie regression analysis on all considered series we have performed Granger's casualty analysis. Table 15 presents the findings for all variables under study with 2 lags. Null hypothesis in the case of Granger's causality model is that "A" does not granger cause "B". On those lines, Table 10 tests the hypotheses about six variables in pairs.

The results show that the probability value for total 30 items (for the pair of 6 variables). Here we have found total 10 items or inter related series where received Probability values are less than .05 (all values are mentioned into bold and italic style in the Table 10). Accordingly, all related null hypotheses have been rejected. This means that in all these cases particular one item Granger causes the other related items.

An estimation of future or projected return from series in context to mutual relationship is also important to observe. Certainly it will lead determine the Cointegration or Inter linkages between the various select indices. The VAR model has proven to be especially useful for describing the dynamic behavior of economic and financial time series and for forecasting. The results of Granger's model of causality are further confirmed in econometrics by applying the VAR model. In most empirical researches, VAR is used to support the results of Granger's model; as the application of Granger's causality alone is not considered a sufficient exercise. The purpose of the VAR is mainly to examine the dynamic adjustments of each of the involved variables to exogenous stochastic structural shocks. Therefore, we also apply the VAR model on the series under reference in order to further confirm the results produced by the Granger's causality model. In Table 16, we present the application of VAR model for all variables.

By the application of VAR model, we observe that the integration of individual variable with the other cannot be established. The main findings of VAR estimation with 2 lags show that few variables have found the negative *t* - statistics (specifically mentioned into bold & italic style in the respective Table 16) which means the adverse Cointegration mutually or no sensitizations reciprocally. Rest variables somewhat equally impacted somewhere together. Here *t* - value = Coefficient / Standard error.

Negative values derived through 1 leg shows no impact on a short run between the series. Further in case of leg 2 values where at first leg value is negative and further it converts as positive, it produces the insignificant sense for financial analysis point of view. Because all the series were day wise closed data and this implication states that in

Table 15. Pairwise Granger's Causality Test

for : BSE Sensex, BSE 100, BSE 200, BSE 500, BSE Mid cap, BSE Small cap			
Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
BSE200 does not Granger Cause BSE100	1488	0.82689	0.4376
BSE100 does not Granger Cause BSE200		0.58014	0.5599
BSE30 does not Granger Cause BSE100	1488	3.19733	**0.0412**
BSE100 does not Granger Cause BSE30		3.60337	**0.0275**
BSE500 does not Granger Cause BSE100	1488	0.65730	0.5184
BSE100 does not Granger Cause BSE500		0.44561	0.6405
MIDCAP does not Granger Cause BSE100	1488	1.30402	0.2717
BSE100 does not Granger Cause MIDCAP		2666.74	**0.0000**
SMALL_CAP does not Granger Cause BSE100	1488	1.01205	0.3637
BSE100 does not Granger Cause SMALL CAP		0.35526	0.7010
BSE30 does not Granger Cause BSE200	1488	2.16501	0.1151
BSE200 does not Granger Cause BSE30		3.23054	**0.0398**
BSE500 does not Granger Cause BSE200	1488	1.08239	0.3391
BSE200 does not Granger Cause BSE500		1.19546	0.3029
MIDCAP does not Granger Cause BSE200	1488	1.69792	0.1834
BSE200 does not Granger Cause MIDCAP		3365.41	**0.0000**
SMALL_CAP does not Granger Cause BSE200	1488	0.90016	0.4067
BSE200 does not Granger Cause SMALL_CAP		0.46049	0.6311
BSE500 does not Granger Cause BSE30	1488	2.54368	**0.0789**
BSE30 does not Granger Cause BSE500		1.24642	0.2878
MIDCAP does not Granger Cause BSE30	1488	0.73867	0.4779
BSE30 does not Granger Cause MIDCAP		1768.16	**0.0000**
SMALL_CAP does not Granger Cause BSE30	1488	1.38809	0.2499
BSE30 does not Granger Cause SMALL_CAP		0.29423	0.7451
MIDCAP does not Granger Cause BSE500	1488	1.98316	0.1380
BSE500 does not Granger Cause MIDCAP		4072.50	**0.0000**
SMALL_CAP does not Granger Cause BSE500	1488	0.74418	0.4753
BSE500 does not Granger Cause SMALL_CAP		0.51835	0.5956
SMALL_CAP does not Granger Cause MIDCAP	1488	6159.09	**0.0000**
MIDCAP does not Granger Cause SMALL_CAP		4.10665	**0.0167**

a difference of one day one index impacted which was initially on first day negatively related mutually. Further here VAR model results also validate the Granger casualty results.

To validate the results of VAR model Forecast error variance decomposition (FEVD) tool of econometric has been applied. It applies the assessment of future return of actual driving or dominating series in mutual relationship between the series. Finally, variance decomposition analysis of the series is presented in Tables 17 to 22. The table decomposes the returns for all six indices. This can be taken as forecasting for short as well as long terms. The variance decomposition analysis implies that by and large, all series are of the fluctuation or impulse of BSE 100 dominatingly and to a smaller percentage in own shock. It can be understood with BSE 30, BSE 200, and

Table 16 . Vector Auto Regression Estimates for BSE Sensex, BSE 100, BSE 200, BSE 500, BSE Mid Cap, BSE Small Cap

	BSE100	BSE200	BSE500	BSE Sensex	MIDC AP	SMALL CAP
BSE100(-1)	0.699103	-0.176535	-0.647778	-0.362541	-4.227639	-2.476051
	(1.01609)	(0.40169)	(1.22748)	(3.41924)	(0.13549)	(1.29928)
	[0.68803]	**[-0.43948]**	**[-0.52773]**	**[-0.10603]**	**[-31.2027]**	**[-1.90571]**
BSE100(-2)	0.172859	0.133839	0.525339	-0.032606	4.267900	2.476611
	(1.01076)	(0.39959)	(1.22104)	(3.40130)	(0.13478)	(1.29246)
	[0.17102]	[0.33494]	[0.43024]	[-0.00959]	[31.6659]	[1.91620]
BSE200(-1)	-9.113398	- 2.554496	-10.76412	-31.08096	1.410464	-4.551484
	(4.65182)	(1.83901)	(5.61960)	(15.6538)	(0.62029)	(5.94828)
	[-1.95911]	**[- 1.38906]**	**[-1.91546]**	**[-1.98553]**	**[2.27387]**	**[-0.76518]**
BSE200(-2)	9.429293	3.669072	11.12647	32.19663	-1.631141	5.092031
	(4.65544)	(1.84044)	(5.62398)	(15.6660)	(0.62078)	(5.95291)
	[2.02543]	[1.99358]	[1.97840]	[2.05520]	[-2.62759]	[0.85538]
BSE500(-1)	2.866868	1.183543	4.720554	8.966629	4.109144	3.651550
	(1.24944)	(0.49394)	(1.50937)	(4.20446)	(0.16660)	(1.59765)
	[2.29453]	[2.39613]	[3.12749]	[2.13265]	[24.6640]	[2.28557]
BSE500(-2)	-2.834720	-1.171136	-3.689204	-8.867092	-4.042231	-3.764769
	(1.25938)	(0.49787)	(1.52138)	(4.23791)	(0.16793)	(1.61037)
	[-2.25089]	[-2.35229]	[-2.42490]	[-2.09232]	[-24.0709]	[-2.33783]
BSE Sensex (-1)	0.199634	0.075585	0.220362	1.718782	-0.098026	0.087621
	(0.08013)	(0.03168)	(0.09680)	(0.26965)	(0.01069)	(0.10247)
	[2.49130]	[2.38596]	[2.27639]	[6.37406]	**[-9.17398]**	[0.85513]
BSE Sensex(-2)	-0.204678	-0.078391	-0.230013	-0.750176	0.091501	-0.103994
	(0.08042)	(0.03179)	(0.09715)	(0.27063)	(0.01072)	(0.10284)
	[-2.54506]	[-2.46566]	[-2.36753]	[-2.77200]	[8.53253]	[-1.01127]
MID CAP(-1)	0.003728	0.002252	0.008944	-0.023853	0.983485	0.058833
	(0.03896)	(0.01540)	(0.04707)	(0.13111)	(0.00520)	(0.04982)
	[0.09569]	[0.14622]	[0.19003]	**[-0.18194]**	[189.308]	[1.18093]
MID CAP(-2)	-0.029487	-0.013570	-0.045524	-0.058276	0.002510	-0.093940
	(0.02556)	(0.01010)	(0.03087)	(0.08600)	(0.00341)	(0.03268)
	[-1.15379]	[-1.34312]	[-1.47452]	[-0.67762]	[0.73642]	[-2.87458]
SMALL CAP(-1)	-0.146198	-0.063872	-0.199866	-0.394839	0.014896	0.881397
	(0.08206)	(0.03244)	(0.09913)	(0.27614)	(0.01094)	(0.10493)
	[-1.78159]	**[-1.96888]**	**[-2.01616]**	**[-1.42985]**	[1.36132]	[8.39982]
SMALL CAP(-2)	0.147274	0.064837	0.203880	0.394682	-0.012754	0.130783
	(0.08186)	(0.03236)	(0.09889)	(0.27547)	(0.01092)	(0.10468)
	[1.79904]	[2.00344]	[2.06162]	[1.43274]	[-1.16837]	[1.24939]
C	27.93662	10.68090	31.48686	100.4893	-2.361565	15.82044
	(12.7819)	(5.05307)	(15.4411)	(43.0121)	(1.70438)	(16.3442)
	[2.18564]	[2.11375]	[2.03916]	[2.33630]	[-1.38558]	[0.96796]

R-squared	0.994384	0.994774	0.995003	0.994049	0.999941	0.997229
Adj. R-squared	0.994339	0.994732	0.994963	0.994000	0.999941	0.997207
Sum sq. resids	7045827.	1101168.	10282473	79785578	125279.2	11520453
S.E. equation	69.11463	27.32316	83.49352	232.5767	9.216020	88.37690
F-statistic	21764.88	23398.02	24476.50	20531.44	2097667.	44241.56
Log likelihood	-8407.672	-7026.761	-8688.908	-10213.29	-5409.616	-8773.489
Akaike AIC	11.31811	9.462044	11.69611	13.74502	7.288462	11.80980
Schwarz SC	11.36446	9.508394	11.74246	13.79136	7.334811	11.85615
Mean dependent	5177.951	2095.831	6554.975	17085.17	6129.604	6955.650
S.D. dependent	918.5571	376.4379	1176.387	3002.667	1199.111	1672.213
Determinant resid covariance (dof adj.)			8.71E+11			
Determinant resid covariance			8.26E+11			
Log likelihood			-33083.53			
Akaike information criterion			44.57195			
Schwarz criterion			44.85005			

BSE 500 where only impact of BSE 100 has resulted till 10 legs. Whereas BSE 100 all through in short run and long run was impressed via own shock.

BSE Midcap and Small cap series were influenced majorly with BSE 100 in short & long run both. Also both indices have shaken with BSE 200 series but it was particularly less compare to BSE 100 but significantly more from rest all indices.

At Midcap, BSE 100 impressed with range of 77% to 83%, whereas BSE 200 impacted with 13% to17% approx. Rest indices impulse for around 1percent in short & long run only. Equally at Small cap, impression of BSE 100 was 64% to 71%, while BSE 200 shocked with 20% to 22% all over leg periods. In case of impact of remaining indices on Small cap, all were found quite insignificant including own shock throughout short and long run period, but slight impulse of BSE 500 were recorded with a range of 6 to 7% for both short and long run.

Research Implications

Such studies can be potentially brought to bear on making intelligible the workings of stock indices and make substantial contribution towards constructing a fine-grained and lasting account of BSE. This study also shades light on and can come handy for investors in their informed investment decision in the realm of BSE. It would be interesting to compare scheme of findings from such similar studies undertaken across different economic setups.

Conclusion

This paper has several practical implications. It gives a deeper understanding of the mutual relationship shared by selected series at the BSE by determining the existence and type of integration among them. The results portray the mathematical based findings which give an explanatory account of the underlying relationship between the stock indices of BSE for investors & users - which are in accordance with the practical scenario discussed in the paper. In fact, systematic observations of daily closed value of series based data analysis describe the behavior of individual performances and the mutual dependency or influences of one series on another at BSE. This understanding will help practitioners better recognize the impact of one series on another. Further, the study will

Tables 17 to 22 . Variance Decomposition for BSE Sensex, BSE 100, BSE 200, BSE 500, BSE Mid Cap, BSE Small Cap

Variance Decomposition of BSE100

Period	S.E.	BSE100	BSE200	BSE Sensex	BSE500	MIDCAP	SMALL CAP
1	69.11463	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	101.3083	99.61636	0.080019	0.139115	0.068734	6.60E-05	0.095705
3	126.4378	99.49001	0.088821	0.183173	0.107755	0.001104	0.129138
4	147.1666	99.42921	0.094704	0.202186	0.123254	0.003042	0.147605
5	165.1550	99.39893	0.098539	0.210128	0.128545	0.005949	0.157905
6	181.1823	99.38184	0.101998	0.213217	0.128862	0.009791	0.164296
7	195.7278	99.37149	0.105246	0.213743	0.126543	0.014540	0.168436
8	209.0992	99.36465	0.108371	0.212843	0.122747	0.020164	0.171227
9	221.5101	99.35957	0.111397	0.211117	0.118116	0.026633	0.173164
10	233.1150	99.35526	0.114336	0.208910	0.113034	0.033914	0.174546

Variance Decomposition of BSE 200

Period	S.E.	BSE100	BSE200	BSE Sensex	BSE500	MIDCAP	SMALL CAP
1	27.32316	99.74818	0.251819	0.000000	0.000000	0.000000	0.000000
2	40.23930	99.57000	0.128694	0.122520	0.062941	5.64E-05	0.115790
3	50.42009	99.48285	0.098630	0.157947	0.099924	0.001203	0.159444
4	58.83286	99.44349	0.083262	0.171688	0.115078	0.003453	0.183034
5	66.13466	99.42750	0.073815	0.175899	0.120580	0.006895	0.195311
6	72.63987	99.42221	0.066914	0.176061	0.121309	0.011485	0.202024
7	78.54390	99.42212	0.061482	0.174173	0.119482	0.017183	0.205556
8	83.97253	99.42444	0.056991	0.171221	0.116203	0.023945	0.207200
9	89.01284	99.42764	0.053163	0.167717	0.112084	0.031727	0.207666
10	93.72775	99.43087	0.049831	0.163949	0.107492	0.040485	0.207377

Variance Decomposition of BSE 200

Period	S.E.	BSE100	BSE200	BSE Sensex	BSE500	MIDCAP	SMALL CAP
1	27.32316	99.74818	0.251819	0.000000	0.000000	0.000000	0.000000
2	40.23930	99.57000	0.128694	0.122520	0.062941	5.64E-05	0.115790
3	50.42009	99.48285	0.098630	0.157947	0.099924	0.001203	0.159444
4	58.83286	99.44349	0.083262	0.171688	0.115078	0.003453	0.183034
5	66.13466	99.42750	0.073815	0.175899	0.120580	0.006895	0.195311
6	72.63987	99.42221	0.066914	0.176061	0.121309	0.011485	0.202024
7	78.54390	99.42212	0.061482	0.174173	0.119482	0.017183	0.205556
8	83.97253	99.42444	0.056991	0.171221	0.116203	0.023945	0.207200
9	89.01284	99.42764	0.053163	0.167717	0.112084	0.031727	0.207666
10	93.72775	99.43087	0.049831	0.163949	0.107492	0.040485	0.207377

Variance Decomposition of BSE Sensex							
Period	**S.E.**	**BSE100**	**BSE200**	**BSE Sensex**	**BSE500**	**MIDCAP**	**SMALL_CAP**
1	232.5767	98.43736	0.598653	0.963985	0.000000	0.000000	0.000000
2	338.6974	97.17430	1.047455	1.630840	0.084705	0.000249	0.062454
3	419.7765	96.81159	1.152390	1.827485	0.127409	0.001562	0.079564
4	486.4882	96.64503	1.208347	1.911380	0.142897	0.003618	0.088732
5	544.3856	96.56480	1.239839	1.947469	0.147118	0.006460	0.094311
6	596.0134	96.52270	1.260976	1.961819	0.146026	0.010055	0.098424
7	642.8947	96.50113	1.276197	1.964364	0.142198	0.014387	0.101720
8	686.0060	96.49130	1.287782	1.960047	0.136898	0.019434	0.104540
9	726.0249	96.48851	1.296905	1.951518	0.130821	0.025176	0.107069
10	763.4437	96.49000	1.304267	1.940335	0.124385	0.031592	0.109417

Variance Decomposition of BSE 500							
Period	**S.E.**	**BSE100**	**BSE200**	**BSE Sensex**	**BSE500**	**MIDCAP**	**SMALLCAP**
1	83.49352	99.28473	0.645135	0.001661	0.068474	0.000000	0.000000
2	123.7285	99.13034	0.439625	0.089794	0.220288	3.88E-05	0.119918
3	155.7041	99.02124	0.403230	0.113416	0.293139	0.001171	0.167804
4	182.1791	98.97442	0.382799	0.121545	0.323970	0.003527	0.193741
5	205.1570	98.95772	0.368768	0.122854	0.336673	0.007214	0.206773
6	225.6199	98.95587	0.356894	0.121379	0.340385	0.012189	0.213283
7	244.1859	98.96147	0.346331	0.118573	0.339146	0.018407	0.216068
8	261.2543	98.97076	0.336667	0.115144	0.334957	0.025813	0.216656
9	277.1014	98.98168	0.327707	0.111452	0.328917	0.034354	0.215892
10	291.9265	98.99304	0.319329	0.107696	0.321680	0.043980	0.214277

Variance Decomposition of MIDCAP							
Period	**S.E.**	**BSE100**	**BSE200**	**BSE Sensex**	**BSE500**	**MIDCAP**	**SMALL_CAP**
1	9.216020	0.026134	6.45E-08	0.079640	0.103885	99.79034	0.000000
2	75.46779	77.52639	17.82995	0.269941	1.440568	2.931367	0.001790
3	116.8896	79.49580	16.75288	0.169538	1.574716	1.813287	0.193787
4	151.7144	80.56332	16.00122	0.145861	1.619737	1.376213	0.293651
5	180.7924	81.26276	15.46495	0.141541	1.644192	1.144889	0.341675
6	205.9556	81.78647	15.05909	0.146807	1.658346	0.992176	0.357112
7	228.2754	82.21236	14.72866	0.157150	1.666793	0.878942	0.356095
8	248.4702	82.57801	14.44450	0.170572	1.671539	0.788789	0.346581
9	267.0086	82.90296	14.19071	0.185948	1.673683	0.713919	0.332785
10	284.2124	83.19812	13.95835	0.202600	1.673850	0.650122	0.316957

Variance Decomposition of SMALL CAP							
Period	S.E.	BSE100	BSE200	BSE Sensex	BSE500	MIDCAP	SMALL_CAP
1	88.37690	64.70259	21.59104	0.023105	7.791196	0.008144	5.883926
2	142.0762	66.34882	22.19963	0.009903	7.385476	0.010825	4.045344
3	187.7836	67.90416	21.96886	0.008124	6.967298	0.008407	3.143149
4	226.2697	68.96845	21.61292	0.008331	6.716909	0.006026	2.687362
5	259.5839	69.70627	21.28348	0.009763	6.551376	0.004675	2.444442
6	289.0979	70.24618	20.99479	0.012047	6.430584	0.004649	2.311751
7	315.7684	70.66648	20.73773	0.014994	6.333933	0.005990	2.240865
8	340.2325	71.01099	20.50338	0.018447	6.251318	0.008657	2.207207
9	362.9277	71.30461	20.28571	0.022280	6.177374	0.012580	2.197441
10	384.1648	71.56209	20.08090	0.026395	6.109077	0.017681	2.203850

also help investors in calculative analysis for forecasting of influencing returns between series, and aid in the selection of series fit for investment at BSE.

Based on the Johansen, Granger and VAR models, this study found that although there existed a mutual static relationship among the six BSE indices considered, significant pair-wise relationships were also present among these indices which proved the existence of mutual or reciprocal associations amongst them. Further, it was observed that an estimation of future or projected returns from the considered series with respect to their mutual relationships was of great importance as it could lead to determination of inter-linkages between selected indices. Thus, the insight that this article provides into the static and pair-wise relationships among the six BSE indices considered along with the direction of their expected future movement, would help practitioners and investors anticipate future trends and capture investment opportunities.

An examination of the six BSE indices and their mutual relationship indicates that diversification is an effective strategy to minimize risk and maximize gains in the long run. In other words, investors would do well to spread their investments across the six indices to get maximum returns with lowest risk. However, before investing, it is critical for investors to have a good understanding of technical and fundamental aspects of stocks and the way the stock market functions.

Limitations of the Study and Scope for Further Research

Although the research manuscript is well designed and explained but collected daily observations of selected indices are from past 6 years, which is a narrow range for drawing the conclusion. This study also stands to contribute towards giving regress, principled, and more importantly, predicative frameworks of how stock indices of BSE perform. Through indices mutual relationship or index Cointegration the risk and return analysis can be made particular for index, sector and company by the investors and society.

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