Market Sentiment Dynamics and Return Volatility in the Indian Equity Market

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Abstract

In this study, we constructed a composite index of irrational market sentiment to ascertain the impact of market sentiment upon return volatility in the Indian equity market using monthly data spanning the time period from April 2007 to January 2015 of four major indices of Bombay Stock Exchange such as : BSE Sensex, BSE 500, BSE Mid-cap, BSE Small-cap. The *Sentindex* significantly portrayed the fluctuations in accordance with the events that took place in the market during the period of analysis, and at the same time, its movements were found to be uncorrelated with that of economic fundamentals. Though the graphical analysis showed indications of higher fluctuations in returns in times of pessimistic sentiments and moderate and calm period of volatility regimes with moderate positive sentiment in the market, from further investigation, we observed that the effect of sentiment was significant only in case of the volatilities in medium and small cap portfolio returns. On examination of temporal dependency, based on ARDL modeling, we noticed significant long-term relationship between return volatility and irrational sentiments in case of such portfolios. An initial shock in the sentiment component was found to create varying magnitude of responses in volatility over the months and was observed to be disappearing after four to five months. These observations necessitate the incorporation of sentiment factors in the pricing models of assets as well as in risk estimation, especially in case of those stocks with the characteristics that are sensitive to market sentiment. Along with this, in order to pinpoint the causes of the persistence of sentiment effects, further investigations on : the nature and trading behavior of investors who participate in such market segments, level of trading and fund flows, sophistication of trading mechanism, and effectiveness of policy level initiatives to eliminate market inefficiency in these segments is recommended.

Key words: **behavioral bias, market sentiment, return volatility, temporal dynamics, ARDL modeling, impulse response**

JEL Classification : G00, G020, G10, G12, G14

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Theoretically, marketization of assets through stock exchanges are expected to provide efficient distribution of the scarce capital across profitable investment ventures, and easy entry and exit for investors compared to that provided by any regulated non-market based credit distribution systems. The market relies on price mechanism to attain these goals. Therefore, the efficiency of the price discovery process of the respective markets plays a crucial role in the allocation of funds, which would have a far-reaching impact upon the economy as a whole. The efficient market hypothesis postulated that the prices discovered in the market will be informationally efficient as the markets would discount all future expectations based upon current information efficiently into current prices and ,therefore, the variations in prices determined between different points of time would follow the martingale process, giving no room for its more profitable prediction, given the available information. The arguments of the efficient market hypothesis have been challenged and have been vastly dealt

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within the finance literature, based on the stylized facts observed in the price formation process across the markets and time (Cowles, 1960 ; Jegadeesh & Titman, 1993 ; Kross & Schroeder, 1984 ; Lakonishok, Shleifer, & Vishny , 1994 ; Mulligan & Banerjee, 2008 ; Pontiff & Woodgate, 2008 ; Sensoy, 2013 ; Titman, Wei, & Xie, 2004 ; Taylor, 1982; Wang, Liu, & Gu, 2009). Though the efficient market hypothesis remains elusive, these empirical observations have opened space for various explanations; fads (Shiller, 1984), overreaction (DeBondt & Thaler, 1985), noise trading (Black, 1986), time varying expected returns and risk perceptions (Kleidon, 1986), and so forth, and the study of the markets from these angles.

In the context of the Indian market, there are several studies, which have reported dependencies and non-normalities in the return distributions (Claessens, Dasgupta, & Glen, 1995; Debabrata & Nityananda, 2007 ; Kumar, 2007 ; Poshakwala & Theobald, 2004 ; Pan & Sinha, 2007; Ryaly, Kumar, Urlankula, 2014 ; Zaremba & Konieczka, 2014), raising concern about the pricing efficiency in this market. Together with this, the movement of stock market indices as well as changes in the economic fundamentals over the last 5 years is notable. The overall performance and pace of growth of the economy during this period was slower and bleak. On the contrary, the major market indices in India have displayed wide variation in their movements over the same period. S&P BSE Sensex and Nifty touched their lowest 15454 points and 4624 points, respectively on December 26, 2011 and mounted the highest 30024.74 points and 9119.2 points, respectively on March 4, 2015. Even in the 1 year period between 2014 and 2015, the lowest point recorded of Sensex was 22481.62 on April 7, 2014 ; while that of Nifty was 6638.55 on May 8, 2014. Similarly, India VIX index, India's first volatility index, which is a key measure of near term market expectation, touched its highest point of 38.95 on May 9, 2014 ; and touched the lowest point of 9.34 on November 24, 2014 in a short span of time. There was remarkable spurt in other market performance indicators such as market capitalisation, turnover ratio, and number of investor accounts of the Indian stock market between 2014 and 2015.

At the same time, the annual profit growth of Indian companies was the worst in Q3 of 2014-15, compared to that in the previous five quarters. The aggregate net profit of 2941 companies declined 16.9% in Q3 of 2014. The profit margin of companies in sectors such as : FMCG, metals, capital goods, infrastructure, automobiles, oil, pharmaceutics were all on a declining trend. The Sensex companies reported 6.5% decline of profit on a year on year basis. On an average, 30% of the Indian corporate sector was limited in its ability to invest in the near future, as they were hurdled by weak profitability and over indebtedness. The percentage of stalled projects in India was around 7% to 8% of GDP consecutively for the last 4 years. The banking sector was also constrained on further lending as their balance sheet deteriorated with non performing assets standing at 12% of the total assets. Indian companies' profit to GDP ratio touched its lowest point of 4.1% by March 31, 2015, much lower than that of developed economies as well as that of other emerging economies. Operating profit margins of BSE 500 companies excluding financial and Oil PSUs fell to 18.18%, lowest in the decade in the financial year of 2014-15 (Government of India, Department of Economic Affairs, 2015).

This paper makes an attempt to examine these observations in the context of the arguments from the behavioural finance literature. As pointed out in the literature, market sentiment, an aggregate of behavioural biases of all the individual investors, can exert an impact on the movement of market returns and volatility. Large level of volatility in the market returns can have detrimental effects on the decision making of risk-averse investors, capital investment, consumption, and other business cycle variables. Therefore, specifically, an examination of the dynamics of market sentiment on the return volatility formations in the Indian market is carried in two dimensions; the response of broad market return volatility to irrational component of the market sentiment; and its variations across size based portfolio return volatility.

Brief Survey of Literature

(1) Market Sentiment - Evolution and Persistence : Market sentiment is an outcome of the heuristic behaviour

based decision making rather than Bayesian rationality based investment decisions of market participants. The biased investment decisions of individual investors evolve as a force that deviate stock prices away from their fundamental values. Keynes described financial instability, particularly in stock markets, as the outcome of the sociological and psychological forces that dominate and influence investors' decisions. In uncertain times, investors are prone to follow the crowd and their actions are reflected in the market as the waves of optimism and pessimism (Keynes 1930, 1936, 1937 as cited in Baddeley, 2010).

The experimental studies in market psychology and investors' behavioural biases (Simon, 1959, 1978 ; Tversky & Kahneman, 1973, 1974 ; Kahneman & Tversky, 1979, 1983) have also corroborated these arguments. Pound and Shiller (1987) and Shiller (2000) highlighted the indications of contagion of investors' naïve trading decisions through word of mouth and the role of social, political, cultural, and psychological factors acting through mechanism of the *ponzi process*, with an inbuilt force in it, in generating similar thinking in large diverse groups of investors. These factors, altogether, lead to irrational decisions among all types of market participants, causing unsustainable price movements in the stock market.

Black (1986) ; De Long, Shleifer, Summers, and Waldmann (1990) ; Barberis, Shleifer, and Vishny (1998) ; Daniel, Hirshleifer, and Subrahmanyam (1998) ; and Abreu and Brunnermeier (2003) also pointed out various factors such as the level of information dissemination, uncertainty about the subsequent move of uninformed traders' demand and their size of trading, cross sectional characteristics of stocks, arbitrage limits in the market, constraints on the position that can be assumed by the arbitrageurs, and synchronization problem of arbitrageurs, which ground to sustain the force of market sentiment, especially in informationally and structurally inefficient markets.

(2) Market Sentiment and Stock Return Volatility : De Long, Shleifer, Summers, and Waldmann (1990) and De, Gondhi, and Sarkar (2011) argued that the presence of noise traders in the market leads markets to price noise-risk since the uncertainty about the next generation noise trader's expectations limits betting on mispricing. This can foster volatility in the returns of those securities that are affected by noise-risk, and this, in turn, affects their returns, depending on the relative market share of both informed traders and noise traders in such securities. Verma and Verma (2007), by segregating the sentiment into rational and irrational components, examined the relative effect of these components on the formation of conditional volatility in the market. The study observed significant negative effect of investor sentiment on stock return volatility ; whereas, it was found to be positive in case of stock returns. The rational component was found to have higher positive effect on stock return than the irrational component, and in case of volatility, only the irrational component evinced a significant effect, which was negative.

Neal and Wheatley (1998); Lee, Jiang, and Indro (2002) ; Bandopadhyaya and Jones (2006); Baker and Wurgler (2006); Kumar (2009); Zhang, Deng, and Yang (2010); Uygur and Tas (2014); Huang, Jiang, Tu, and Zhou (2014); Lutz (2015); Corredor, Ferrer, and Santamaria (2015); Seo and Kim (2015); Smales (2015); Chen and Vincent (2016); Shi, Liu, and Ho (2016); Yang, Jhang, and Chang (2016) ; Bathia, Bredin, and Nitzsche (2016), and so forth dealt with the empirical examination of the relationship between market sentiment, market return, and volatility. The relationship between market sentiment and market returns was found to be in different direction between current and future periods. A positive (negative) relationship was observed between current market sentiment and market returns (return volatility), while the relationship was found to be negative in case of current market sentiment and future market returns.

Lee et al. (2002) observed that the magnitude of bullish (bearish) changes in sentiment lead to downward (upward) revision in conditional volatility. Uygur and Tas (2014) noted that earning shocks have stronger influence on return volatility at times of higher market sentiment in their investigation of sentiment and conditional volatility relationship in various markets. Further, Smales (2015) reported of asymmetric impact of market sentiment on the gold future volatility. Seo and Kim (2015) and Yang, Jhang, and Chang (2016) suggested

of incorporating market sentiment factor respectively in the option implied information based volatility forecasting and in realized volatility forecasting on the basis of empirical evidences.

(3) Research Observations from the Indian Stock Market : The prevalence of behavioural biases of Indian investors in investment decision making has been reported in several studies. De et al. (2011) observed that individual investors displayed higher disposition effect and faced greater wealth loss as compared to that of institutional investors, while non-financial corporations evinced a higher degree of over confidence. Similarly, prudence, precautionary attitude, and information asymmetry were also found to be playing a significant role in individual investors' behaviour in the Indian market (Chandra & Kumar, 2012). On the market sentiment and stock price relationship, Dash and Mahakud (2012) reported of strong long run and short run relationship and a unidirectional causality, that is, market sentiment granger causing stock price formations. Chandra and Thenmozhi (2013) noted that higher levels of investor sentiment introduced more correlated trading behaviour, which, in turn, resulted in stronger return co-movements in the Indian market. Zygaldo, Szpulak, and Szyszka (2014) also observed high sensitivity of excess returns to changes in the investor moods during periods of negative sentiment in the Indian market in their examination based on Thomson Reuters Marketpsych index.

The impact of market sentiment on market returns was found to be asymmetric across stock returns categorized based on size, profitability, dividend payment (Gupta, 2015; George & Suresh, 2015). Market sentiment is found to have a significant effect on return volatility as well. Aggarwal (2012) found a strong positive relationship between investor sentiment and transitory volatility. Further, the study noted an improvement in liquidity in the future market in periods of bullish sentiments and a decline in order flow persistence once the feedback trading was controlled. Kumari and Mahakud (2015), based on irrational aggregate sentiment index, also examined the sentiment-return volatility relationship in the Indian market. The study observed a significant role of negative investor sentiment on the return volatility. The volatility in the Indian market also evinced signs of clustering, high persistence, and asymmetries in the response to the arrival of negative and positive shocks (Nalina & Shivaraj 2014; Suman & Chahal, 2013).

(4) Significance of the Study : The Indian economy has been experiencing a high level of transformation in all its realms over the last two decades. At the same time, the sentiment persistent factors such as : arbitrage limits, synchronization problem of arbitrageurs, increasing heterogeneity in investor base, disproportionate information accessibility and distribution, and higher role of intermediaries are prevalent in the market. Therefore, an examination of the role of sentiment in driving the market indicators is of high relevance. Most of the studies in behavioural finance that have been carried out on the Indian market have identified Indian investors being influenced by various psychological factors.

Since, overall, market performance is the outcome of all these micro-factors, an analysis of their impact on market indicators, especially on return volatility, with an aggregate measure of market sentiment is essential as it can shed light on the dynamics involved that would help proper investment decision making of stakeholders from various quarters. The aggregation of market sentiment, being an unobservable variable, is a troublesome task. Unlike the previous studies in the Indian market, we have considered the net buy - sell position of each investor segment from the Indian stock market separately, as their aggregation can lead to loss of information, along with other variables. This study relied on principal component analysis technique to filter the influence of rational factors on sentiment variables to derive irrational sentiment component and also to avoid the information loss and other modelling problems associated with other regression based elimination. Impulse response analysis and auto regressive distributed lag regression model (ARDL) were applied to examine the temporal dependence between the variables under study.

Data and Methodology

The study was carried out on monthly data for the period from April 2007 to January 2015. We constructed a composite index of market sentiment using proxies such as net of buy-sell of each investor category, advance - decline ratio, market trade volume, IPO index, new equity issues, price-earnings ratio, and price - book ratio in the construction of the sentiment index. Apart from this, data on average call money rate, industrial production index, foreign trade balance, fiscal deficit, and wholesale price index were also used in the study. Volatility in returns was calculated for selected indices of BSE such as : Sensex, BSE 500, BSE mid-cap, and BSE small-cap. All the required data were retrieved from a database of Bombay Stock Exchange (BSE) and Reserve Bank of India (RBI).

↳ **A Brief Account of Construction of the Sentiment Index :** Though no measure of sentiment can be a completely comprehensive one, the most widely accepted and applied aggregate measure of sentiment index is of Baker and Wurglur's (2007) composite market sentiment index. They constructed a composite sentiment index applying the principal component analysis on the standardized values of the selected proxies of investor sentiment after adjusting for the impact of economic fundamentals such as industrial production index, growth in consumer durables, non - durables and services, and NBER recession information. The first principal component was used for index construction.

On similar lines, Dash and Mahakud (2012) also used data on turnover volatility ratio, share turnover velocity, advance decline ratio, change in margin borrowing, buy-sell imbalance ratio, put-call ratio, number of IPOs, equity issue in total issue, dividend premium, fund flow and cash to total assets in the mutual fund market, and price-to-earnings high-low difference, and so forth to construct the sentiment index. We followed partially the method of Baker and Wurglur (2007) and Dash and Mahakud (2012). The sentiment proxies such as net of buy-sell in different investor accounts such as : client, non - resident Indians, foreign institutional investors, domestic institutional investors and proprietary accounts; advance decline ratio, market trade volume, IPO index, new equity issues, price-earnings ratio, and price - book ratio were used to construct the composite sentiment index. The principal factors were derived from the *Z*-standardized vector of this data. The first five factors were considered as their Eigen-values were found to be above one, which all together explained 76.4% of the variability in the vector of sentiment measures.

Since influence of economic fundamentals were not eliminated in the first stage, we examined the correlation coefficient of the first five components with the standardized fundamental economic variables such as : average call money rate, industrial production index, foreign trade balance, fiscal deficit, and whole sale price index. Since each principal component is linearly uncorrelated, we assumed that the component that has insignificant correlation with economic variables and higher level of correlation with sentiment proxies should hold the irrational factor component. The Table 1 and Table 2 present the correlation coefficients of respective components

Table 1. Correlation Between Principal Components and Economic Fundamentals

Economic Variables	*PC 1*	*PC 2*	*PC 3*	*PC 4*	*PC 5*
Call Money Rate#	-0.2475	-0.1265	-0.3666	-0.0867	-0.2156
Whole Sale Price Index#	-0.4387	-0.0439	-0.2531	-0.3847	-0.4718
Index of Industrial Prod#.	-0.3366	0.0337	-0.1231	-0.2602	-0.3317
Trade Balance#	0.2070	0.1578	0.3636	0.1095	0.3042
Fiscal Deficit#	-0.3946	-0.1146	-0.2011	0.2999	-0.2013

#All the variables are *Z*-standardized.

Data sources : RBI and BSE. Values given are calculated by the Authors

Table 2. Correlation Between Principal Components and Sentiment Proxy Variables

Sentiment Proxy Variables	*PC 1*	*PC 2*	*PC 3*	*PC 4*	*PC 5*
Clients#*	0.1605	-0.5307	-0.1878	0.5152	0.1376
Non Resident Indians#*	0.3065	-0.5359	0.3844	0.3503	0.0026
Proprietors#*	0.0351	0.0137	0.1745	-0.3874	-0.0219
Foreign Institutional Investors#*	0.4665	-0.3233	0.2784	0.4478	0.0320
Domestic Institutional Investors#*	0.4139	-0.1892	0.1681	0.7733	0.2129
Initial Public Offers Index#	0.4162	0.5457	0.2419	-0.0446	0.7449
Advance Decline Ratio#	0.2728	0.4589	-0.2042	0.0871	0.0344
Market Trade Volume#	0.2879	0.6313	0.2791	0.1280	0.4721
New Equity Issues#	0.4930	0.3566	0.3265	0.0119	0.4849
Price Earnings Ratio#	0.3251	0.5804	0.4432	-0.2018	0.8484
Price-Book Ratio#	0.4874	0.3243	0.2550	-0.0579	0.8651

All the variables are Z-standardized values

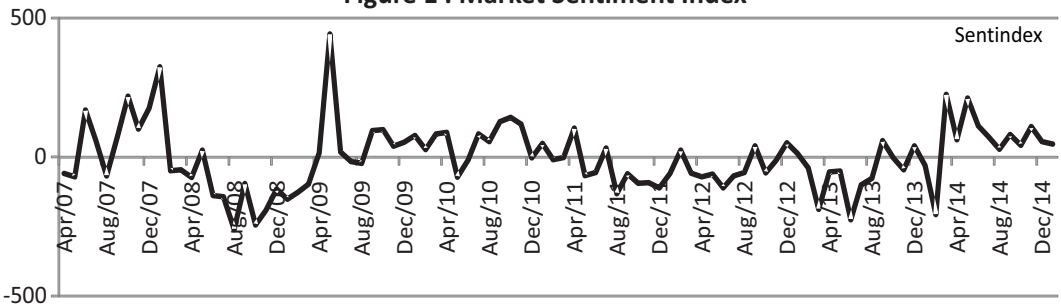
* Standardized values of Net buy-sell of respective accounts

Data sources : RBI and BSE. Values given are calculated by the Authors

with fundamental economic variables and sentiment proxy variables considered in this analysis. It can be observed from the Table 1 that the second principle component *(PC2)* has insignificant correlation to the standardized values of economic fundamental variables compared to other principal components. All the other four components maintained higher correlation with the economic variables. This indicates lower levels of association of second principal component with economic fundamentals.

In the Table 2, the correlations between principal components and sentiment proxy variables are presented. Here also, the second principal component *(PC2)* evinced high correlation with the sentiment proxy variables compared to other components. Broadly, this component was less correlated with net trading position of institutional investors such as : FIIs, DIIs, and proprietors as they are characterized as rational traders in the literature. The other variables like total trade volume, advance-decline ratio, IPO index, price-earnings ratio, and net trading through client accounts and non-resident Indian accounts were highly correlated with the second principal component. We assumed that since the principal component analysis, by definition, transforms the original variables into a set of linearly uncorrelated principal components, the common residual variance explained by the second component *(PC2)* would be unique. Its insignificant correlation coefficients with macro economic variables and higher level of correlation with sentiment proxy variables compared to that of other principal components makes us to conclude that the second principal component explained the irrational

Figure 1 . Market Sentiment Index



Data sources : RBI and BSE. Values given are calculated by the Authors

sentiment induced variation in the original data set. Therefore, based on this statistical evidence, we considered the second principal component as our measure of market sentiment *(Sentindex)*.The equation 1 presents the sentiment proxy variables together with their respective factor loadings as coefficients in the *Sentindex* equation.

$$Sentindex_t = -0.409\ Clnstd_t - 0.287\ NRIstd_t - 0.357 * Prostd_t - 0.159 * FIIsstd_t - 0.176 * DIIsstd_t + 0.14 * IPOstd_t + 0.280 * ADstd_t + 0.361 * TVstd_t + 0.328 * NewIssuestd_t + 0.307 * Pestd_t - 0.185 * Pbstd_t * \quad (1)$$

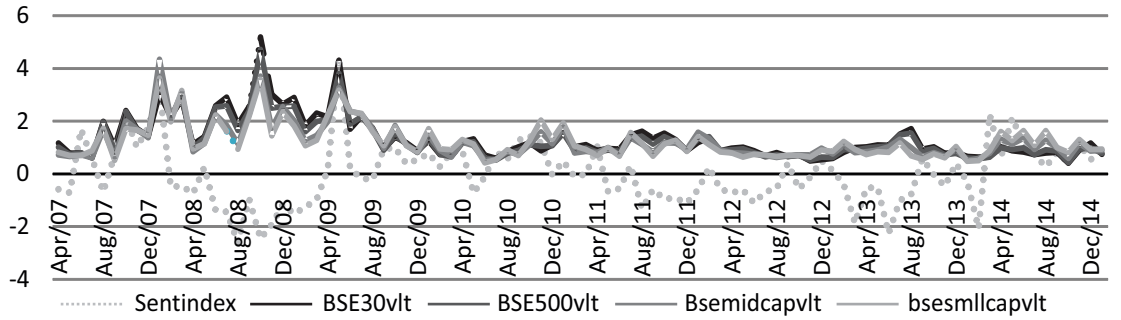
The Figure 1 portrays the movement of *Sentindex* constructed based on equation (1) from April 2007 to January 2015. The *Sentindex* records positive upward momentum in the market sentiment in periods such as : April 2007 - January 2008, April 2009-May 2011, and February 2014 - January 2015. The other periods were stained with pessimism in the market. The year 2008 witnessed Union Government's uncertainty and serial blasts in Bangalore, market fear and onset of U.S. rescue plan for the global financial crisis (July 2008), Mumbai terror attack (November 2008), last term of 1st UPA rule, and reversal of FII inflows. The market experienced loss of retail investor confidence in the years that followed ; the ratio of retail investment turnover to total turnover touched its decadal lowest points in 2013. It is only by 2014 that retail investment showed signs of return to the market. The sentiment index well captures quite a long period of pessimism that the market went through from Q2 of 2011 to February 2014. The spurt in the market expectations with the new Union Government by May 2014 is also well portrayed in its movements.

Empirical Analysis

(1) Return Volatility and Market Sentiment : In this section, we examine the relationship between the market sentiment and return volatility of indices of BSE such as; Sensex, BSE 500 index, BSE mid-cap index, and BSE small-cap index. The return volatility is calculated by taking the standard deviation of the daily returns for the respective months. The graphical presentation of return volatility and *Sentindex* is shown in the Figure 2.

In the Figure 2, the dotted line represents the movement of sentiment index, while solid lines portray return volatility of indices considered for analysis. We observed different cluster formation in the return deviations over the period. The market experienced higher levels of fluctuations from April 2007 and touched its peak by October 2008, followed by a moderation and downward revision till July 2010. Another period of wider fluctuations lasted up to March 2012, followed by a calm period up to May 2013. The markets resumed another cluster of wider deviations from March 2014. A cross-examination of movements in sentiment index and return volatility reveals the following visual indications :

Figure 2. Return Volatility and Market Sentiment



Data sources : RBI and BSE. Values given are calculated by the Authors

(i) Higher level of fluctuation in volatility is observed when market sentiment is negative or when the market is highly pessimistic.

(ii) Moderate positive sentiment in the market is coupled with a moderate and calm period of volatility regime.

(iii) The magnitude and direction of change in market sentiment seems to have a lagged effect upon the movements of return volatility.

(2) Temporal Dynamics Between Market Sentiment and Return Volatility - ARDL Modeling and Bound Testing : In this section, we examined the temporal dynamics between the variables. On examination of stationarity based on the Augmented Dickey Fuller test, it is found that the return volatility data follows the first difference stationary process *I*(1), while *Sentindex* data follows *I*(0). Therefore, to examine the long term relationship between the variables, auto regressive distributed lag regression model (ARDL) and bound testing methodology was adopted in this analysis. The following section briefs the procedure followed in this method of analysis (Giles, 2013).

We carried out the analysis on all the four indices separately, and the lag structure for each case was selected based on the AIC criterion. The conditional error correction (Conditional ECM) equations specified for bound testing are :

$$\Delta BSE30vlt_t = \alpha_0 + \alpha_1 \Delta BSE30vlt_{t-1} + \alpha_2 \Delta BSE30vlt_{t-2} + \alpha_3 \Delta Sentindex_{t-1} + \alpha_4 \Delta Sentindex_{t-2} + \beta_1 BSE30vlt_{t-1} + \beta_2 Sentindex_{t-1} + \varepsilon_t \quad (2)$$

$$\Delta BSE500vlt_t = \alpha_0 + \alpha_1 \Delta BSE500vlt_{t-1} + \alpha_2 \Delta BSE500vlt_{t-2} + \alpha_3 \Delta Sentindex_{t-1} + \alpha_4 \Delta Sentindex_{t-2} + \beta_1 BSE500vlt_{t-1} + \beta_2 Sentindex_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta BSEmidcapvlt_t = \alpha_0 + \alpha_1 BSEmidcapvlt_{t-1} + \alpha_2 \Delta Sentindex_{t-1} + \beta_1 BSEmidcapvlt_{t-1} + \beta_2 Sentindex_{t-1} + \varepsilon_t \quad (4)$$

$$\Delta BSEsmllcapvlt_t = \alpha_0 + \alpha_1 \Delta BSEsmllcapvlt_{t-1} + \alpha_2 \Delta Sentindex_{t-1} + \beta_1 BSEsmllcapvlt_{t-1} + \beta 2 Sentindex_{t-1} + \varepsilon_t \quad (5)$$

Table 3. Bound Test- BSE Sensex Volatility and *Sentindex*

$\Delta BSE30vlt_t = \alpha_0 + \alpha_1 \Delta BSE30vlt_{t-1} + \alpha_2 \Delta BSE30vlt_{t-2} + \alpha_3 \Delta Sentindex_{t-1} + \alpha_4 \Delta Sentindex_{t-2} + \beta_1 BSE30vlt_{t-1} + \beta_2 Sentindex_{t-1} + \varepsilon_t$

	α_0	α_1	α_2	α_3	α_4	β_1 #	β_2
Coefficient	0.002	-0.45	-0.23	0.0073	0.0051	-0.217	-7E-04
Prob.	0.041	0.003	0.036	0.325	0.414	0.022	0.323

R-sq. 0.323 Adj. R-sq. 0.275 **Wald Test: Null Hyps:** $\beta_1 = \beta_2 = 0$

Breusch-Godfrey Serial Correlation LM Test:				Test Stat.	Value	*df*	Pro.
F-stat.	0.543	Prob. F(2,82).	0.583	*F*-stat	2.766*	2,84	0.068
Obs. *R*-sq	1.191	Pro. Chi-Sq.(2).	0.551	Chi-sq	5.532	2	0.062

Bound Test Result	**Level of Signi.**	**Lower Bound**	**Upper Bound**	***F*-stat**
Pesaran Critical Value Bounds	5%	4.94*	5.73	2.76*
(Unrestricted intercept and no trend)	10%	4.04	4.78	

N.B: *BSE*30*vlt*$_t$ stand for the return volatility in BSE Sensex index.

* The *F* stat. value is lower than the lower bound Pesaran Critical Value at the 5% level of significance. It indicates no co-integration (long run relationship) between return volatility and market sentiment movement.

The *t* stat. ofβ_1 , (-2.31), is below lower bound *t* value even at the 10% level of significance (-2.57), corroborating the acceptance of no co-integration

Data sources : RBI and BSE. Values given are calculated by the Authors

Table 4. Bound Test - BSE 500 Index Volatility and *Sentindex*

$\Delta BSE500vlt_t = \alpha_0 + \alpha_1 \Delta BSE500vlt_{t-1} + \alpha_2 \Delta BSE500vlt_{t-2} + \alpha_3 \Delta Sentindex_{t-1} + \alpha_4 \Delta Sentindex_{t-2} + \beta_1 BSE500vlt_{t-1} + \beta_2 Sentindex_{t-1} + \varepsilon_t^*$

	α_0	α_1	α_2	α_3	α_4	$\beta_1^{\#}$	β_2
Coefficient	0.00282	-0.49	-0.2178	0.0086	0.00584	-0.219	-0.0036
Prob.	0.047	0.000	0.055	0.235	0.341	0.026	0.596

R-sq. 0.3439 Adj. R-sq. 0.297 **Wald Test: Null Hyps:** $\beta_1 = \beta_2 = 0$

Breusch-Godfrey Serial Correlation LM Test:				Test Stat.	Value	df	Pro.
F-stat.	0.244	Prob. F (2, 82).	0.783	F-stat	2.544	2,84	0.084
Obs. *R*-sq	0.540	Pro. Chi-Sq. (2).	0.763	Chi-sq	5.080	2	0.078

Bound Test Result	**Level of Signi.**	**Lower Bound**	**Upper Bound**	***F*-stat**
Pesaran Critical Value Bounds	5%	4.94*	5.73	2.544*
(Unrestricted intercept and no trend)	10%	4.04	4.78	

N.B: $BSE500vlt_t$ stand for the return volatility in BSE 500 index.

* The *F* stat. value is lower than the lower bound Pesaran Critical Value at the 5% level of significance. It indicates no co-integration (long run relationship) between return volatility and market sentiment movement.

The *t* stat. of β_1, (-2.25), is below lower bound *t* value even at the 10% level of significance (-2.57), corroborating the acceptance of no co-integration.

Data sources : RBI and BSE. Values given are calculated by the Authors

The serial correlations in residual terms of all these specifications were examined using Breusch-Godfrey Serial Correlation LM test and the dynamic stability of these models were examined based on CUSUM test. We found no evidences of serial correlation as well as structural breaks in any of these specifications over the sample period at the 5% percent level of significance. Since these specifications were dynamically stable, we examined the significance of β_i coefficients of each equation, null hypothesis of $\beta_1 = \beta_2 = 0$, based on Wald test, and the *F* statistic value of each equation were exposed for bound testing to examine if there is a long run association between the respective market index return and the sentiment index. Together with this, the bound *t* - test of $\beta_0 = 0$ is also examined based on Pesaran, Shin, and Smith (2001). *I*(0) and *I*(1) bounds for *t* - statistic were also examined to substantiate the results.

The Tables 3, 4, 5, and 6 present the coefficient estimates and their *p*-values, Breusch-Godfrey serial correlation LM test results, Wald test results of β_i coefficients, and Bound test results, respectively for all the cases based on Pesaran critical value bounds for unrestricted intercept and no trend.

It is observed from the Table 3 that the Wald test *F* stat. value is below the Pesaran lower bound value both at 5% and 10% level of significance. Therefore, as per the guidelines, it indicates the absence of any co-integrating equation (no long run relationship) between these two variables. Though the model is dynamically stable, the sentiment is found to be of no significance in explaining return volatility in BSE Sensex.

As in the case of BSE Sensex, the Bound test result of BSE 500 Index in the Table 4 shows that the *F*- stat. value of the Wald test is lower than the lower bound Pesaran table values both at the 5% and 10% level of significance, indicating the absence of any co-integration between market sentiment and BSE 500 return volatility.

The Table 5 presents the Bound test results of BSE mid-cap return volatility and market sentiment index. The structure of the specification of the model is of lag one as per the AIC criterion. The *F* statistic value of Wald's test is 5.10, which falls within the Pesaran critical value bounds at the 5% level of significance, which makes it difficult to decide on if there is any co-integration between the variables concerned. However, at the 10% level of significance, the *F* statistic value is higher than the Pesaran upper bound table value, indicating a long-run relationship between the return volatility and the market sentiment.

Bound test results of BSE small-cap index volatility and market sentiment is reported in the Table 6. The results show clear evidence of co-integration between these variables as the *F* statistic value 6.529 of β coefficients from

Table 5. Bound Test- BSE Mid-Cap Index Volatility and *Sentindex*

$\Delta BSEmidcapvlt_t = \alpha_0 + \alpha_1 \Delta BSEmidcapvlt_{t-1} + \alpha_2 \Delta Sentindex_{t-1} + \beta_1 BSEmidcapvlt_{t-1} + \beta_2 Sentindex_{t-1} + \varepsilon_t^*$

	α_0	α_1	α_2	$\beta_1^{\#}$	β_2
Coefficient	0.00409	-0.3973	0.00909	-0.3263	0.0029
Prob.	.00049	0.0003	0.1285	0.002	0.6435

R-sq. 0.3715 Adj. *R*-sq. 0.3426 **Wald Test: Null Hyps:** $\beta_1 = \beta_2 = 0$

Breusch-Godfrey Serial Correlation LM Test:				Test Stat.	Value	df	Pro.
F-stat.	2.087	Prob. F(1,86).	0.0.1522	*F*-stat	5.1022	(2, 87)	0.008
Obs**R*-sq	2.1797	Pro. Chi-Sq.(1).	0.1398	Chi-sq	10.205	2	0.006

Bound Test Result[#]	**Level of Signi.**	**Lower Bound**	**Upper Bound**	***F*-stat**
Pesaran Critical Value Bounds	5%	4.94	5.73	5.1022*
(Unrestricted intercept and no trend)	10%	4.04	4.78*	

N.B: $BSEmidcapvlt_t$ stand for the return volatility in BSE Mid Cap index.

* The *F* stat. value is higher than the upper bound Pesaran Critical Value at the 10% level of significance. It leads to the rejection of the null hypothesis of no long run relationship between the variables.

The *t* stat. of β_1 , (-3.17) is above bound *t* value at the 10% level of significance (-2.91), corroborating the rejection of the null hypothesis.

Data sources : RBI and BSE. Values given are calculated by the Authors

Table 6. Bound Test - BSE Small-Cap Index Volatility and *Sentindex*

$\Delta BSEmidcapvlt_t = \alpha_0 + \alpha_1 \Delta BSEsmallcapvlt_{t-1} + \alpha_2 \Delta Sentindex_{t-1} + \beta_1 BSEsmallcapvlt_{t-1} + \beta_2 Sentindex_{t-1} + \varepsilon_t^*$

	α_0	α_1	α_2	$\beta_1^{\#}$	β_2
Coefficient	0.00484	-0.32403	0.00686	-0.38763	0.00596
Prob.	0.0014	0.0029	0.2422	0.0006	0.3394

R-sq. 0.35871 Adj. R-sq. 0.32923 **Wald Test: Null Hyps:** $\beta_1 = \beta_2 = 0$

Breusch-Godfrey Serial Correlation LM Test:				Test Stat.	Value	*df*	Pro.
F-stat.	3.281	Prob. F(1,86).	0.073	*F*-stat	6.529	(2, 87)	0.002
Obs**R*-sq	3.38144	Pro. Chi-Sq.(1).	0.0659	Chi-sq	13.058	2	0.001

Bound Test Result	**Level of Signi.**	**Lower Bound**	**Upper Bound**	***F*-stat**
Pesaran Critical Value Bounds	5%	4.94	5.73*	6.52*
(Unrestricted intercept and no trend)	10%	4.04	4.78	

N.B: $BSEsmllcapvlt_t$ stand for the return volatility in BSE Small Cap index.

* The *F* stat. value is higher than the upper bound Pesaran Critical Value at the 5 % level of significance. It leads to the rejection of the null hypothesis of no long run relationship between the variables.

The *t* stat. of β_1, (-3.58) is above the bound *t* value at the 5% level of significance (-3.22), corroborating the rejection of the null hypothesis.

Data sources : RBI and BSE. Values given are calculated by the Authors

Wald test is higher than the Pesaran critical upper bound values 5.73 and 4.78 both at the 5% and 10% level of significance, respectively.

In cases where long run relationship was identified, we examined the speed of adjustment of the systems to equilibrium from any divergence by introducing the error correction term (ECT) into the equations (4,5) by replacing the lagged values of the variables in their level form. The error correction term is calculated from the residuals from the following equation :

Table 7. Temporal Dynamics Between Market Sentiment and BSE Mid-cap Volatility

$\Delta BSEmidcapvlt_t = \alpha_0 + \alpha_1 \Delta BSEsmallcapvlt_{t-1} + \alpha_2 \Delta Sentindex_{t-1} + \gamma_1^{*} ECT(-1) + \varepsilon_t^{\wedge}$

	α_0	α_1	α_2	γ_1
Coefficient	5.0E-05	-0.395	0.0094#	-0.327*
Prob.	0.9343	0.0002	0.0748	0.0018
R-sq. 0.3714	Adj. R-sq. 0.3500			
Breusch-Godfrey Serial Correlation LM Test :				
F-stat.		2.089	Prob. *F*(1,87).	0.151
Obs**R*-sq 2.157			Pro. Chi-Sq.(1).	0.141

*The coefficient of the error correction term is significant and negative which indicates the monthly speed of adjustment of the model.
# Indicates the short run effect of sentiment upon the BSE Mid Cap Volatility and it is significant at the 10% level of significant.
^ The model is dynamically stable based on CUSUM test (not reported) at the 5% level of significance.
Data sources : RBI and BSE. Values given are calculated by the Authors .

Table 8. Temporal Dynamics Between Market Sentiment and BSE Small-Cap Volatility

$\Delta BSEmidcapvlt_t = \alpha_0 + \alpha_1 \Delta BSEsmallcapvlt_{t-1} + \alpha_2 \Delta Sentindex_{t-1} + \gamma_1 * ECT(-1) + \varepsilon_t^{\wedge}$

	α_0	α_1	α_2	γ_1
Coefficient	0.00052	-0.318	0.008#	-0.389*
Prob.	0.9327	0.0029	0.124	0.0005
R-sq. 0.357	Adj. R-sq. 0.335			
Breusch-Godfrey Serial Correlation LM Test:				
F-stat.		3.3055	Prob. *F*(1,87).	0.0725
Obs**R*-sq		3.3675	Pro. Chi-Sq.(1).	0.0665

*The coefficient of the error correction term is significant and negative which indicates the monthly speed of adjustment of the model.
# Indicates the short run effect of sentiment upon the BSE Small Cap Volatility. We accept the null hypothesis of no relationship as it cannot be rejected even at the 10% level of significance.
^ The model is dynamically stable based on CUSUM test (not reported) at the 5% level of significance.
Data sources : RBI and BSE. Values given are calculated by the Authors

$$ECT = (Y_t - \alpha_0 + \alpha_i X_{it}) \qquad (6)$$

Thus, equations 4 and 5 are modified into the following :

$$\Delta BSEmidcapvlt_t = \alpha_0 + \alpha_1 \Delta BSEmidcapvlt_{t-1} + \alpha_2 \Delta Sentindex_{t-1} + \gamma_1 * ECT(-1) + \varepsilon_t \qquad (7)$$

$$\Delta BSEsmllcapvlt_t = \alpha_0 + \alpha_1 \Delta BSEsmllcapvlt_{t-1} + \alpha_2 \Delta Sentindex_{t-1} + \gamma_1 * ECT(-1) + \varepsilon_t \qquad (8)$$

Here, the γ_i represents the speed of adjustment of the system to the equilibrium, which should take a negative sign. The coefficient α_2 indicates the short run dynamics between the variables in each equation. The Table 7 and Table 8 present the results from the analysis, and both these models are found to be dynamically stable.

The Table 7 reports the results of unrestricted error correction regression run to examine the long run effects of the market sentiment on BSE mid-cap volatility ; 'γ', the coefficient of the error correction term, is significant at the 5% level of significance and the coefficient has a negative sign. The coefficient value is -0.327, indicating that

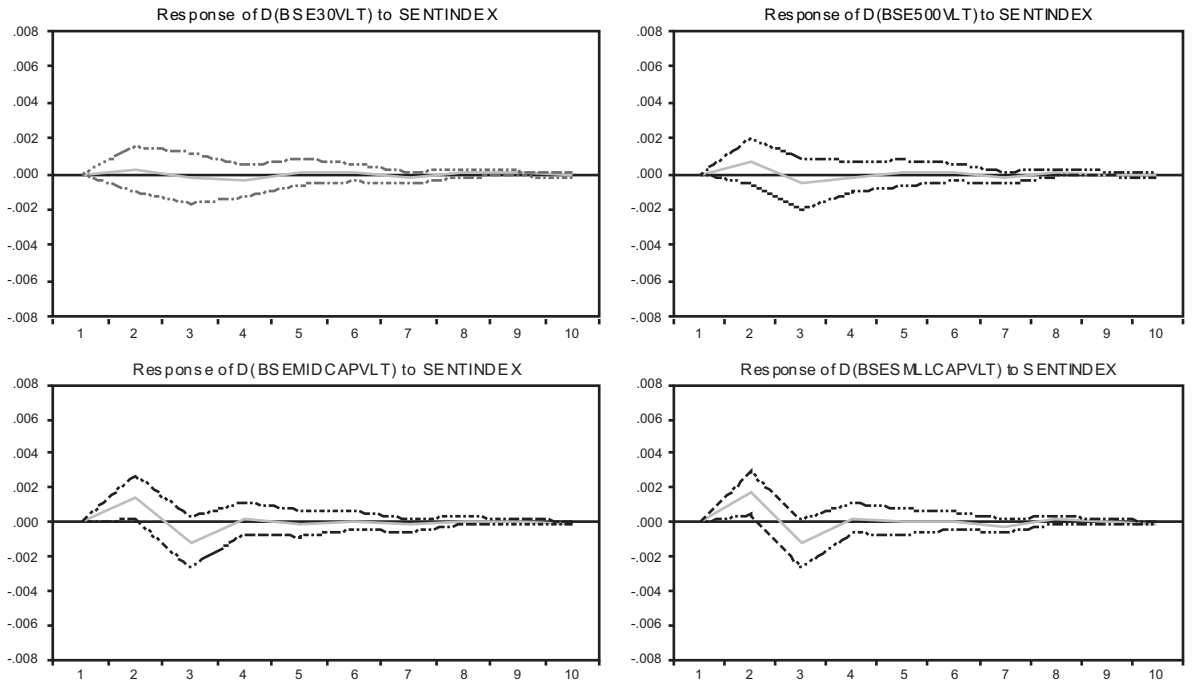
32% of any divergence from the equilibrium is corrected within the one month period. The short run effect of sentiment on volatility is found to be significant at the 10% level of significance. But the magnitude of this impact is very low.

From the results depicted in the Table 8, we observe that 38% of the any disequilibrium between BSE small-cap volatility and market sentiment is corrected within a period of one month ; 'γ' is also significant at the 5% level of significance, and is negative in sign. Unlike in the case of BSE mid cap volatility, the short term effect of market sentiment is found to be insignificant.

(3) The Impulse Response of Return Volatility to Market Sentiment : Impulse response analysis examines the reaction of a dynamic system over a time period to an initial one time exogenous shock or innovation in one of the variables, holding all other shocks in all times constant. The data on the monthly return volatility of the four indices considered in the analysis are non-stationary at the level form, and they are all first order stationary *I*(1) ; while, the sentiment index is stationary at level form *I*(0). Since the volatility data was non- stationary, we transformed them into their first difference form. A VAR system of equations of lag 2, based on AIC criterion, was constructed and examined for the impulse responses of each volatility data to Cholesky-one standard deviation innovation in the Sentindex. The Figure 3 presents the impulse response of return volatility to market sentiment.

The effect of variations in the return volatility to a shock in sentiment index is fluctuating, and the magnitude of response also varies across the portfolios, though the pattern of response is found to be similar. It is observed that the effect is positive in the first two periods, but the monthly difference in return volatility became negative in the later periods. The system is observed to regain its normality in five months of time. The effect of a shock in sentiment is relatively higher in case of BSE small-cap volatility and BSE mid-cap volatility as compared to the other two cases.

Figure 3. Impulse Response of Return Volatility to Sentiment
Response to Cholesky One S.D. Innovations ± 2 S.E.



Data sources : RBI and BSE. Values given are calculated by the Authors .

Research Implications and Scope for Further Research

The *Sentindex* constructed in this analysis significantly portrays the fluctuations in accordance with the events that took place in the market during the period of analysis. The spurts and decline in accordance with events such as government uncertainty and serial blasts in Bangalore, U.S. rescue plan for global financial crisis (July 2008), Mumbai terror attack (November 2008), General elections 2009 (April- May 2009), earthquake in China (April 2010), pessimism in connection with the global financial crisis, Indo- Pak border incidents (January 2013), terror attack in Hyderabad (February 2013), North India flood (June 2013), General elections 2014, and so forth are well captured by the *Sentindex*.

At the same time, the movements of *Sentindex* are found to be unrelated with the movements of economic fundamentals. It is an indication that the index well captures an irrational component of the sentiment in the Indian market. Though the graphical analysis has shown indications of higher fluctuations in return volatility in times of pessimistic sentiments, as reported by Kumari and Mahakud (2015), and a moderate and calm period of volatility regimes with moderate positive sentiment in the market, from further examinations, we observe that the effect of sentiment is significant only in case of volatilities in medium and small cap portfolio returns and are asymmetric as well. Empirical evidences from other markets have also found high probability of naïve trading decisions of investors who are dealing in small, young, unprofitable, and less liquid stocks (Baker & Wurgler, 2006 ; Kumar, 2009 ; Lee et al., 2002 ; Li & Gilbert, 2010). Furthermore, on examination of temporal dependency, based on ARDL modeling, we noticed significant long term relationship between volatility in returns and irrational sentiments in case these portfolios and the speed of market correction was also found to be varying between them. An initial shock in the sentiment component is creating fluctuating responses in similar pattern, but in varying magnitudes across the portfolios over time and the shock effect is found to be disappearing in five months of time in all the cases.

These observations necessitate the incorporation of sentiment factors in the pricing models of assets as well as in risk estimation, especially in case of those stocks with the characteristics that are sensitive to market sentiment. Along with this, in order to pinpoint the causes of the persistence of sentiment effects, further investigations on the nature and trading behavior of investors who participate in medium and small cap market segments, level of trading and fund flows, sophistication of trading mechanism and effectiveness of policy level initiatives to eliminate market inefficiency in these segments is required.

Limitations of the Study

The main contribution of this study rests in its modified approach in the construction of irrational sentiment index, which remarkably captures the irrational sentiment of the market. A point of caution is that though the relationship between sentiment and volatility identified from this analysis is statistically significant and corroborates to those findings which are already reported in literature, the economic significance of these results are not verified in this analysis. A reexamination of the findings with better estimates of return volatility would substantiate the validity of the findings from this analysis.

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