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The implied volatility index: Is '*investor fear gauge*' or '*forward-looking*'?

Imlak Shaikh [a,*], Puja Padhi [b]

[a] *Department of Management, Birla Institute of Technology & Science, BITS Pilani, Pilani, Rajasthan 333 031, India*
[b] *Department of Humanities and Social Sciences, Indian Institute of Technology Bombay, Mumbai 400 076, India*

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Abstract

The paper aims to examine implied volatility as the *investor fear gauge* or/and *forward-looking* expectation of future stock market volatility within emerging markets setting-India VIX. The earliest results evidenced that VIX is the gauge of investor fear, where in the expected stock market volatility rises when the given market is declined. It is also proven that expected volatility is being unbiased estimate of the actual return volatility (30-calendar days); hence, during the market turmoil VIX likely to be biased. Lastly, it is suggested that the nervousness of investor yields potential profit to the options seller (market crises). Thus, our research has practical implications for various reasons, such as, portfolio risk management, stock market volatility forecast, and options pricing.

JEL classification: G01; G11; G14

Keywords: Implied volatility index; Investor sentiment; Fear; Forward-looking; India VIX

1. Introduction

Implied volatility is the ex-ante measure of volatility, which is derived using the Black–Scholes (BS) options pricing model. In other words, it is an estimate of the volatility that approaches to the BS option price and market price of an option. It depends on several inputs of BS option pricing model, for example, *time-to-expiration*, *spot price*, *exercise price*, *risk-free-rate-of-interest*, and *call/put observed market price*. Hence, price of options remains more variable than other inputs. It is apparent that inserting high value of volatility the then BS model will yield high price of option. Based on this perspective, one would say that higher the premium charged on option implies more market anxiety among the market participant, and anticipating high volatility of the underlying over remaining life of the option.

In the recent past, behavioral finance scholars have made significant attempts in exploring diverse range of investment strategies, for example, return predictability, determinants of stock prices, investment performance and investor sentiment, information content of implied volatility index, behavioral investment strategy, and volatility spillover effects (Cakici & Topyan, 2013; Jain-Chandra & Unsal, 2014; Narayan, Narayan, & Singh, 2014; Park & Kim, 2014; Ryu, 2012; Salvador, 2012; Sun, Tsai, & Wang, 2013; Taşdemir & Yalama, 2014; Uygur & Taş, 2014). Albeit, we do not find any pertinent study referring emerging markets that deals with the investor's '*fear*' and '*greed*' index. Herewith, we aim to explore forward-looking volatility index and thereby set to explain the investor sentiment in various trading regimes in the Indian setting.

Our aim of the study is to describe how this implied volatility acts as the investors' *fear*, and explains the future stock market volatility. Moreover, an attempt is made to show how investor sentiment (fear) is gauged in the volatility index (India VIX). In particular, we determine whether VIX is the forward-looking or/and it is the fear of the market participant.

* Corresponding author. Tel.: +91 9998493869.
E-mail addresses: imlak786@gmail.com, imlak.shaikh@pilani.bits-pilani.ac.in (I. Shaikh), pujapadhi@iitb.ac.in (P. Padhi).
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The implied volatility index (VIX) is the trade mark of Chicago board options exchange (CBOE), introduced in 1993, and further modified in 2003. The new methodology is model-free forward-looking based on S&P 500 index options, and it is the markets' expectation of the future market volatility over 30 day horizon (Whaley, 2000, 2008). Implied volatility index is the measure of expected volatility for the near future, it is estimated out of the trading prices of the options written on equity index. India VIX is a volatility index based on the S&P CNX Nifty equity index option prices. Daily best bid-ask prices of OPTIDX (options written on S&P CNX Nifty equity index) options contract considered, volatility in percentage is calculated which indicates the expected market volatility over the next 30 calendar days (20–22 trading days). The implied volatility index (India VIX[1]) uses the same methodology as developed by the CBOE.[2] The Nobel work of Black and Scholes (1973) and Merton (1973) in the line of option pricing has made possible constructing the implied volatility index from the best bid-ask prices of option. In this study our focus is on India VIX constructed in the similar manner of Chicago board of option exchange VIX®. India VIX constructed out of the best bid-ask option prices written on the S&P CNX Nifty equity index.

Whaley (2000, 2008) points out on the CBOE's 'investor fear gauge' index; it is the forward-looking measure of future stock market volatility, and this index is constructed by market participants through observed option prices. The high the level of VIX implies greater fear. Whaley (2000) derives the relation between stock market returns and changes in VIX, the relationship is of asymmetric in nature (e.g. Fleming, Ostdiek, & Whaley, 1995; Giot, 2005; Whaley, 2000). Whaley argues that VIX is more a barometer of invertors' fear (investor sentiment) of the downside risk and it is a barometer of investors' excitement (or greed) in a market rally.

At this point one can say that VIX is the investors' sentiment index and prepared by market participant, hence it is the barometer of future stock market risk. The implied volatility index (VIX, India VIX) is generally constructed using observed option prices. The market participant buy call/put options to hedge/trade the volatility, and the same observed option price is used to derive VIX in real time. Whaley (2000) point out that high level of VIX is observed due to high degree of market turmoil.

Arak and Mijid (2006) attempt to analyze the volatility measures (VIX/VXN) to determine whether volatility index is the forecast of future stock market volatility or it is the fear of market participants. The nervousness of the investors, raises option premium, hence selling options at the high price becomes profitable at one particular time. But, if expected volatility causes to rise in option premium, in turn the volatility to be high and the same condition will not yield the profit. Arak and Mijid (2006) try to answer whether VIX/VXN is 'fear' or 'forecast' and conclude that implied volatility appear to be partly fear gauge and partly forecast of the future volatility.

The recent studies (e.g. Dowling & Muthuswamy, 2005; Ederington & Guan, 2010; Frijns, Tallau, & Tourani-Rad, 2010; Giot, 2005) has shown that asymmetric impact holds on the implied volatility. The systematic foundation of asymmetric relationship between implied volatility and the stock market returns was first given by Schwert (1989, 1990) and Fleming et al. (1995) they find significant negative and asymmetric relation between volatility and returns. Fleming et al. (1995) show that how implied volatility index has been calculated, moreover they explain the strong inter-temporal relation between implied volatility and stock index returns. Moreover, they find an inverse and asymmetric relation between future stock market volatility and stock returns.

The earlier empirical work of Bates (2000), Poteshman (2001), Pan (2002) and Dennis, Mayhew, and Stivers (2006) they find good degree of negative relation between returns and implied volatility. In addition, the empirical work (Bollerslev & Zhou, 2006; Fleming et al., 1995; Low, 2004; Whaley, 2000) explains that implied volatility significantly attributed toward negative and positive return shocks. They find that implied volatility falls significantly for large positive return shocks. Hence, at this point one can say that implied volatility rises for the negative return shocks and falls following the positive return shocks. The literature evidences in favor of asymmetric relation (Bates, 2000; Bollerslev & Zhou, 2006; Dennis et al., 2006; Dowling & Muthuswamy, 2005; Ederington & Guan, 2010; Fleming et al., 1995; Frijns et al., 2010; Giot, 2005; Pan, 2002; Poteshman, 2001; Schwert, 1989, 1990).

Trading on the volatility provide more opportunities for the options seller, a volatile market creates nervousness among the market participants, and fearful investors demand more hedge funds to protect their market positions in short term. The high demand pressure on call and put option ultimately causes high premium for the option seller. Moreover, when market experience spike in the volatility, option holder have more alternative in short term for new strikes, this kind of market conditions also provide potential profit from the fearful investors. More particularly, worries about the future state of stock market are reflected through volatility index. For example, market participant trade into options to manage their downside risk, similarly for upside risk they buy call options. At one particular point of time due to spike in the VIX, it encourages the investor to buy options; at that time if options writer sell options at their theoretical price than there will be normal price of the options, and fair market expected volatility. But, if option seller wants to turn this condition into profit, options writer can sell options to the fearful investors at higher premium. Hence, this empirical work attempt to answer whether India VIX is the fear gauge or forward-looking. The empirical evidences clearly show that India VIX is the forecast of future stock market volatility, and it is the unbiased estimate of the actual realized return volatility. The proxies of investor sentiment for various time lag returns have shown significant

[1] See more about India VIX http://www.nseindia.com/content/vix/white_paper_IndiaVIX.pdf.

[2] See more about CBOE VIX http://www.cboe.com/micro/vix/vixwhite.pdf.

negative correlation with market volatility. When investors experience high negative return in the market they feel nervous, and demand more options even though options with higher premium, that causes high level of implied volatility index for short term. The evidences on the fear variable reveal that India VIX is the gauge of investor fear for the short term.

The work has been organized as: Section 1 deals with the background of the problem followed by related literature review, Section 2 describes the data sources and empirical model, Section 3 reports the empirical results and discussion and Section 4 ends with the conclusion.

2. Data sources and empirical model

2.1. Data sources and identification of crises period

This empirical work consists of 1468 daily data points of the S&P CNX Nifty equity index and India VIX. The period of sample starts from November 1, 2007 and ends on September 30, 2013. The stock index and market volatility index are openly available from the website of National Stock Exchange of India (NSE).[3] Moreover, the entire dataset has been sampled for each month; hence we have 71 monthly observations for the given sample period. Indeed, the entire sample has been classified in sub-periods, such as crises period and low volatile/normal period. There are mainly two approaches used to determine the crises period; Ad hoc approach (e.g., Baur, 2012; BIS, 2009; Forbes & Rigobon, 2002; Louis, 2009) in which the sample period is classified arbitrarily, while another approach is statistical in which the period of crises is identified endogenously (e.g., Boyer, Kumagai, & Yuan, 2006; Dimitriou & Kenourgios, 2013; Dimitriou, Kenourgiosb, & Simos, 2013; Shaikh & Padhi, 2013a). We use statistical approach to determine the crises period, Markov Regime Switching Model (MR-SM) is most appropriate tool to account for the period classification endogenously. Our endogenous variable under study is monthly close of India VIX; we employ MR-SM method, which plots the smoothed probabilities in two regimes (Regime 0 & 1, see Fig. 1). Regime [0] plots the sample values for the stable period, while Regime [1] plots the value of turbulent period (see Fig. 1 and Appendix A). MR-SM method suggest the turbulent period that starts from November, 2007 and ends on August, 2009, similarly the low volatility/normal period consist of September, 2009 to September, 2013.

2.2. Empirical model

The aim of our study is to explain whether India VIX is the true indicator of investor sentiment (fear) or it is the forward-looking expectation of future stock market volatility. The empirical model in terms of ordinary least squares (OLS) is structured as,

$$IVIX_t = f(volatility\ of\ the\ stock\ index\ returns; investor\ sentiment)$$

$$IVIX_t = \alpha + \beta_1 VOL_t + \beta_2 IS_{t-1} + u_t \quad (1)$$

2.3. Construction of the variabless

Implied volatility index ($IVIX_t$): India VIX is the investor sentiment index of Indian stock market, calculated out of the observed options prices written on Nifty equity index. India VIX (IVIX) is the expectation of future stock market volatility for 22-day horizon (i.e. 30 calendar days). Here, the variable $IVIX_t$ is obtained for the period 2007M11 to 2013M09 on the very first trading day of the respective months as closing value of India VIX. The study on the information content of implied volatility as the forecast of the future stock market volatility (e.g. Christensen & Prabhala, 1998; Christensen & Hansen, 2002; Hansen, 2001; Li & Yang, 2009; Padhi & Shaikh, 2014; Shaikh & Padhi, 2013a, 2013b, 2014) has shown that monthly time series values are the best measure of future realized volatility. The rationale behind converting daily data into monthly is to control the problem of autocorrelation. The literature well documented that implied volatility gives the best estimate of future stock market volatility of 20- to 22-day horizon of monthly estimates.

Realized volatility (VOL_t): A continuously compounded log-return was calculated for the Nifty equity index, on the very next day and till the end of the month in reference to the closing value of volatility index ($IVIX_t$). Based on each month's returns the simple standard deviation was calculated and the same value was annualized.

Let $r_t = \ln(Nifty_t) - \ln(Nifty_{t-1})$,

$$VOL_t = \sqrt{\frac{365}{30-1}\sum (r_t - \overline{r_t})^2} \quad (2)$$

Investor sentiment (IS_1): Arak and Mijid (2006) points out that investor sentiment (fear) cannot be measured directly, hence we take the proxy of the investor sentiment, as the percentage change in the S&P CNX Nifty index for 1-day, 5-day, 10-day and 22-day contemporaneous equity returns. Here, we consider the *h-day* horizon returns on the equity index, which is one of the novel aspects of the study as compare to pervious works.

Investor sentiment (IS_2): this represents the negative values of 1-day, 5-day, 10-day and 22-day equity index returns and the positive values are replaced with zeroes. Giot (2005) show that negative stock return impacts higher than the positive returns on the expected stock market volatility.

The equation (1) has been estimated for the sample period 2007M11 to 2013M09, and the residual term u_t is assumed to be normally distributed that follows white noise process. In order to resolve the problem of contemporaneous causality the lagged values of IS_1 and IS_2 has been considered. An

[3] The values of daily India VIX from November 2007 and onwards is available from PROWES CMIE database, one of the authentic databases on the monitoring of Indian economy. NSE website provides only from March 2009.

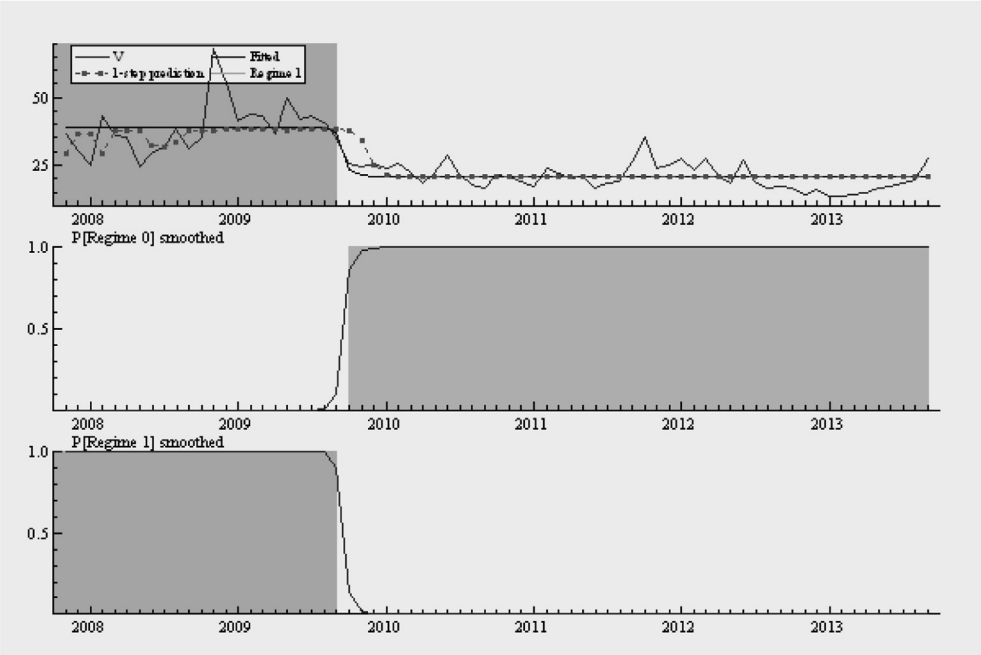

Fig. 1. Markov Regime Switching Model showing period of crises.

autoregressive AR(p) term has been allowed in each multiple regression to control the problem of autocorrelation. The slopes of the above model are estimated using OLS regression in which the standard errors are hetroscedastic and autocorrelation consistent (HAC-SE).

2.4. Hypotheses of the model

(i) *Intercept* (α): a positive statically significant intercept is expected for the model.
(ii) *Slope* (β_1): the slope of the VOL_t variable is supposed to be positive and statistically significant. If the slope β_1 is positive and significant, we can conclude that expected stock market volatility is the good forecast of realized volatility.
(iii) *Slope* (β_2): IS_1 and IS_2 are the two proxies of investor sentiment and both the variable are expected to be negatively associated with implied volatility index; hence the slope β_2 should be negative and statistically significant. IS_t is the variable that assumes the returns of underlying stock index, and an indicator of investor's nervousness during the negative returns experienced in the market.

2.5. Summary statistics

The relationship between investor sentiment and expected stock market volatility has been presented in Table 1. Table 1 reports summary statistic on mean, standard deviation and correlation for the variables $IVIX_t$, VOL_t, IS_1 and IS_2, the descriptive statistics have been presented in three different panels, Panel A shows the results for the whole sample, Panel B reports for the crises period, and Panel C describes the results on low volatile market period. The test of unit root on monthly times series data clearly shows that volatility estimates are stationary at level (see Appendix B). Starting with the mean, the average implied volatility found to be 26.69%, and the average actual realized volatility computed 28.46%, and the correlation between two volatility series is 0.708 (also see Fig. 2). These are the prima facie evidences show that implied volatility is the forward-looking and it is the expectation of the future stock market volatility. The standard deviation of VOL_t is 16.46 which is more than the $IVIX_t$, this implies that realized volatility is more volatile, and we can conclude that the implied volatility is the smoothed expectation (e.g., Christensen & Prabhala, 1998; Hansen, 2001; Shaikh & Padhi, 2013a, 2013b) of stock market volatility. It is seen that during crises period, the average implied volatility appears to be 39.06%, which is higher than the normal rage (e.g., 15–30%, Whaley, 2000), and the standard deviation of VOL_t is also higher than the $IVIX_t$, and the correlation between two volatility do not appear statistically significant. It is apparent from the results that during the market turmoil expected volatility do not explain the future stock market volatility, and it appears as biased estimate (Christensen & Prabhala, 1998).

But, during the low volatile market the correlation (0.489) between these two volatility remains positive and significant (see Fig. 2, right side 2010–2013). One of the important results one can observe that the correlation between IS_1/IS_2 and $IVIX_t$ appears to be negative, and statistically significant (for 1-day, 5-day, 10-day and 22-day equity index returns). Hence, descriptive statistics provide an adequate evidence on the fear and expected stock market volatility which are negatively correlated (see Fig. 3, show the time series plot of India VIX

Table 1
Summary statistics.

Statistics	$IVIX_t$	VOL_t	Investor's sentiment (fear)							
			IS_1				IS_2			
			1-day	5-day	10-day	22-day	1-day	5-day	10-day	22-day
Panel A Full sample 2007M11:2013M09										
Mean	26.69	28.46	0.21	0.78	0.20	0.47	−0.58	−1.03	−1.67	−2.84
Std. dev.	10.79	16.46	1.87	3.65	4.85	8.50	1.13	1.83	3.20	4.96
Correlation	0.708[a]		−0.070	0.166	0.0190	0.198[c]	−0.294[b]	0.059	−0.085	−0.042
Numbers	71	71	71	71	71	71	71	71	71	71
Panel B Global financial crises and investor fear 2007M11:2009M08										
Mean	39.06	46.25	0.25	1.53	−0.31	0.39	−1.01	−1.22	−2.76	−5.10
Std. dev.	9.86	18.29	2.84	5.06	6.86	13.19	1.68	2.11	4.54	7.32
Correlation	0.284		0.334[c]	0.525[b]	0.004	−0.119	0.0001	0.244	0.075	−0.310[c]
Numbers	22	22	22	22	22	22	22	22	22	22
Panel C Low volatility period and investor fear 2009M09:2013M09										
Mean	21.13	20.47	0.19	0.44	0.43	0.51	−0.39	−0.94	−1.18	−1.82
Std. dev.	5.06	6.20	1.24	2.79	3.68	5.40	0.71	1.71	2.26	3.02
Correlation	0.469[a]		−0.275[b]	−0.138	−0.134	−0.219	−0.458[a]	−0.130	−0.162	−0.353[a]
Numbers	49	49	49	49	49	49	49	49	49	49

Note: correlation: the correlation statistic is presented for $IVIX_t$ and VOL_t, and the rest of the correlation coefficient is between $IVIX_t$ and IS_1 & IS_2 for lagged returns. Significant at [a]1%, [b]5%, [c]10% levels.

and Nifty stock index). When market participant experience negative return (e.g. 1-day, 5-day, 10-day and 22-day equity index returns) they become more nervous, they demand more options to hedge the market holdings. This kind of market movement allows charging of more premiums on the options rather than the fair price, and that allows the option seller to make profit out of this market condition.

3. Empirical results and discussion

In this section the equation (1) has been estimated and presented in three different tables. Table 2 describes the estimation for the whole sample period, and Table 3 represents the behavior of expected market volatility during global financial crises, while Table 4 reports the results on low volatile market after the crises.

3.1. The volatility index (IVIX) as forward-looking

First, we wanted to test whether implied volatility index ($IVIX_t$) is a forecast of future volatility is or not. Panel A of Table 2, illustrate the univariate regression of $IVIX_t$ on realized volatility-VOL_t where the slope of the realized volatility appears to be 0.32 (with t-stat = 4.53, significant at 1% level). In multiple regressions (5-day, 10-day, 22-day returns) by including investor sentiment variable IS_1, the slope of the volatility does not change significantly. The positive significant slope of the realized volatility signifies that implied volatility ($IVIX_t$) forecast about 0.32 of each one percentage point of volatility increases. The previous studies (e.g. Christensen & Prabhala, 1998; Hansen, 2001; Shaikh & Padhi, 2013a, 2013b) regress the actual volatility against expected volatility and test the forecasting ability of implied volatility. If we run the regression based on the previous empirical work, the slope of the expected market volatility appears 1.079 (with t-stat = 10.44, significant at 1% level), and the adj. $R^2 = 0.50$. At this point we can say that India VIX is the forward-looking and it is unbiased estimate of future stock market volatility. But, the results during the global financial crises speak the different story. Table 3, reports the slope of VOL_t (0.18), which is very small on the counter part of entire sample and the estimates based on low volatile/normal market. In Table 4, the slope of realized volatility is 0.38, which is quite lager than the previous regressions. It is apparent from the analysis that expected volatility remains more biased due to regime shift. One more plausible explanation for this event could be investor became more nervous due to global financial crises took place during this period, and they bought options at very high premium than the fair prices. A high price of option yields significant profit (less the transaction cost) conditions, and consequently high levels of expected volatility.

3.2. Volatility index as investor fear gauge

The investor sentiment cannot be measured directly, hence we calculate contemporaneous index returns as the investor sentiment (for 1-day, 5-day, 10-day and 22-day Nifty returns) and categorized as IS_1 and IS_2. IS_1 is the monthly returns that consist of all positive and negative returns, and IS_2 shows only negative returns. The variable IS_1 and IS_2 are the *fear gauges* of the investor sentiment, a negative value signifies the *nervousness* of the market participant, and hence they hedge the market holdings through options. The higher the market anxiety, higher will be premium on options and resulting expected volatility will be higher. '*Fear*' we mean more profit, turmoil period lead to more demand for option, more demand

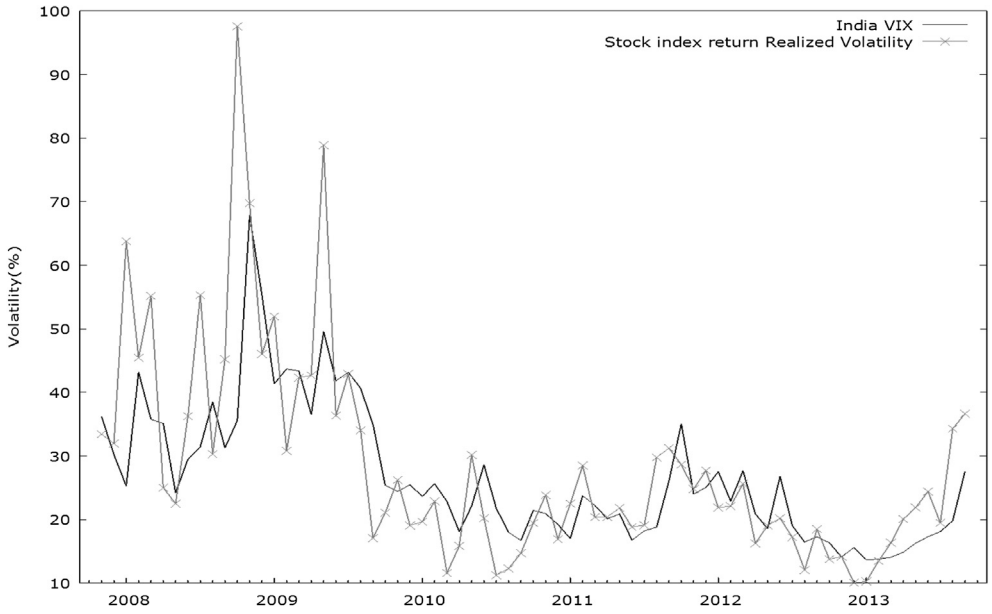

Fig. 2. Time series plot of implied volatility and actual realized return volatility.

raises the premium, higher the premium higher will be the expected volatility. We attempt to answer this view point through empirical results presented in Tables 2–4

The slope of IS_1, in panel C and D of the Table 2, appears to be negative {i.e. −0.19 (10-day returns), −0.23 (22-day returns)}, and both the slopes are statistically significant at 10% level. In additions, as we know that negative return show larger impact than what do the positive returns (e.g., Giot, 2005). The coefficient of IS_2 is respectively −0.39 (1-day), −1.00 (5-day), −0.29 (10-day) and −0.68 (22-day), and remains statistically significant. The absolute value of IS_2 is larger than the absolute value of IS_1, this confirms that negative returns show larger *anxiety* among the market participants.

During the market turmoil period the *nervousness* of the market participant is evidenced from the Table 3. The estimation results for 5-day and 22-day stock return provide an adequate evidence that India VIX is the indicator of '*fear*' of the investor, and it is the gauge of investor sentiment over the next 30 calendar days. The estimates of IS_2 in panel B and D are respectively −1.50 and −0.60, in absolute term the slopes

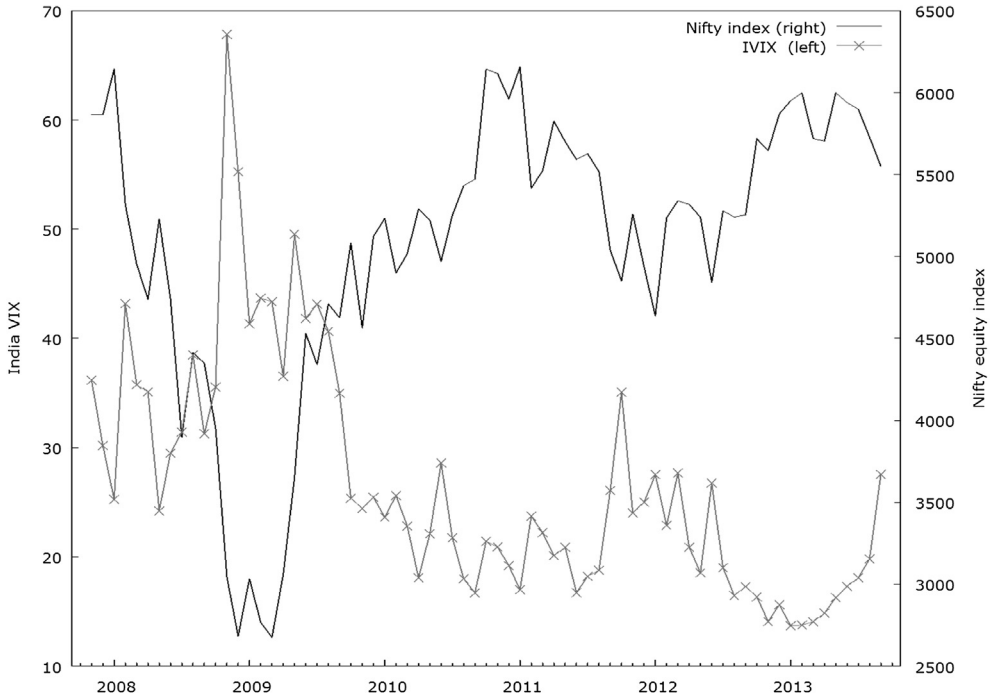

Fig. 3. Time series plot of India VIX and Nifty index.

Table 2
On the relation between expected market volatility and inventor's sentiment (fear).

Dep. var.	Intercept	VOL_t	IS_1	IS_2	AR(p)	Adj. R^2	F-stat	DW-stat
Panel A 1-day contemporaneous stock index returns								
$IVIX_t$	5.83[a] (3.45)	0.32[a] (4.53)			0.43[a] (5.90)	0.63	59.52[a]	2.08
$IVIX_t$	5.67[a] (3.44)	0.31[a] (4.78)	0.45 (0.76)		0.44[a] (6.77)	0.63	40.09[a]	2.08
$IVIX_t$	5.89 (3.42)	0.32[a] (4.70)		−0.39[c] (−1.67)	0.42[a] (5.72)	0.63	39.34[a]	2.07
$IVIX_t$	5.41[a] (3.93)			0.45 (0.67)	0.80[a] (14.81)	0.62	57.36[a]	2.20
Panel B 5-day contemporaneous stock index returns								
$IVIX_t$	5.91[a] (3.41)	0.32[a] (4.53)	0.09 (0.30)		0.43[a] (5.33)	0.63	39.24[a]	2.09
$IVIX_t$	4.51[a] (2.89)	0.32[a] (4.80)		−1.00[c] (−1.92)	0.45[a] (6.12)	0.66	44.35[a]	2.05
$IVIX_t$	4.85[a] (3.42)			−0.68[c] (−1.88)	0.79[a] (16.65)	0.63	60.26[a]	2.21
Panel C 10-day contemporaneous stock index returns								
$IVIX_t$	5.81[a] (3.30)	0.32[a] (4.38)	−0.19[b] (−1.98)		0.44[a] (5.54)	0.63	40.24[a]	2.11
$IVIX_t$	5.56[a] (3.27)	0.31[a] (4.28)		−0.29 (−1.66)	0.43[a] (5.57)	0.63	40.37[a]	2.07
$IVIX_t$	5.49[a] (4.09)			−0.08 (−0.35)	0.78[a] (15.94)	0.61	56.99[a]	2.19
Panel D 22-day contemporaneous stock index returns								
$IVIX_t$	5.13[a] (3.26)	0.30[a] (4.57)	−0.23[c] (−1.65)		0.49[a] (7.24)	0.66	44.65[a]	2.13
$IVIX_t$	4.58[a] (3.44)	0.28[a] (5.00)		−0.68[a] (−3.28)	0.45[a] (6.82)	0.73	61.52[a]	2.31
$IVIX_t$	5.94[a] (3.88)			−0.18 (−0.94)	0.75[a] (12.58)	0.62	58.19[a]	2.24

Table 2 reports the estimation of eq. $IVIX_t = \alpha + \beta_1 VOL_t + \beta_2 IS_{t-1} + u_t$ for whole sample; the values in parenthesis shows the t-statistics, the standard errors are HAC consist. Significant at [a]1%, [b]5%, [c]10% levels.

are quite larger than the entire sample and low volatile market results.

Table 4, reports the evidence on fear during the low volatile/normal period that starts from September 2009 and ends on September 2013. We expect negative slope for IS_1 and IS_2 variables, in each row of Table 4. The table reports negative slopes of these two variables and remains statically significant. If we focus on the 5-day stock returns that observed by the investors in five days gap, the slope of IS_1 (−0.25) and IS_2 (−0.48) appears to be negative and significant at 10% and 1% level respectively. One of the important findings of the study is that absolute value of IS_2 appears greater than the absolute value of IS_1, this signifies that investor are more *nervous* when they experience large negative returns. The identical results are also obtained for 10-day and 22-day stock returns.

One more interesting outcome during the turmoil period can be noticed that market *anxiety* occurs 3 times more than the low volatile period (e.g., the slope of 5-day gap stock

Table 3
On the relation between expected market volatility and inventor's sentiment (fear and crises).

Dep. var.	Intercept	VOL_t	IS_1	IS_2	AR(p)	Adj. R^2	F-stat	DW-stat
Panel A 1-day contemporaneous stock index returns								
$IVIX_t$	13.21[b] (2.12)	0.18[c] (1.88)			0.45[a] (4.91)	0.20	3.48[b]	2.49
$IVIX_t$	13.73[b] (2.05)	0.18[c] (1.86)	0.10 (0.23)		0.44[a] (4.09	0.15	2.19	2.50
$IVIX_t$	13.62[b] (1.97)	0.18[c] (1.85)		0.18 (0.23)	0.45[a] (4.75)	0.15	2.19	2.49
$IVIX_t$	23.80[a] (4.06)			0.68 (0.82)	0.41[a] (4.27)	0.09	2.03	2.01
Panel B 5-day contemporaneous stock index returns								
$IVIX_t$	11.88 (1.32)	0.18[c] (1.85)	−0.14 (−0.29)		0.49[b] (2.55)	0.15	2.22	2.51
$IVIX_t$	6.14 (0.61)	0.22[b] (2.17)		−1.50[c] (−1.70)	0.54[a] (3.69)	0.26	3.32[b]	2.38
$IVIX_t$	19.60[a] (3.40)			−1.06 (−0.74)	0.47[a] (3.96)	0.13	2.53[c]	1.86
Panel C 10-day contemporaneous stock index returns								
$IVIX_t$	13.22[b] (2.05)	0.18[c] (1.84)	0.01 (0.04)		0.45[a] (4.76)	0.15	2.18	2.48
$IVIX_t$	13.50[c] (1.92)	0.18[c] (1.86)		0.05 (0.15)	0.45[a] (4.48)	0.15	2.19	2.48
$IVIX_t$	23.74[a] (3.84)			0.16 (0.49)	0.41[a] (3.94)	0.08	1.92	1.94
Panel D 22-day contemporaneous stock index returns								
$IVIX_t$	13.41[b] (2.08)	0.18[c] (1.83)	−0.03 (−0.20)		0.45[a] (4.60)	0.15	2.20	2.50
$IVIX_t$	13.50 (1.49)	0.20[c] (1.84)		−0.60[b] (−1.99)	0.35[b] (2.55)	0.09	2.60[c]	2.08
$IVIX_t$	23.75[a] (3.77)			−0.17 (−0.63)	0.37[a] (2.66)	0.09	2.04	1.95

Table 3 reports the estimation of eq. $IVIX_t = \alpha + \beta_1 VOL_t + \beta_2 IS_{t-1} + u_t$ for crises period; the values in parenthesis shows the t-statistics, the standard errors are HAC consist. Significant at [a]1%, [b]5%, [c]10% levels.

Table 4
On the relation between expected market volatility and inventor's sentiment (fear and low volatile market).

Dep. var.	Intercept	VOL_t	IS_1	IS_2	AR(p)	Adj. R^2	F-stat	DW-stat
Panel A 1-day contemporaneous stock index returns								
$IVIX_t$	4.82[b] (2.18)	0.38[a] (4.85)			0.39[a] (4.70)	0.45	20.87[a]	1.92
$IVIX_t$	4.80[b] (2.16)	0.38[a] (5.07)	−0.21 (−0.45)		0.39[a] (4.47)	0.44	13.75[a]	1.93
$IVIX_t$	4.49[b] (2.17)	0.39[a] (5.36)		−0.85[c] (−1.74)	0.38[a] (4.23)	0.46	14.39[a]	1.97
$IVIX_t$	7.91[a] (4.06)			1.07 (1.17)	0.64[a] (7.41)	0.43	19.72[a]	1.94
Panel B 5-day contemporaneous stock index returns								
$IVIX_t$	4.40[b] (2.06)	0.39[a] (5.35)	−0.25[c] (−1.80)		0.41[a] (4.79)	0.49	14.70[a]	1.95
$IVIX_t$	3.99[c] (1.92)	0.38[a] (5.11)		−0.48[a] (−3.24)	0.41[a] (4.84)	0.47	15.11[a]	1.92
$IVIX_t$	8.54[a] (4.25)			−0.10 (−0.44)	0.58[a] (7.20)	0.42	18.03[a]	2.02
Panel C 10-day contemporaneous stock index returns								
$IVIX_t$	3.98[b] (1.99)	0.39[a] (5.18)	−0.27[a] (−4.21)		0.43[a] (5.02)	0.48	15.84[a]	1.94
$IVIX_t$	4.01[c] (1.90)	0.38[a] (5.09)		−0.36[a] (−3.58)	0.41[a] (4.62)	0.47	15.07[a]	1.85
$IVIX_t$	8.58[a] (4.26)			−0.02 (−0.09)	0.59[a] (7.24)	0.41	17.95[a]	2.00
Panel D 22-day contemporaneous stock index returns								
$IVIX_t$	4.04[b] (2.12)	0.37[a] (5.69)	−0.21[b] (−2.03)		0.44[a] (5.71)	0.49	16.61[a]	1.96
$IVIX_t$	3.51[c] (1.92)	0.36[a] (6.00)		−0.54[a] (−3.06)	0.43[a] (5.50)	0.55	20.38[a]	2.06
$IVIX_t$	8.80[a] (4.17)			−0.19 (−0.89)	0.56[a] (6.38)	0.43	18.85[a]	2.08

Table 4 reports the estimation of eq. $IVIX_t = \alpha + \beta_1 VOL + \beta_2 IS_{t-1} + u_t$ for normal period; the values in parenthesis shows the t-statistics, the standard errors are HAC consist. Significant at [a]1%, [b]5%, [c]10% levels.

returns is −1.50 (IS_2), which is three times more than the low volatile period (−0.48)). This empirical evidence provides important insight for the option pricing and profit opportunities that occurs during the turmoil period for option seller. For example, during the market crises/turmoil period say for the March, 2009, the details of at-the-money options is: Expiration date 26-March-2009, put options observed price = 108.75, spot price = 2645.12, strike = 2650, and assuming MIBOR (Mumbai-inter-bank-offered-rate) 10%, The empirical evidences explain that faire price of this option should be 36.25, but it was traded thrice of its faire value (i.e. at 108.75).

Finally, the empirical results evidenced that India VIX is the *forward-looking* index of the expected stock market volatility of the S&P 50 Nifty equity index over the next 30 days. At the same time it is the *gauge* of the investor sentiment about their *nervousness* during the market crises.

4. Conclusions

The study demonstrated the behavior of expected stock market volatility in terms of actual realized volatility and stock market returns (investor sentiment). Moreover, the analysis has been presented for the whole sample and sub-period by taking into account the global financial crises. The span of data points consists of 71 monthly observations from November 2007 to September 2013. This is the first attempt in the emerging markets like India, in which we model the India VIX as the gauge of the investor 'fear' and 'forward-looking'.

The important findings of the study reveal the facts that India VIX is both; it is the *fear* indicator of the investor's nervousness, and the best unbiased estimate of future stock market volatility. It is apparent from the summary statistic that both the indices are negatively associated, this happens due to the asymmetric relation between returns and volatility (e.g., Fleming et al., 1995; Giot, 2005). Moreover, the magnitude of the asymmetry is not identical, the absolute values of IS_2 is more than the IS_1, this signifies that when the market participant experience negative return in the market they bid high price of the option and demand more hedge funds to protect their portfolio. Hence, fear of the investor gives an opportunity to the options seller to make profit out of the overpriced option (put option).

Appendix A. Markov Regime Switching Model

Estimate	Coefficient	t-Statistic	p-Value of t-stat
Constant(0)	20.85	21.6	0.000
Constant(1)	38.80	27.5	0.000
Sigma	6.64	11.8	0.000
Prob.{0|1}	0.041	1.02	0.311

Transition probabilities

	Regime 0, t	Regime 1, t
Regime 0, $t+1$	1.000	0.041
Regime 1, $t+1$	0.000	0.958

Appendix B. Unit root test of monthly volatility (India VIX)

Unit root test	Test statistics and p-value	
ADF-test	−2.87	0.053*
PP-test	2.76	0.068*

*Significant at 10% level.

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