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An Examination of Asymmetric Relation between Implied Volatility Index and Its Underlying Asset

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Abstract

The volatility index is the measure of 30-day expected volatility. Its association with stock index returns provides an insight to the volatility traders to launch derivatives products so that it can be used as a hedging tool. The aim of the present study is to empirically examine the relationship between the implied volatility indices and its underlying asset in context of developed and developing markets (like U.S., Japan, Germany, and China). The empirical findings report the asymmetric behaviour which indicates that a larger impact on implied volatility indices are from negative return shocks as compared to positive returns. This evinced that the investors and traders respond highly to negative returns in low volatile period by demanding more options at high premium which makes the implied volatility high. Therefore, the negative relationship between IVIX and stock index returns makes the index relevant for investors to diversifying their portfolio so that they can mitigate the investment risk associated with the volatility.

Keywords: Indian Implied Volatility Index, Informational Content, Hedging, Derivatives, Asymmetric Relationship, Day of the Week Effect

Introduction

The conventional tool widely used in empirical finance, investment banking and asset management is to estimate the variance of return or the expected return on the investments. The variance of returns or the distribution of return around an expected return is a measure of risk or volatility in the market. The estimated variance of return plays a pivotal role in option pricing and intended for various trading strategies as well. In the past few years, there has been a growing interest to forecast the expected volatility of the market (Banerjee, Doran, & Peterson, 2007; Christensen & Prabhala, 1998; Latane & Rendleman, 1976; Szakmary, Ors, Kim, & Davidson, 2003; Siriopoulos & Fassas, 2009). The need to forecast the expected volatility through implied volatility index has recently attracted much attention from researchers and intrigued them to empirically examine the relationship between the index and its underlying asset.

Implied volatility index is calculated through real-time options prices which forecast the 30-day near term volatility. The literature has emphasized on the relationship between the contemporaneous return and volatility which shows the asymmetric behaviour. The asymmetric behaviour can be explained by the fact that the turbulence in the market leads to high levels of volatility index. In other words, the negative returns leads to high volatility than the fall in volatility index by the same level of positive returns as suggested by Whaley (2000) and therefore it is known as a barometer of investor sentiment or fear. Now the pertinent question is why this relation exists between the two indices. It is because to insure their investments, the options traders demand more put options at the high premium during the market turmoil which makes the volatility index high and during the complacency, the less demand of options generates low premium levels which drops the level of volatility index. To empirically examine this relation, the aim of the study is to analyse the association between the contemporaneous stock index returns and implied volatility index. The volatility index

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measures the investors' expectation of volatility or the uncertainty expected by the market over month implied by the option prices (Narwal, Mittal and Chhabra, 2017).

Several studies have appeared in recent years documenting this relationship such as (Frijns, Tallau, & Tourani-Rad, 2010; Giot 2005b; Gonzalez & Novales, 2009; Kumar, 2012; Ryu, 2012). The motivation behind the study is to develop a theory which will give an insight to VIX derivatives as a well thought-out hedging tool for the market participants i.e. investors, traders, hedgers and for risk managers to develop or diversify their portfolio. The inverse or negative relationship between the two indices makes volatility index derivatives plausible for the investor to hedge their risk (Brenner, Ou, & Zhang, 2006). In this context, CBOE (central board options exchange) introduced VIX futures and VIX options in 2004 and 2006 respectively. On the same ground, NSE also launched VIX futures in 2014, which motivates to establish this relationship in the Indian market, in order that the academicians and practitioners could make a better decision while forming their portfolio.

Review of Literature

This section disserts the literature which examines the association between stock returns and historical volatility (Bollen & Whaley, 2004; Dennis, 2006; Hibbert, Daigler, & Dupoyet, 2008; Low, 2004). Christie (1982) and French, Schwert, and Stambaugh (1987) acknowledged this relationship negative as well as asymmetric. Schwert (1990) interpreted the asymmetric relationship as the fall in prices of the underlying creates fear in the mind of investor which instigate them to demand more put options leads to raise in the volatility index levels than the downfall in expected volatility with a similar size gain in prices. In the literature, this asymmetric relationship is explained by two explanations, i.e. volatility feedback hypothesis and leverage effect, but it is not easy to disentangle the fact from the given literature.

The literature of the implied volatility index has widely documented the association between the two in developed markets. The implied volatility is calculated through the premium charged by options seller to insure the position of the options buyer in the derivative market. It can be used as an expected uncertainty forecasted by options traders calculated through their intuition or informational content implied in the option prices or the premium amount charged by them with respect to the risk factor as perceived by them. The literature of implied volatility documented the negative-asymmetric association with underlying index returns. Initially, this relationship is acknowledged more for the developed countries i.e. for the US market (Simlai, 2010; Whaley, 2009), European market indices (Siripolous & Fassas, 2008), and Greek market (Skiadopoulos, 2004). The earlier studies (e.g. Carr & Wu, 2006; Fleming, 1995; Giot, 2005; Simon, 2003) analysed the relationship between the volatility indices and their underlying index, and confirm the asymmetry in the market as in the low volatility regime, the response is more pronounced to negative stock returns.

The literature which evinced the asymmetric volatility relation (e.g. Bates, 2000; Bollerslev & Zhou, 2006; Frijns *et al.,* 2010; Poteshman, 2001; Pan, 2002; Giot, 2005; Schwert, 1989, 1990). Furthermore, there are many studies which documented the negative and asymmetric relationship in various developed markets i.e. Giner and Morini (2004) and Gonzalez and Novales (2007) for the Spanish market, Gonzalez and Novales (2009) for VDAX-NEW, VSMI and VIBEX-NEW, Frijns *et al.* (2010) for the Australian market, McAleer and Wiphatthananthakul; (2010) for the Thailand market, Ederington and Guan (2010) for the US market, Ryu (2012) for the Korean market, and Shaikh and Padhi (2016) for the Indian market. Except Dowling and Muthuswamy (2005), all the above-mentioned studies found the asymmetrical-negative contemporaneous relationship. Consistent with the previous results, the findings of Badshah (2009) show significant improvement, in context of various developed market, but the argument given by the study doesn't support the above-mentioned hypothesis of leverage and volatility feedback whereas the results of the study could be explained by investor sentiment and through behavioural explanation. Moreover, the study also examines the seasonal pattern present in implied volatility indices, which found to be significant in literature (Dowling and Muthuswamy, 2005; Frijns *et al*., 2010) specifically monday effect is found to be significant in most of the cases.

Since the beginning of the volatility index in developing countries, only a few studies have been conducted so far. Hence, there is a need to further explore the topic and to update or validate the empirical evidence. Most of the research has been done in developed countries like the USA, UK etc., in developing countries like India, very few studies have been conducted to explore the asymmetric relationship of implied volatility index with their underlying. Moreover, to the author's best knowledge, very few publications found that address the issue of the asymmetric negative relationship after the introduction of volatility futures in February 2014 on Indian implied volatility index.

Current research on implied volatility index is focused on its relationship with stock index returns in the Indian and international market. It further explores if any seasonal pattern holds in it or not. The binary OLS regression analysis was performed in order to obtain empirical results. For this, the binary regression models have been framed, the empirical results demonstrate the negative relationship between the indices. Also, through Wald F-Statistics it is confirmed that the relation is asymmetric in nature which suggests that negative shocks are more pronounced than positive ones and evinced that the implied volatility is a fear gauge index which measures the fear of investors more of greed, as proposed by (Whaley, 2009). The seasonality pattern demonstrates the Monday effect and the results thus obtained are compatible with the literature (Shaikh & Padhi, 2016). Though it falls significantly up to Friday, this can help options traders in the pricing of options by observing the seasonal pattern.

The structure of the remaining paper is as follows: third section provides the data and sets out the methodology and hypothesis for the study. Fourth section portrays the relationship by dint of a figure and discusses the summary statistics elaborating a negative association between implied volatility indices and stock index returns. Fifth section explains the empirical results and discussion, followed by sixth section which draws out the conclusion and seventh section suggesting some practical implications of the study.

Data and Methodology

The dataset undertaken under study is time series in nature and consists of daily closing prices of implied volatility indices and stock returns of different developed and developing nations. To establish the relation, India and China are used under study as developing countries i.e. India VIX (henceforth IVIX), VHSI and US, Japan, Germany have been taken as developed nation having VIX, VXJ, VDAX respectively as their volatility indices. The data has been collected from the official websites of the selected nations. The data used under study comprised normal period exclusive of the crises period of 2008 which helps to examine the sentiment of the investor as depicts through the fear gauge index of Indian market i.e. Indian implied volatility index.

The study examines the contemporaneous asymmetric relation between Indian implied volatility index and its underlying asset. The dataset consists of daily closing prices of India VIX and the underlying Nifty 50 index which has been retrieved from NSE of India. The sample period consists of data of India VIX from March 2009 to December 2016 which is our main variable under study except for VHSI as per the data availability from 2011. India VIX is the Indian implied volatility index which comprised the option prices based on Nifty 50 index. The methodology used to develop the IVIX is same as adopted by VIX of CBOE. The VIX volatility index is the US market index prepared using the option prices of S&P500 index as its underlying. The VHSI volatility index is based on the option prices of Hang Seng stock exchange. The VXJ and VDAX are also option-based volatility indices having Nikkei 225 and DAX 30 as their underlying assets. All the above-mentioned volatility indices taken for the sample are based on the model-free methodology adopted by CBOE (NSE, 2010).

Model Framework for Asymmetric Relation and Hypotheses Formulation

From the literature, it may be inferred that the relationship exists between the implied volatility index and the underlying index (Giot, 2005; Simon, 2003). The relationship is described as asymmetric which shows that the downside risk is more pronounced in the volatility index.

To set up this relation, the one-day contemporaneous log returns for IVIX and corresponding relative one-day closing in Nifty 50 index has been calculated.

$$R_t^{IVIX} = \ln(IVIX_t) - \ln(IVIX_{t-1}) \text{ ....(i)}$$

$$R_t^{NIFTY} = \ln(NIFTY_t) - \ln(NIFTY_{t-1}) \text{ ....(ii)}$$

To investigate the contemporaneous relationship among R_t^{IVIX} and R_t^{NIFTY}, the simple OLS regression is used for estimation. The literature suggests that to examine the asymmetric effect, the dummy variable model is suitable. Accordingly, the model framed under study has been tested and experimented by several authors on the datasets of developed nations. The model specification in form of binary variable is as follows:

$$R_t^{IVIX} = \delta_1^- B_t^- + \delta_2^+ B_t^+ + \mu_t \text{ ....(iii)}$$

In equation (iii), B implies for binary variable, that assumes value '1' for variable B_t when R_t^{NIFTY} is negative otherwise 0. Similarly, $B_t^+ = 1 - B_t^-$ is obtained. Equation (iii) demonstrates the asymmetry between R_t^{IVIX} and R_t^{NIFTY}(that explains that on implied volatility index negative return shocks affect more than the positive return shocks). Equation (iii) is modified by introducing interaction dummy as:

$$R_t^{IVIX} = \delta_1^- B_t^- + \delta_2^+ B_t^+ + \delta_3^- (R_t^{NIFTY}) B_t^- + \delta_4^+ (R_t^{NIFTY}) B_t^+ + \mu_t \text{ ....(iv)}$$

To explore the impact of large and small stock returns on the volatility, equation (v) is framed. In equation (iv), two more variables as the square of stock returns have been introduced to explore the impact of the size of stock returns on the return of volatility index. The sign of the coefficients of these two variables (δ_5^- and δ_6^+) in equation (v) clearly implies the increase and decrease in volatility index. The positive sign depicts that volatility increases with the large and small change in stock returns and vice versa.

$$R_t^{IVIX} = \delta_1^- B_t^- + \delta_2^+ B_t^+ + \delta_3^- (R_t^{NIFTY}) B_t^- + \delta_4^+ (R_t^{NIFTY}) B_t^+ + \delta_5^- (R_t^{NIFTY})^2 B_t^- + \delta_6^+ (R_t^{NIFTY})^2 B_t^+ + \mu_t \ldots \quad \text{(v)}$$

Similarly, to know the asymmetric relationship between the returns and implied volatility index of other sample countries, the above-mentioned models have been applied which also confirms the asymmetry in the international market and also compares the results of the model between the developed and developing nations. The standard error of the OLS regression model is heteroscedasticity and autocorrelation consistent which is tested by using White's heteroskedastic test. To check the significance of the coefficients, Wald F-Statistics has been applied which demonstrates the joint effect of the dummy coefficients.

Regression Model for Seasonality in India VIX

The former section has explained the model framework undertaken to examine the contemporaneous relationship between the Nifty returns and implied volatility index, further the study explores whether some seasonal pattern is present in the implied index or not i.e. day–of-the-week effect. For this, equation (vi) has been formed using the five days of the week as a dummy variable and also the one lag of implied volatility index is taken to examine the lag impact.

$$\Delta IVIX_t = \sum_{i=1}^{5} \alpha_i B_{it} + \gamma \Delta IVIX_{t-1} + e_t \text{ ....(vi)}$$

where B_{it} assumes the value 0 and 1 in the form of a dummy variable, B_{it}=1 for Monday,0 otherwise. Here *'i'* depict for Monday, Tuesday, Wednesday, Thursday, Friday. $\Delta IVIX_t$ is calculated using the following equation:

$$IVIX_t = \sum_{i=1}^{5} \alpha_i B_{it} + \gamma \; IVIX_{t-1} + e_t \text{ ....(vi)}$$

If the seasonal pattern holds in implied volatility index, then the slope α_i in equation *(iv)* should be statistically significant and different from zero.

Hypotheses Formulation

The above binary regression model is applied to the sample for testing the following empirical hypotheses:

Hypothesis 1- H1: There is a significant asymmetric relation between contemporaneous return and implied volatility.

Hypothesis 2- H2: The significance of the contemporaneous association of stock returns is more pronounced by the extreme negative returns on implied volatility index.

Hypothesis 3- H3: There is a significant negative association exists between stock index returns and implied volatility index.

Hypothesis 4- H4: There is a significant difference between the size impact of positive and negative returns on implied volatility levels.

Hypothesis 5- H5: There is a significant difference in the returns of the days of the week of implied volatility index.

Summary Statistics

Fig. 1 depicts a time-series plot of the contemporaneous relationship between the IVIX movements and Nifty 50 index over the period from 2-3-2009 to 31-12-2016. It shows that the negative relationship persists between both the indices. As the volatility index go up the stock, returns goes down and vice-versa. It has the implication for portfolio managers and hedge fund managers to exercise the negative relationship which graphically shown in Fig. 1.

Further to explore the relationship and behaviour of the indices, the summary statistics have been used which describes the data at closing values at level and also describes it by the daily returns in Table 1 and Table 2 respectively.

Tables 1 and 2 summarise the descriptive statistics of IVIX and Nifty 50 index showing the daily closing values and daily returns respectively. The summary statistics of daily prices and returns gives an insight into the properties and an asymmetric relation between the India VIX and Nifty 50 index. The behaviour of the data can be analysed by the descriptive during the full sample period as well as for the sub-periods.

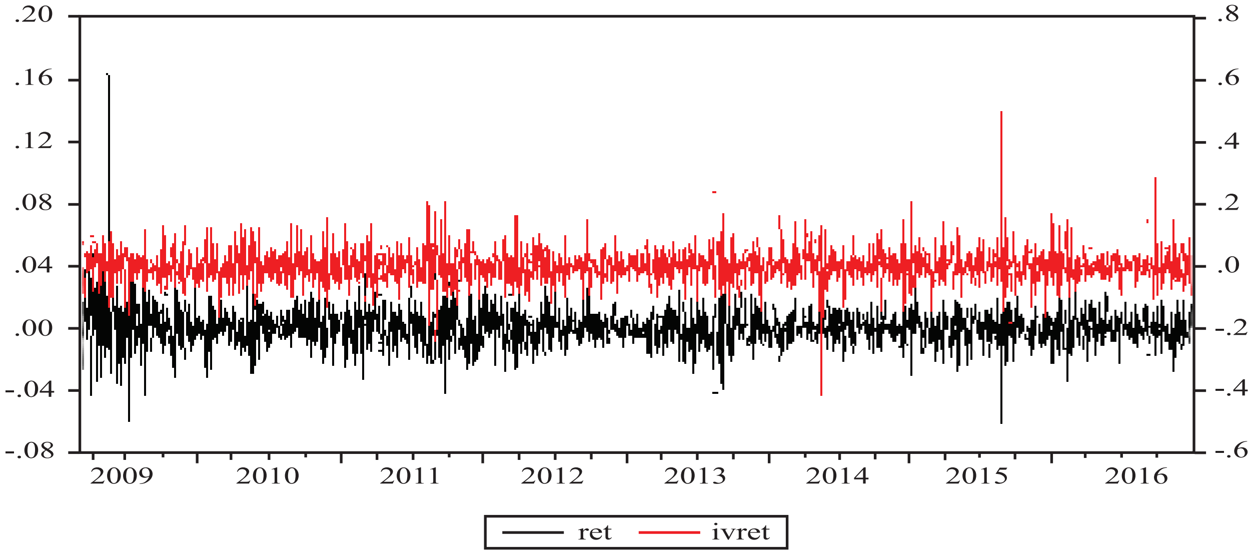

Fig. 1: Graphical Analysis

Table 1 shows the summary statistics of India VIX and Nifty index at the level for daily closing prices. The average expected volatility for the full period is being observed between 2 % to 6%. The maximum expected volatility for the full sample of daily closing is 56.07 percent and the minimum is 11.56 percent. For the sub-periods, the maximum range of India VIX is between 25.96% and 37.70% and the minimum range is between 11.56% and 16.73%.

As shown in Table 1, the relationship between the India VIX and Nifty at level shows that as the average price of nifty is high (low), the period shows low (high) volatility i.e. in 2016 the Nifty Index is at 8092.19 and the India VIX depicts low volatility level at 16.60 % which is minimum during the sub-periods. Comparatively in 2011, the mean closing price of Nifty is at 5335.11 which is lowest but the India VIX shows the high level of 23.83% which clearly shows the negative relationship. Moreover, the high volatile period experiences the high level of VIX as compared to the low volatile period.

Table 1: Summary Statistics of India VIX and Nifty Index Levels

		INDIA VIX				NIFTY Index			
Period	**Obs.**	**Mean**	**Max.**	**Min.**	**SD**	**Mean**	**Max.**	**Min.**	**SD**
2009-16	1941	21.12	56.07	11.56	7.25	6308.34	899.25	2573.15	1424.17
2009	203	36.04	56.07	22.94	8.11	4366.33	5201.05	2573.15	718.40
2010	252	21.81	34.37	15.22	3.81	5461.13	6312.45	4718.65	420.53
2011	247	23.83	37.19	16.73	4.34	5335.91	6157.60	4544.20	350.21
2012	251	19.74	28.92	13.04	4.19	5341.52	5930.90	4636.75	300.23
2013	250	18.88	32.49	13.07	4.38	5915.90	6363.90	5285	227.27
2014	244	17.11	37.70	11.56	5.50	7360.30	8588.25	6000.90	786.54
2015	248	17.61	28.71	13.14	2.89	8285.91	8996.25	7558.80	348.17
2016	247	16.60	25.96	12.75	2.20	8092.19	8952.50	6970.60	503.39

In 2009, high SD of VIX shows high volatile period with high mean value of 36.04 as compared to the low volatile period of 2.20 SD in 2016 which shows low level VIX levels at 16.60.

Table 2 shows the summary of the returns calculated for the IVIX and Nifty 50 index for different sub-periods to analyse the behaviour of return and the asymmetric relationship between the two. The mean return of full sample period shows the negative relationship as the mean return of the Nifty index is 0.0576 and the return of IVIX is negative i.e. -0.0529. It gives strong evidence that the negative relationship exists between the two indices i.e. for the negative stock returns the corresponding expected volatility return appears to be positive and vice versa. Similar results exist in respect to the international market as shown in Table 3. Table 2 also provides the asymmetric volatility phenomena, as shown in 2011 and 2015 the negative return shows high standard deviation for IVIX as compared to positive returns in a low volatile period.

Table 2: Summary Statistics of India VIX and Nifty Index Returns

India VIX						NIFTY Index			
Period	**Obs.**	**Mean**	**Max.**	**Min.**	**SD**	**Mean**	**Max.**	**Min.**	**SD**
2009-16	1941	-0.0529	0.4968	-0.4143	0.052	0.0576	0.1633	-0.0609	0.012
2009	203	-0.0030	0.1312	-0.1591	0.048	0.0032	0.1633	-0.0602	0.0209
2010	252	-0.1364	0.1545	-0.1630	0.053	0.0655	0.0343	-0.0313	0.010
2011	247	0.0175	0.00173	-0.2435	0.0002	-0.1144	0.0355	-0.0416	.0132
2012	251	-0.2751	0.1651	-0.1222	0.044	0.0980	0.0273	-0.0276	0.0095
2013	250	0.0415	0.2344	-0.1477	0.047	0.0259	0.0373	-0.0416	0.011
2014	244	-0.0028	0.1650	-0.4143	0.055	0.1119	0.0294	0.0212	0.007
2015	248	-0.0348	0.4968	-0.1844	0.058	-0.0167	0.0258	-0.0609	0.0102
2016	247	0.0441	0.2869	-0.1041	0.048	0.0120	0.0331	-0.0337	0.009

This evinced that the investors and traders respond highly to negative returns in the low volatile period as they demand more put options at the high premium which makes the implied volatility index high (Giot, 2005).

Further, Table 3 shows there is no significant difference between the mean values of VIX, VDAX, VHSI and India VIX as they ranged between the levels of 19 to 21 except for VXJ which is comparatively at the high mean value of 24.91 during the sample period. During the full sample period taken under study the standard deviation of implied volatility level ranges from the 5.99 to 7.25. Apart from it, the negative relationship between the two indices is there, as negative stock values are corresponding to the high level of VIX and vice-versa.

Table 3: Summary Statistics of International Market Dataset at Level and Return Series of Both Volatility Indices and Its Underlying Index

	US				Germany			
	VIX Close	S & P 500 Close	VIX Ret	S & P 500 Ret	VDAX Close	DAX Close	VDAX Ret	DAX Ret
Mean	19.09	1573.23	-0.06	0.0589	21.50	8024.27	-0.04	0.0568
Max.	50.93	2271.72	0.40	0.0683	47.30	12374.73	0.28	0.0589
Min.	10.32	676.53	-0.35	-0.068	10.80	3666.41	-0.27	-0.0706
S.D	6.90	410.17	0.07	0.0105	6.28	2013.58	0.05	0.0134
Obs.	1973				1990			

	Japan				China			
	VXJ Close	Nikkei Close	VXJ Ret	Nikkei Ret	VHSI Close	Hang-Seng Close	VHSI Ret	Hang-Seng Ret
Mean	24.91	12976.19	-0.04	0.0503	20.18	22157.54	-0.04	6.13E-05
Max.	72.88	20868.03	0.57	0.0742	47.82	28442.75	0.45	0.0551
Min.	13.84	7054.98	-0.33	-0.1057	11.53	16250.27	-0.20	-0.0601
S.D	6.59	3807.24	0.06	0.0144	5.99	2076.178	0.05	0.0119
Obs.	1918				1323			

Empirical Results and Discussions

Table 4 reports the OLS regression results for equation (iii) which is shown in the first row of the table to explain the individual impact of negative and positive return shocks on the implied volatility index. The results report for various sub-periods and full sample period. To describe and analyse the relationship between two variables, three regression models have been framed which is based on the binary framework in the form of 0 and 1. In other words, equation (iii) focuses on the asymmetric effect of stock returns on implied volatility in the form of binary variables δ_1^- and δ_2^+ explained in Table 4. It is obvious from the results that an asymmetric effect is present in the model.

The Wald F-stat is also applied for coefficient diagnostics to know the joint effect of the coefficients. It reports the test of null hypothesis that δ_1^- and δ_2^+ which is also statistically significant in almost cases. Evidently, they are statistically different from zero in that provided through Wald F-stats. In most cases the null hypothesis that the absolute values of δ_1^- and δ_2^+ are equal can be rejected, which supports Hypothesis 1. This indicates that there is significant asymmetric relation exists between contemporaneous return and implied volatility which is consistent with the previous studies (Fleming, 1995; Giot, 2005; Shaikh & Padhi, 2016; Whaley 2000) except Dowling and Muthuswamy (2005).

In the second model i.e. equation (iv), two additional variables have been introduced to examine the impact of stock returns on volatility. It is noticed that the absolute values of these two variables i.e. δ_3^- and δ_4^+ are also found to be asymmetric as the coefficient δ_3^- has larger value than δ_4^+. The asymmetric effect is stronger and statistically significant in full sample period and it further explains for sub-periods in the first two columns of the table. The asymmetric negative relationship is found between the two selected indices. The findings of Model 2 led to the acceptance of Hypothesis 2 indicating that the significance of the contemporaneous association of stock returns is more pronounced by the extreme negative returns on implied volatility index implying that the relationship among variables is asymmetric which indicates that the negative return shocks yield a larger impact on implied volatility indices as compared to positive returns (Giot, 2005; Shaikh & Padhi, 2016).

Moreover, the results signify that the response of implied volatility index to the underlying stock returns is different with respect to the low or high trading periods. The table also provides that in low volatility period of 2015 and 2016 the response of IVIX to negative stock returns is more as compared to other sub-periods. Although in full sample period and sub-periods, the negative relationship is shown by the coefficients δ_3^- and δ_4^+. This finding led to accepting Hypothesis 3 that there is significant negative association between stock index returns and implied volatility index, but during high volatile period when the market experienced a peaked volatility then option traders are not interested to bid as it makes no sense for them to bid when stock market falls in high volatile market as compared to low volatile market where they can make profitable strategies and therefore they act aggressively to the negative returns in low trading environment.

Now, the next step is to analyse the size effect. To examine the impact of squared stock returns on implied volatility, two more variables have been introduced. The motivation behind this is to unveil the size impact of stock returns on implied volatility index. The estimated coefficients are given in Table 4 for India VIX and Nifty 50 index. It shows δ_5^- is statistically significant only in three sub-periods i.e. 2012, 2013, and 2015, while δ_6^+ is significant in full sample period. It describes that the larger and smaller stocks have not much impact on implied volatility index movements. The coefficients diagnostics results by Wald F-stats are not statistically significant, excluding the sub- periods of 2013 and 2014. The findings did not support Hypothesis 4, implying that there is no significant difference between the size impact of positive and negative returns on implied volatility levels on Indian implied volatility index. The results are contrary to the previous study by Shaikh and Padhi (2016) who found this relationship significant but it reconfirms the results of Giot (2005).

Table 5 summarises the result of various developed and developing countries i.e. USA, Germany, Japan, and China taken as sample under the study, to analyse the negative and asymmetric relationship between the implied volatility index and its underlying asset. It has been found that the negative return-volatility relation exists between the indices of all countries which can be used to hedge the investment risk in the international market and make the diversification possible under international context. The results shown under the third column of Table 5 have larger absolute values than column four, which clearly depicts the asymmetric relationship. The negative returns have more impact in implied volatility returns than do positive returns. The hypothesis is also tested through Wald F-stats of coefficients diagnostics. It reports the test of null hypothesis that δ_3^- and $\delta_4^+ = 0$ which is statistically significant in almost all cases. The findings support the H1, H2, and H3 hypotheses implying that the above-mentioned sample countries have the significant asymmetric negative relation between contemporaneous return and implied volatility index and also the negative returns have more impact which gives the clear indication that implies implied volatility as a 'fear gauge index'.

The above results are similar to that of India VIX and also compatible with the previous studies conducted by Giot (2005) and Shaikh and Padhi (2016) for the US market and Indian market respectively and by Badshah (2009) and Sarwar (2012) on multiple markets.

Table 5 also reports the impact of the size of stock returns on VIX and VDAX, which explains the asymmetric negative relationship between the two. Moreover, the Wald F-stat shows the statistically significant results confirming that the coefficient δ_5^- has larger impact than δ_6^-, which conveys that negative return shocks makes larger movement in expected volatility as compared to the positive returns, even when the returns got squared. The results thus obtained are compatible with the previous study done by Shaikh and Padhi (2016) on Indian implied volatility index. It supports hypothesis H4 that there is significant difference between the size impact of positive and negative returns on implied volatility levels.

From this, we deduce that the quadratic effect of returns on implied volatility index is present in USA and German markets also.

Taking into account the results of Table 4 and Table 5, the study confirms that the asymmetric negative relation exists between the IVIX and Nifty 50 index, but there is no quadratic or size effect present in the data.

To explore the seasonal pattern present in implied volatility index of India, the binary regression model is applied to estimate the day-of-the-week effect. To analyse the relationship, equation (vi) has been used and the results are discussed in Table 6 based on the estimation results of the dummy regression model. It shows that the weekend effect is present in the full sample period as well as for individual years. In full sample period, 0.41 basis point increase in the volatility is positively statistically significant at 1% percent level. Also, the study can remark that the Monday effect is there in individual years which depicts the seasonal pattern or the weekend effect which is negatively significant except in 2011. Besides, it explains that the value falls from Tuesday to Friday which is statistically significant, except for Wednesday. The findings led to accepting H5 implying that the day of the week holds in Indian implied volatility index. The presence of the day-of-the-week effect contradicts the efficient market hypothesis which makes possible for the traders to make abnormal profits with the help of these seasonal patterns (Shaikh & Padhi, 2016).

Table 4: Linear Regression Results showing association between Volatility Index and Its Underlying Asset of IVIX

Period	Obs.	$\delta \bar{1}$	$\delta \bar{2}$	$\delta \bar{3}$	$\delta \bar{4}$	$\delta \bar{5}$	$\delta \bar{6}$	$\bar{R}^2$	Wald F-Stat
Dependent variable: R_t^{IVIX}									
2009-2016	1941	0.02(13.70)* -0.00(-3.32)* -0.00(-2.51)**	-0.02(-13.69)* -0.01(-6.25)* -0.00(-2.87)**	-3.40(-18.34)* -3.27(-8.19)*	-0.99(-6.58)* -1.87(-8.55)*	4.22(0.37)	12.66(5.51)	0.16 0.29 0.3	375.07(0.00)* 101.82(0.00)* 0.53(0.46)
2010	252	0.03(6.72)* -0.01(-1.19) -0.01(-1.17)	-0.03(-6.74)* -0.01(1.94)*** 0.00(-0.32)	-4.46(-8.24)* -5.13(-3.16)*	-1.97(-3.46)* -4.27(-2.71)*	-26.62(-0.43)	98.49(1.56)	0.27 0.44 0.44	91.05(0.00)* 10.07(0.00)* 2.12(0.14)
2011	247	0.03(7.21)* -0.01(-1.84)*** -0.00(-0.40)	-0.03(-7.28)* -0.00(-0.31) -0.00(-0.52)	-3.96(-8.42)* -2.25(-1.81)***	-2.98(-6.37)* -2.40(-1.64)	60.74(1.47)	-19.59(-0.42)	0.03 0.51 051	104.75(0.00) * 2.15(0.14) 1.69(0.19)
2012	251	0.01(4.11)* -0.01(-1.75)*** 0.00(0.27)	-0.01(-5.02)* -0.01(-1.04) -0.00(-0.52)	-3.63(-6.02)* 0.24(0.13)	-1.69(-3.46)* -2.18(-1.39)	180.30(2.31)**	20.92(0.32)	0.14 0.28 0.28	41.08(0.00) * 6.21(0.01)** 2.48(0.11)
2013	240	0.01(4.94)* -0.00(-1.31) 0.00(1.31)	-0.01(-4.69)* -0.00(-0.93) -0.00(-0.32)	-3.20(-6.97)* 0.62(0.54)	-1.55(-3.35)* -2.28(- 1.83)***	124.81(3.61)*	26.70(0.62)	0.15 0.32 0.35	46.46(0.00) * 6.33(0.01) ** 3.20(0.07)***
2014	244	0.01(2.42)** -0.01(-1.44) -0.00(-0.12)	-0.00(-2.03)** -0.00(0.55) 0.01(1.89)***	-4.11(-4.02)* 0.41(0.13)	-0.89(-1.07) -8.16(-3.85)*	270.79(1.55)	378.61(3.70)*	0.03 0.09 0.15	10.03(0.00)* 6.01(0.01) ** 0.28(0.59)
2015	248	0.02(4.21)* -0.02(-4.66)* -0.00(-0.61)	-0.02(-4.46)* 0.00(0.70) 0.01(1.49)	-5.78(-12.87)* -1.21(-1.45)	-3.52(-5.01)* -6.07(-3.05)*	119.20(6.30)*	129.37(1.35)	0.13 0.51 0.57	37.68(0.00)* 7.27(0.00)* 0.01(0.91)
2016	247	0.02(5.96)* -0.01(-3.20)* -0.01(-1.78)**	-0.02(-5.39)* -0.01(-1.73)*** -0.01(-1.60)	-5.35(-10.76)* -4.08(-2.97)*	-1.85(-3.85)* -1.38(-1.06)	53.74(0.99)	-21.29(-0.38)	0.2 0.48 0.48	64.68(0.00) * 25.54(0.00) * 0.94(0.33)

The standard errors are consistent of hetroscedasticity and autocorrelation; the value in parenthesis shows the t-statistic.

*,**,***Significant at 1, 5 and 10 percent level, respectively

Table 5: Linear Regression Results showing association between Volatility Index and Its Underlying Asset of VIX, VXJ, VDAX and VHSI

Period	Volatility Index	Obs.	$\delta \bar{1}$	$\delta \bar{2}$	$\delta \bar{3}$	$\delta \bar{4}$	$\delta \bar{5}$	$\delta \bar{6}$	$\bar{R}^2$	Wald F-Stat
2009-2016	VIX	1973	0.01(25.19)*	-0.04(23.70)*					0.37	1196.72(0.000)*
			0.00(2.66)*	-0.01(-8.03)	-5.84(31.54)*	-3.65(-19.76)*			0.63	70.23(0.000)*
			0.00(0.75)	-0.00(-2.59)*	-6.79(-17.27)*	-5.99(16.30)*	-29.14(-2.71)*	71.72(7.32)*	0.64	48.31(0.000)*
2009-2016	VXJ	1918	0.02(14.21)*	-0.02(-13.77)					0.16	391.59(0.000)*
			-0.02(-9.69)*	-0.01(-6.26)*	-4.65(-31.04)*	-1.09(-6.79)*			0.45	259.82(0.000)*
			-0.01(-7.20)*	-0.01(-5.94)*	-4.25(-14.77)*	-0.63(-1.83)***	8.25(1.64)	-12.01(-1.50)	0.45	4.60(0.000)*
2009-2016	VDAX	1990	0.03(25.45)*	-0.03(-23.99)*					0.38	1223.50(0.000)*
			0.00(1.68)**	-0.00(-4.38)*	-3.36(-29.65)*	-2.63(-22.90)*			0.63	20.52 (0.000)*
			-0.00(-1.92)***	-0.00(-0.56)	-4.68(-17.54)*	-3.82(-13.91)*	-34.54(-5.42)*	34.54(4.74)*	0.64	51.06 (0.000)*
2011-2016	VHSI	1322	0.02(12.34)*	-0.02(-12.62)*					0.19	311.92(0.000)*
			-0.019(-8.37)*	-0.01(-6.99)*	-5.00(-26.73)*	-0.96(-4.77)*			0.48	214.52 (0.000)*
			-0.01(-5.06)*	-0.01(-5.46)	-3.93(-9.19)*	-0.97(-2.03)*	-30.94(2.77)*	0.07(0.00)	0.48	3.08 (0.000)*

Table 6: Regression results of day of the week effect on IVIX

Period	Obs	Monday	Tuesday	Wednesday	Thursday	Friday	$\Delta IVIX_{t-1}$	$\bar{R}^2$
2009-2016	1941	0.4148(6.60)*	-0.1078(-1.70)***	-0.0599(-0.9523)	-0.2016(-3.21)*	-0.1186(1.86)***	-0.0251(-1.10)	0.029
2010	252	0.3002(1.75)***	-0.1005(-0.58)	0.1526(0.87)	-0.4340(-2.56)**	-0.0328(-0.18)	-0.0432(-0.68)	0.02
2011	247	0.3373(1.53)	-0.1421(-0.64)	-0.2794(1.25)	0.1379(0.60)	0.1627(0.74)	-0.0315(-0.49)	0.0013
2012	250	0.3445(2.71)*	-0.4996(-3.84)*	0.0207(0.15)	-0.0631(-0.49)	-0.0944(-0.75)	-0.0942(-1.47)	0.082
2013	250	0.4535(3.26)*	0.1203(0.87)	0.0178(0.12)	-0.4880(-3.56)*	-0.0916(-0.63)	0.0830(1.30)	0.079
2014	244	0.3961(2.20)*	-0.1859(-1.02)	-0.1303(-0.74)	0.0556(0.29)	-0.1232(-0.67)	0.0465(0.72)	0.009
2015	248	0.4589(2.86)*	-0.0460(-0.28)	0.0500(-0.31)	-0.2356(-1.44)	-0.1231(-0.72)	0.0105(0.16)	0.023
2016	247	0.2369(1.93)***	0.0291(0.23)	-0.0078(-0.06)	-0.0442(-0.37)	-0.1847(-1.56)	-0.0747(-1.15)	0.012

The standard errors are consistent of hetroscedasticity and autocorrelation; the value in parenthesis shows the t-statistic.

*,**,***Significant at 1, 5 and 10 percent level, respectively

Summary and Conclusion

The study has been carried out on volatility index which measures the 30-day expected volatility. The focus of the study is to draw attention to the relationship of contemporaneous returns and its association with implied volatility index in developing countries and compare it with the findings of developed countries. The study makes novel attempt to examine this relationship in the Indian market after the introduction of volatility futures in February 2014 on Indian implied volatility index. The sample period taken is according to the availability of data on Indian implied volatility index from March 2, 2009 to December 31, 2016 to order to examine the asymmetric association and seasonality pattern in respect of various sub-periods i.e. full sample period and individual years. The negative relationship between IVIX and stock index returns makes the index relevant for investors to diversifying their portfolio so that they can mitigate the investment risk. The existing literature suggests that this theoretical relationship would give a base to develop a theory which helps regulators to trade future and options on the volatility index. The findings of the study clearly show how VIX derivatives can be used as a risk management tool (i.e. Badshah, 2009; Giot, 2005; Sarwar, 2012; Shaikh & Padhi, 2016).

Further, the empirical result reports the asymmetric relation which also makes the implied volatility as a fear gauge index, it describes the relationship as which indicates that the negative return shocks yield a larger impact on implied volatility indices as compared to positive returns. Moreover, the results signify that the response IV index to the underlying stock returns is different with respect to the low or high trading periods. During high volatile period when the market experienced a peaked volatility, option traders are not interested to bid as it makes no sense to them to bid when stock market fall in high volatile market as compared to low volatile market where they can make profitable strategies. Therefore, they act aggressively to the negative returns in low trading environment. Based on the estimation results of the dummy regression model, we can show that there presents a weekend effect in the full sample period as well as for individual years. The presence of the day-of-the-week effect contradicts the efficient market hypothesis which makes possible for the traders to make abnormal profits with the help of these seasonal patterns (Shaikh & Padhi, 2016).

Implications of the Study

The literature suggests that the information content of the implied volatility index possesses relevant implications for portfolio managers, asset management companies, regulatory authorities, policy makers, and most importantly for hedgers. Risk management is considered to be an important tool for hedgers and portfolio managers. Indicatively the highly negative and asymmetric contemporaneous correlation exists between volatility index and their underlying. It makes the diversification possible so that the investors or hedgers can hedge their possible risk by taking a position in future and options on a VIX index. It can also be used as to generate more profitable strategies. Moreover, the study can also be extended by examining the predictive power of the index by taking long and short positions to take an index as the relationship between the indices makes it a signaling device to grab the opportunity, besides the high-frequency data can be used to analyse this relation in the short-term horizon.

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