

Linkage between India Implied Volatility Index and Stock Index Returns

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Abstract

The present study examines the linkage between the change in implied volatility index and the underlying stock index return in the Indian stock market. The empirical results revealed that the contemporaneous return is the most important factor that determines the changes in the current India implied volatility. Besides, the empirical evidences confirm the negative asymmetry volatility-return relation, supporting the behavioral explanations (the affect and representativeness heuristics) rather than financial leverage hypothesis.

Keywords

India Implied Volatility Index, Asymmetric Volatility-Return Relation, Fear and Greed Index

1. Introduction

The nexus between stock market returns and volatility has been well documented in the financial economic literature and the empirical evidences show a negative and asymmetric return-volatility relation. The two well-known theories documented in the literature to elucidate the negative return-volatility association are the leverage hypothesis and the volatility feedback hypothesis which are based on fundamental factors of the firm. According to the leverage hypothesis, proposed by Black [1] and Christie [2], if a firm's debt raises the firm's debt/equity-ratio and risk level rises and as a corollary the value of its equity falls, *i.e.* as the risk level raises, the volatility of the equity is also expected to rise. Conversely the volatility feedback hypothesis, proposed by Campbell and Hentschel [3], states that positive shocks to volatility cause negative returns which means if anticipated future stock returns increase when volatility increases, then current stock prices (and hence returns) will drop to adjust to this change in future an-

ticipations. Thus, an increase to volatility causes negative returns. However, the authors found empirically feeble support for their volatility feedback hypothesis.

Besides, Shefrin [4] reported a negative return–risk relation due to the underlying principle that as investors view more return and less risk to be representative of good investments. This notion can be extended to the market such that higher negative (positive) returns and higher (smaller) risk or volatility are viewed as connected uniqueness of market behavior. Dennis *et al.* [5] explains that the return-volatility relation is only a market occurrence, not a firm one. Moreover, Hibbert *et al.* [6] documented that the leverage and volatility feedback hypotheses are not relevant to the intraday evidences because they are only enough to explain the long term return-volatility association. It is not lucid to consider that a firm’s leverage varies significantly within the course of a single day. Meanwhile, the risk premium assumed in the volatility feedback hypothesis also tends to vary within the long-term business cycle rather than within the intraday interval. Hence, the authors support behavioral explanations for the negative return-volatility relation.

The option implied volatility index is often referred to as investors’ sentiment, fear and greed index and the most notable feature of the implied volatility index is its negative correlation with the underlying stock market index. The investors’ sentiment or fear is featured by a fall in the underlying stock market index or negative index return and if negative return is connected with an asymmetrically larger rise in the implied volatility index, investors will take this phenomenon into account when they make assessment. Therefore, the examination of negative return-implied volatility relation behaviour is a subject of great interest to investors, practitioners and academics, alike. Most importantly, it is immense helpful for capital market regulators and policy makers as they equipped to launch volatility-related derivatives such as futures and options on various volatility indices. In this study, the attempt has been made to examine the linkage between the change in implied volatility index and the underlying stock index return in the Indian stock market.

The rest of the article is organized as follows: Section 2 provides the review of related literature. Section 3 presents the methodology of the study. Section 4 and Section 5 provides the empirical findings and the concluding remarks, respectively.

2. Review of Literature

Several empirical studies have been established based on the leverage hypothesis and volatility feedback hypothesis. For instance, Bekaert and Wu [7] studied for the Japanese stock market and supported the volatility feedback hypothesis for an asymmetric effect. Low [8] found weak support for the financial leverage hypothesis for the asymmetry. Giot [9] and Bollerslev and Zhou [10] found that the US stock market exhibits asymmetry relation with implied volatility. Dennis *et al.* [5] provided the evidences that the asymmetric relation between return and implied volatility was mainly due to the systematic market-wide risk factors ra-

ther than comprehensive firm-level effects. For the US market, Hibbert *et al.* [6] neither supported the leverage nor volatility feedback effects and they advocated for the behavioural explanation and extrapolation bias concepts. Besides, Fernandes *et al.* [11] confirmed negative volatility-return for the US stock market. Badshah [12] found negative and asymmetric association among implied volatility index and its corresponding stock market index of the US and Europe. Tang [13] and Frijns *et al.* [14] found negative and asymmetric return-volatility relation in the case of Korean and Australian stock market, respectively. Siriopoulos and Fassas [15] established a significant negative and asymmetric linkage in the Greek stock market, which is contradictory to the earlier finding of Skiadopoulou [16]. Lee and Ryu [17] confirmed the existence of asymmetric volatility phenomenon in the Korean and the US stock markets. Similarly, Shaikh and Padhi [18] found the negative and asymmetric effect in the Indian stock market.

Most of the empirical studies in this subject were mainly focused on developed and emerging equity markets. However, the studies in the context of Indian stock market are found to be meager. To the best of knowledge, Shaikh and Padhi [19] is the only study attempted to investigate the asymmetric contemporaneous linkage between India VIX and NIFTY Index and they established linkage is negative and asymmetric. In another study, Shaikh and Padhi [19] investigated the behaviour of India VIX during, before and after the scheduled macroeconomic news release and they implicitly assumed the symmetric behaviour of market reactions towards positive and negative shocks. Therefore, these studies may lead to misleading conclusion in the subject of negative and asymmetric return-volatility relation in the Indian context. The present study throws light on this subject and will provide the exact inferences for the policy decision makers, regulators and investors.

3. Methodology

The regression model is employed to assess the asymmetric relation between returns on the S & P CNX NIFTY and changes in the India implied volatility index. Following Hibbert, *et al.* [9], we constructed the following model specifications to examine the return-volatility linkage.

Model 1:

$$\Delta IVIX_t = \alpha_0 + \alpha_1 r_t^{(+)} + \alpha_2 r_t^{(-)} + e_t \quad (1)$$

$$r_t = \beta_0 + \beta_1 \Delta IVIX_t^{(+)} + \beta_2 \Delta IVIX_t^{(-)} + e_t \quad (2)$$

Model 2:

$$\Delta IVIX_t = \psi_0 + \psi_1 r_t + \psi_2 r_t^2 + e_t \quad (3)$$

Model 3:

$$\Delta IVIX_t = \omega_0 + \omega_1 r_t + \omega_2 r_{t-1} + \omega_3 r_{t-2} + \omega_4 r_{t-3} + \omega_5 IVIX_{t-1} + \omega_6 IVIX_{t-2} + \omega_7 IVIX_{t-3} + e_t \quad (4)$$

$$r_t = \mu_0 + \mu_1 \Delta IVIX_t + \mu_2 \Delta IVIX_{t-1} + \mu_3 \Delta IVIX_{t-2} + \mu_4 \Delta IVIX_{t-3} + \mu_5 r_{t-1} + \mu_6 r_{t-2} + \mu_7 r_{t-3} + e_t \quad (5)$$

In the above models, $\Delta IVIX$ is the change in the IVIX at time t , give by $IVIX_t - IVIX_{t-2}$. r_t is the contemporaneous daily percentage change in the S & P CNX NIFTY index. $r^{(+)}$ and $r^{(-)}$ denotes positive return and denotes negative return, respectively. $\Delta IVIX^{(+)}$ and $\Delta IVIX^{(-)}$ represents positive and negative changes in the IVIX, respectively. r_t^2 is the square of the contemporaneous return on the S & P CNX NIFTY. r_{t-1}, r_{t-2} and r_{t-3} are the one, two and three day lag returns for the S & P CNX NIFTY index, respectively. $\Delta IVIX_{t-1}, \Delta IVIX_{t-2}$ and $\Delta IVIX_{t-3}$ are the one, two and three day lag changes in the IVIX, respectively.

The following hypotheses can be tested using the empirical models mentioned above.

Hypothesis I:

The first hypothesis connected to Model 1 is that negative return inflicts a larger impact on the change in the current India VIX than positive return does. In other words, the return-volatility relation is asymmetric, *i.e.* implied volatility reacts differently to negative and positive returns. This implies that the slope coefficient of the negative return (α_2) have to be statistically significant and should be larger, in absolute term, than that of the positive return coefficient (α_1).

Hypothesis II:

The second hypothesis linked to Model 2 is that contemporaneous return on the S & P CNX NIFTY index is the significant factor in determining changes in the India VIX. This signifies that the slope coefficient of the contemporaneous return on the S & P CNX NIFTY index (ψ_1) have to be statistically significant. If this hypothesis does not hold, then the leverage or volatility feedback effects can elucidate the return-volatility relation.

Hypothesis III:

The third hypothesis associated to Model 2 is that the size effect, represented by squared return (r_t^2), might exist. The insignificant coefficient of the squared return shows the absence of the size effect.

Hypothesis IV:

The fourth hypothesis allied to Model 3 posits that lagged returns on the S & P CNX NIFTY index are the vital factors in determining the change in the current implied volatility. This indicates that the slope coefficients of the lagged returns ($\omega_2, \omega_3, \omega_4$) have to be statistically significant. If the coefficients of lagged returns are insignificant, then the leverage effect might not hold in daily data.

The study is based on time series data comprising daily closing values of S & P CNX NIFTY 50 index of National Stock Exchange (NSE), India. NSE is selected as it has the highest turnover and number of trades in equity and derivatives segment in India. The NIFTY 50 is a diversified 50 stock index accounting for 12 sectors of the economy. It is used for a variety of purposes such as benchmarking fund portfolios, index based derivatives and index funds. The NIFTY 50 Index represents about 66% of the free float market capitalization of the stocks listed on NSE as on 31, May 2016. Moreover, the India Implied Volatility Index (IVIX)

considered for the study is developed by the NSE and the India VIX historical data is available from 2nd March 2009. Hence, the sample period for the study is considered from 2nd March 2009 to 31st August 2016. The daily data points of the S & P CNX NIFTY index and India VIX are collected from the website of National Stock Exchange of India (NSE), Mumbai (<https://www.nseindia.com>).

4. Empirical Results

In view of the fact that, India VIX represents the investor’s perception of the market volatility in the near term, it is anticipated that higher volatility reflects the negative sentiment of investors and thus lowering the stock index. On the other hand, a low India VIX reflects the positive investors’ sentiment and thus higher trading participation in the stock market. Hence, the NIFTY index and the India VIX are negatively correlated. **Figure 1** depicts that the India VIX tends to drop when NIFTY goes up, and vice versa. Besides, the NIFTY is negatively correlated (-0.6514) with the India VIX as shown in **Figure 1**, implying that the India VIX is an excellent hedging device.

Table 1 shows the descriptive statistics and unit root test statistics of the NIFTY return and the change in implied volatility index for the sample period of

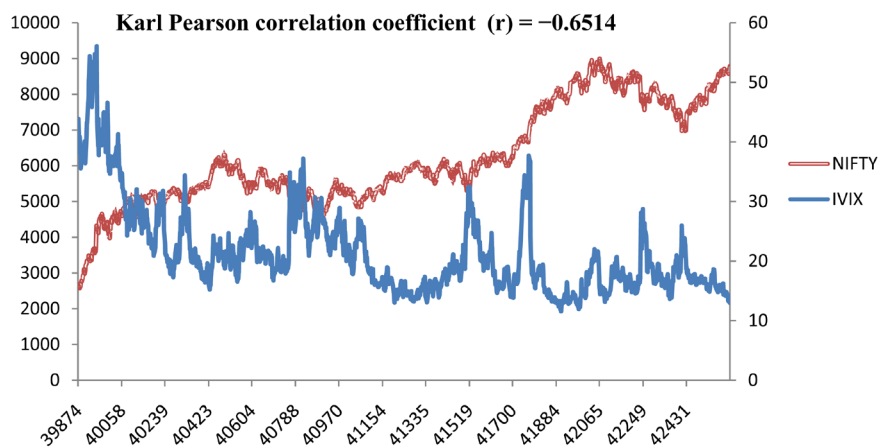


Figure 1. Movements of India implied volatility index and the S & P CNX NIFTY index.

Table 1. Descriptive statistics and unit root test results.

	$\Delta IVIX_t$	r_t
Mean	-0.0162	3.3215
Maximum	11.015	651.50
Minimum	-12.472	-490.95
Std. Dev.	1.2718	69.028
Skewness	-0.1185	0.1621
Kurtosis	14.546	8.8328
Jarque-Bera Statistics	10225* (0.0000)	2616.3* (0.0000)
ADF Test Statistics	-43.972* (0.0001)	-40.009* (0.0000)

Authors own computation. Data are retrieved from the National Stock Exchange Website (<http://www.nseindia.com>). Figures in the parenthesis () indicates p-value. *denotes the significance at one percent level.

2nd March 2009 to 31st August 2016. For the change in IVIX, the mean value is negative (-0.0162) and the series is negatively skewed and leptokurtic. The mean of NIFTY index return is positive (3.3215) and the return series is positively skewed and leptokurtic. The Jarque-Bera statistics reject the null hypothesis, at one percent significant level, that the NIFTY return and change in IVIX series is normal against the alternative hypothesis that the both series is non-normal. The Augmented Dickey-Fuller (ADF) test statistics are statistically significant at one percent level, signifies that the change in IVIX and NIFTY returns series are stationary.

Table 2 provides the regression results between the changes in the India Implied Volatility index and its underlying S & P CNX NIFTY index returns. The estimated intercept is close to zero and it is statistically significant at one percent level, implying that if the S & P CNX NIFTY index does not change over the day, the change of IVIX should be negligible. The estimated coefficient of the negative return is found to be significant at one percent level and larger than that of the positive return, which is statistically significant at one percent level. This shows that if the S & P CNX NIFTY index exhibits a negative return of 100 basis points or 1 percent, the India implied volatility will rise by 0.0133 percent. Conversely, a positive return of 100 basis points or 1 percent will cause a meager fall in the India implied volatility by 0.0065 percent. It is clear from the results that coefficient of negative return of S & P CNX NIFTY index is found to be higher in absolute value than positive return, implying the effect is asymmetric. This confirms that negative returns of the stock index are associated with much greater relative changes in the implied volatility index than are positive returns. Hence, the IVIX index reflects investor fears of market downward. Besides, the table results show that coefficient of positive changes in IVIX is found to be statistically significant at one percent level and larger than that of the negative changes in IVIX which is statistically significant at one percent level. This indicates that S & P CNX NIFTY return changes much higher as IVIX changes in positive than negative manner, hence investors are more sensitive on the rising of IVIX index.

Table 2. Regression results for changes in the India Implied Volatility index and S & P CNX NIFTY index returns.

Intercept	$r_t^{(-)}$	$r_t^{(+)}$	DW Statistics	R^2
-0.1968* [-3.6383]	-0.0133* [-16.848]	-0.0065* [-7.7921]	1.8986	0.2470
Dependent Variable: r_t				
Intercept	$\Delta IVIX_t^{(-)}$	$\Delta IVIX_t^{(+)}$	DW Statistics	R^2
14.516* [6.2230]	-17.050* [-9.0907]	-28.977* [-13.804]	2.0014	0.0794

Authors own computation. Data are retrieved from the National Stock Exchange Website (<http://www.nseindia.com>). Figures in the parenthesis [] indicates t-value. *denotes the significance at one percent level. r and $\Delta IVIX$ are the S & P CNX NIFTY index return and the changes in India Implied Volatility index, respectively. $r^{(+)}$ and $r^{(-)}$ denote positive return and denotes negative return, respectively. $\Delta IVIX^{(+)}$ and $\Delta IVIX^{(-)}$ represent positive and negative changes in the IVIX, respectively.

Table 3 reports the regression results for India implied volatility reaction to S & P CNX NIFTY market return shocks. The regression results show that the coefficient of contemporaneous return (r_t) is found to be negative and statistically significant at one percent level, suggesting that the contemporaneous return of S & P CNX NIFTY is the most significant factor that determines changes in current India implied volatility. The squared return (r_t^2), introduced by Giot [9] and Hibbert *et al.* [6] is incorporated in the regression model to evaluate the size effect of the return. The significant coefficient of the squared return shows that small and large returns can influence the changes in implied volatility index differently, and also it suggests that the estimated regression model is superior, as it taken into account the size effect that persuade the change in the India VIX.

Table 4 reports the regression results between the lagged changes in the India Implied Volatility index and its underlying S & P CNX NIFTY index returns. The estimated coefficients of contemporaneous return and one-day lagged return are found to be negative and statistically significant at one percent level. It

Table 3. Regression results for India implied volatility reaction to S & P CNX NIFTY market return shocks.

Dependent Variable: $\Delta IVIX_t$				
Intercept	r_t	r_t^2	DW Stat.	R^2
-0.0690* [-2.5813]	-0.0133* [-16.848]	1.76E-05* [9.3017]	1.9649	0.2780

Authors own computation. Data are retrieved from the National Stock Exchange Website (<http://www.nseindia.com>). Figures in the parenthesis [] indicates t-value. *denotes the significance at one percent level. r and $\Delta IVIX$ are the S & P CNX NIFTY index return and the changes in India Implied Volatility index, respectively. r_t^2 is the square of the contemporaneous return on the S & P CNX NIFTY.

Table 4. Regression results for lagged changes in the India implied volatility index and S & P CNX NIFTY index returns.

Dependent Variable: $\Delta IVIX_t$									
Intercept	r_t	r_{t-1}	r_{t-2}	r_{t-3}	$\Delta IVIX_{t-1}$	$\Delta IVIX_{t-2}$	$\Delta IVIX_{t-3}$	R^2	DW Statistics
0.0072 [0.2849]	-0.0092* [-25.063]	-0.0026* [-6.0876]	-0.0004 [-1.0600]	0.0001 [0.3158]	0.0246 [1.0541]	-0.0749* [-3.2164]	-0.0135 [-0.5883]	0.2666	2.001

Dependent Variable: r_t									
Intercept	$\Delta IVIX_t$	$\Delta IVIX_{t-1}$	$\Delta IVIX_{t-2}$	$\Delta IVIX_{t-3}$	r_{t-1}	r_{t-2}	r_{t-3}	R^2	DW Statistics
2.6145*** [1.8774]	-27.554* [-25.063]	0.8300 [0.6518]	-2.7350** [-2.1500]	0.8430 [0.6694]	0.1269* [5.4105]	-0.0451*** [-1.9109]	0.0152 [0.6503]	0.2607	1.999

Authors own computation. Data are retrieved from the National Stock Exchange Website (<http://www.nseindia.com>). Figures in the parenthesis [] indicates t-value. *, ** & ***-denote the significance at one, five and ten percent level, respectively. r_t and $\Delta IVIX_t$ are the S & P CNX NIFTY index return for the period “ t ” and the changes in India Implied Volatility index for the period “ t ”, respectively. r_{t-1} , r_{t-2} and r_{t-3} are the one, two and three day lag returns for the S & P CNX NIFTY index, respectively. $\Delta IVIX_{t-1}$, $\Delta IVIX_{t-2}$ and $\Delta IVIX_{t-3}$ are the one, two and three day lag changes in the IVIX, respectively.

is also observed that the coefficient of contemporaneous return, in absolute value terms, is higher than the one-day lagged return which supports potential behavioral explanations rather than the leverage hypothesis. This suggests that contemporaneous negative linkage between changes in the India VIX and market returns take over the linkage of expected volatility with past and future stock market returns. Since the leverage hypothesis is related to longer term lagged effects, the strong significant effect from current return is contradicting the leverage hypothesis for the asymmetric volatility. The significantly negative coefficient of one-day lagged return indicates that a negative shock imposes a stronger impact on the change in implied volatility than a positive shock, supporting leverage hypothesis. However, the two-day and three-day lagged coefficients of return are found to be statistically insignificant in determining the changes in the IVIX. Hence, the leverage hypothesis is at best a weak explanation for the asymmetric volatility. This further supports potential behavioral explanations rather than the leverage hypothesis. In other words, the leverage hypothesis might not hold in daily data. Moreover, the lagged coefficient ($IVIX_{t-2}$) of changes in the IVIX is found to be statistically significant at five percent level, confirming clear asymmetric return-volatility linkage. The study results validate the negative and asymmetry between return and implied volatility relation in the Indian stock market.

5. Conclusions

The present study examines the linkage between the change in implied volatility index and the underlying stock index return in the Indian stock market. The regression results revealed that the contemporaneous return is the most important factor that determines the changes in the current India implied volatility. Besides, the empirical evidences confirm the negative asymmetry volatility-return relation, supporting the behavioural explanations (the affect and representativeness heuristics) rather than financial leverage hypothesis.

The great concern and nervousness of the investor on the contemporaneous negative return affect them negatively emotionally and the falling market is viewed as representative for the future. In falling markets, investors buy put options for hedging and speculations in a much higher degree than they buy call options in rising markets. Hence, the implied volatility increases and leads to a negative risk-return linkage. This increased implied volatility related to rising put prices is a consequence of the heuristics as well as loss aversion or downside fear. The study validates that the India implied volatility index is the fear and greed index of the investors' sentiment and stock market volatility, which will be immense helpful to the investors in providing diversification benefits and acts as the effective hedging device. The study encourages the policy makers of National Stock Exchange (NSE), the Securities and Exchange Board of India (SEBI), to establish India VIX on individual stocks to enhance more market liquidity and transparency.

In a synchronized market landscape, financial markets are interdependent and

volatility in one market has spillover effects on the other. This dimension of India VIX can be examined by measuring the integration of India VIX with the volatility indices of major economies of the world.

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