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Cross Market Volatility Spill overs: An Empirical Analysis of Transmission Effect between US (S&P 500) and Indian (NIFTY 50) Equity Markets

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Abstract: *At Present the global economy is dynamic and unpredictable in nature and the financial panic spreads beyond the borders. So, in this study we are going to examine the volatility spill over of the equity market i.e., from the US market (S&P 500) to Indian market (NIFTY 50) there by understanding the cross-border financial transmission which is asymmetrical in nature and caused by unstable macroeconomic events. The aim of the study is to measure the spill over of volatility and to understand the effect of the 3 factors namely currency risk (USD/INR), global Fear (CBOE VIX) and 10year sovereign yield spread individually and combined. A sample of 348 weekly data were collected from secondary sources and analysed using R-programming and by using tools like GARCH (1,1) model, Vector Auto regression (VAR), Granger Causality, Threshold VAR, and Multivariate VARX model to Calculate volatility and to understand the relationship between the factors. The result Indicates that the spill over is asymmetrical when global markets are calm (VIX < = 20), only 9.23%. Indian market volatility is caused by us market but when panic break outs (VIX > 20), 38.6% Of Indian market Volatility is due to the US market. Other factors like currency risk and 10year yield Spread have an insignificant Impact individually, but when all 3 factors are combined, the market shock transmitted is significantly higher. Therefore, this study implies that during crises Indian equity market depends heavily on the Us Market.*

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Introduction

Now-a-days due to the advancement in technologies, relaxation in regulations in the emerging nations for trading and increase in the awareness of the information related to the market globally thereby indicating that the overall global financial system is unified. Here, the US equity market acts as a global leader that determines the global liquidity and risk appetite. Even though, Indian market grows significantly and attracts Foreign Institutional capital, it relies highly on the external macroeconomic shocks from the US market.

It is important to understand when and how the shocks transmit across the borders for the financial stakeholders to keep the investment safe and to know how deep the shocks travel from the US market to emerging countries' markets like Indian market (NIFTY 50) and how to manage these shocks in order to maintain the economic stability.

Problem Statement

The existing researches treat the volatility spillage as a static and symmetrical process and does not include the impact of the factors like currency risk (USD/INR), global fear (CBOE VIX), and 10year sovereign yield spread. But in reality, we have to study the impact of the factors and the dynamic and asymmetrical nature of the volatility spillage from the US market (S&P 500) to Indian market (NIFTY 50).

Research Objectives

- To examine the level of impact of the US market (S&P 500) volatility on the Indian market (NIFTY 50) volatility.
- To analyse whether shocks in the S&P 500 transmit significantly to the Indian equity market.
- To examine the moderating role of the USD/INR currency exchange rate fluctuations on the volatility transmission.
- To evaluate the degree of the global fear (CBOE VIX) that impacts the spillage of volatility using regime-switching thresholds (calm vs. panic break out periods).
- To examine the role of the Sovereign Yield Spread moderator on the volatility transmission.
- To evaluate the impact of all the 3 macroeconomic variables together on the volatility transmission.

Literature Review

"Meteor shower" hypothesis proposed by Engle, Ito, and Lin (1990) acts as the backbone for the spill over of cross-border volatility and it indicates that volatility from one market generally "rains down" (i.e., passes down) into other markets globally due to the overlapping of the time zones.

Evolution of the spill over Studies

Early empirical studies indicate that the movement of global information follows a Certain order. Kumar and Mukhopadhyay (2002) mentioned that the US market (S&P 500) is the global "price maker" and other countries especially India are "price takers" as the volatility of US market has a significant impact on the other markets (especially NIFTY 50) on the next day when the market opens. Thereby following the Meteor shower hypothesis which is the base for transmission studies. But Kaur (2004) later explained that the Indian market does not react to the Us market when global economic situation is stable and reacts only when extremely high external global shocks occur.

Addressing the "Time Zone" Bias

Researchers later found that studying the daily closing prices leads to inaccurate results. Baumöhl and Výrost (2010) studied the daily modelling and explained that the US and Indian trading hours do not overlap leading to a non-synchronous trading bias. Thereby suggested to use weekly data to avoid intraday noises, Settlement delay, and time-zone bias (lags). Camilleri and Green (2014) also supported the claim that the market Movement of India is a delayed reaction to the US market previous day movement and depends on its closing price.

Role of the Macroeconomic Moderators

Recent researchers focused on what increases the spill over effect. Misha, Swain and Malhotra (2007) identified that Institutional Capital flow is the primary factor that increases the spill over caused. Kalra (2025) explained that increasing panic break out in the S&P 500 largely impacts the NIFTY 50 than its calm Situation indicating an asymmetrical movement. Mishra, Sahay, and Sharma (2025) supported this by linking this to CBOE VIX and Said that global fear is exported immediately. Additionally, Jangid (2025) indicated that despite the increase in the domestic retail investors in India, the market depends on the US monetary policies and fluctuates accordingly. Therefore, Rajuroy (2024) and Saini & Sharma (2025) concluded that if global liquidity dries up, the overall global market crashes together thereby India is not a "Safe Haven" during crisis.

Research Gap

Existing models test these factors individually but not together and use daily data instead of weekly data leading to time zone bias and they do not include the effect of sovereign yield spread to understand the impact on Volatility spill over.

Hypotheses

Based on the identified gap, below are the 5 hypotheses framed

- **Objective 1 & 2**

H_0: The US market (S&P) Shocks do not significantly transmit and cause the volatility in the Indian market (NIFTY 50).

H_1: The US market (S&P 500) shocks are significantly transmitted and cause the volatility in the Indian market (NIFTY 50).

- **Objective 3 (USD/INR)**

H_0: The exchange rate (USD/INR) does not significantly impact the volatility spillover.

H_1: The exchange rate (USD/INR) significantly impact the volatility spillover.

- **Objective 4 (VIX Regime-Switching)**

H_0: Global fear (CBOE VIX) does not significantly affect the spillover effect and the transmission is same during both the calm and panic periods.

H_1: Global fear creates high asymmetric transmission, thereby increasing the spillovers significantly during panic breakout.

- **Objective 5 (Sovereign Yield Spread)**

H_0: The Sovereign Yield Spread does not significantly impact the volatility spillage.

H_1: The Sovereign Yield Spread significantly impacts the spillage, thereby revealing that capital flight increases the market shocks.

- **Objective 6 (Combined Multivariate Effect)**

H_0: The 3 macroeconomic factors (VIX, USD/INR, Yield Spread) do not act together to cause significant impact on the volatility spillover

H_1: The 3 macroeconomic factors act together simultaneously to cause significant impact on the volatility spillover.

Data Collection and Instruments

As all data is secondary, it is collected from public financial sources and 348 weekly data is collected to observe the market behaviour of nearly 7 years (2019 to 2025).

Core Variables

Weekly closing prices of the S&P 500 and the NIFTY 50. These values are converted into continuous log return values to reduce unnecessary noises and to make the data stationary.

Moderating Variables

- **CBOE VIX:** To measure the effect of the global market Uncertainty.
- **USD/INR (Exchange rate):** To measure the effect of currency Value depreciation risk
- **Sovereign yield spread:** to measure the effect of institutional Capital fight

(Calculation: Sovereign yield spread = US 10-year Treasury yield - India 10-year Government Bond Yield).

Data Analysis Techniques

Data was processed and R-statistical programming was used to study the econometric modelling.

- **Stationarity Tests:** Augmented Dickey-Fuller (ADF) test was used to confirm that the data used is stationary and to avoid false correlations.
- **Volatility Estimation:** Univariate GARCH (1,1) model was used to calculate the volatility of both the equity markets.

- **Dynamic Interaction:** Granger Causality test was applied to know the direction of the volatility spillage. Additionally, standard Vector Autoregression (VAR) model was used to understand the relationship between the time series variables.
- **Shock Measurement:** Impulse Response Functions (IRF) was used to identify the direction and duration of the shocks passed and Forecast Error Variance Decomposition (FEVD) was used to evaluate the percentage of impact of the shock.
- **Regime Switching:** Threshold VAR was used by dividing the 7-year sample into a "Calm period" (VIX <= 20) and a "Panic period" (VIX > 20) to understand how global fear changes the intensity of the spillage.
- **Moderation Models:** VARX models were used to evaluate the impacts of the 3 factors separately, and a Multivariate VARX model was used to evaluate the impact of the 3 factors together on the volatility spillover.

Results / Data Analysis

Descriptive Statistics and Preliminary Testing

Augmented Dickey-Fuller (ADF) test verified that the log return values of both the equity markets S&P 500 ($p = 0.01$) and the NIFTY 50 ($p = 0.01$) were stationary.

GARCH (1,1) model revealed that the both markets showed high volatility with a score of 0.932 for the S&P 500 and 0.859 for the NIFTY 50. Thereby, indicating that when shock reaches the markets, the volatility caused is very high.

Objective 1 & 2: Baseline Impact and Transmission Magnitude

Granger Causality test revealed that in long-term, the closing price values indicates that the S&P 500 causes the NIFTY 50 markets movement (p-value = 0.0001424). But the log return values indicates that the US market does not cause the Indian market returns (p-value = 0.4297). thereby, concluding that in long term, the US market impacts the movement of the Indian market.

Forecast Error Variance Decomposition (FEVD) test describes that 32.05% of the variance in the NIFTY 50 was caused by the shocks in the S&P 500 and the remaining 67.95% of the variance in the NIFTY 50 was due to the internal factors. The Impulse Response Function (IRF) showed that the shocks in the S&P 500 are transmitted immediately to the NIFTY 50.

Objective 3: The Moderating Role of USD/INR

The factor USD/INR exchange rate showed that it caused only minor shift when it acts alone. Though, there is only a minor effect, the S&P 500 still caused 31.96% of the NIFTY 50's variance. Therefore, the effect of currency exchange rate on its own on volatility spillover is insignificant.

Objective 4: The Moderating Role of Global Fear (Regime-Switching VIX)

The 7-year sample was segregated into two periods based on the CBOE VIX fear gauge. The results showed a highly asymmetrical impact on the volatility:

- The Calm Regime (VIX <= 20): The 206 weeks data when the global markets are safe, the VIX had insignificant impact on the NIFTY 50 volatility caused by the S&P 500 and the FEVD showed that only 9.23% of the volatility of the NIFTY 50 is caused by S&P 500.
- The Panic Regime (VIX > 20): The panic breaks out in the 140 weeks data showed that the VIX had a higher negative impact on volatility of the Indian market and FEVD showed that the impact was increased to 38.6%.

Objective 5: The Moderating Role of Sovereign Yield Spread

The Sovereign Yield Spread on its own showed an insignificant impact (p-value = 0.658) on the volatility spillover caused by the US market. Thereby indicating that the market moderators do not act on their own.

Objective 6: The Combined Moderating Effect (Multivariate VARX)

A Multivariate VARX model was used to evaluate how the 3 factors (VIX, USD/INR, and Yield Spread) act together simultaneously. It revealed that,

- CBOE VIX effect remained highly significant ($p < 0.001$).
- Yield Spread which on its own had insignificant impact also showed a high significant impact ($p < 0.001$).
- USD/INR also affects the volatility spillover ($p = 0.0033$) when combined with other factors.

Therefore, it indicates that increasing global fear, currency rate fluctuation and interest rate forced capital fight increases the equity market volatility spillover.

Discussion

The results of this study explained the cross-border volatility spillover and proved the "Meteor Shower" hypothesis that volatility passes down from the US market (S&P 500) to the Indian market (NIFTY 50). The factors like currency exchange rate (USD/INR) and sovereign yield spread on their own does not have an effect on the volatility spillover but global fear (CBOE VIX) showed that even though during calm period it impacts only 9.23% of spillover, during the panic break outs spillover is increased to 38.6% thereby indicating asymmetrical movement.

Therefore, the increasing global fear, currency rate fluctuation and interest rate forced capital fight together increases the equity market volatility spillover.

Comparison with Previous Studies

The result of this study rejects the popular "decoupling hypothesis," and supports the claims of Rajuroy (2024) and Saini & Sharma (2025) that India is not a safe haven during global crises. Granger causality tests supported the Efficient Market Hypothesis provided by Kumar and Mukhopadhyay (2002) that US is the global price maker and India is a price taker. Additionally, by using the weekly data, the time-zone bias identified by Baumöhl and Výrost (2010), was avoided.

Theoretical and Practical Implications

The multivariate model eliminated variable bias as the Sovereign Yield Spread and USD/INR on its own had insignificant impact on the volatility caused, but when combined with global fear, they showed a high impact on the market behaviour.

This proves the theory of capital flight. When US Federal Reserve increases the interest rate, it reduces the effect of risk premium provided by the emerging nations to the foreign institutional investors. Thereby, the markets of the emerging nations become less attractive to investors and they withdraw the investments immediately leading the crashing of the equity market and the value of the currency depreciates. This leads to an increase in the shocks passed from the US market (S&P 500) to the Indian market (NIFTY 50).

The practical implications included that the Indian equity market provides great protection and growth for the portfolio managers and intraday trade investors thereby acting as a good geographical diversification. But investors must understand that during global crises (panic break out), the Indian does not provide diversification effect and act according to the crises.

Conclusion

This study examined the volatility spill overs from the US S&P 500 to the Indian NIFTY 50 over a period of approximately 7 years. The basic model revealed that US shocks caused 32.05% of volatility in the Indian market. The regime-switching model indicated that the when panic break outs in the US market (CBOE VIX >20), the shocks are significantly passed down to the India market. Additionally, the Multivariate model proved that it is wrong to look at the factors separately and they (increasing global fear, currency rate fluctuation and interest rate forced capital fight) together increases the equity market volatility spillover. Thereby, disproving the decoupling theory and reveals that US macroeconomic factors impact the volatility of the Indian equity market.

Limitations and Future Research

Limitations are that the study fails to explain that some domestic sectors like Fast Moving Consumer Goods and Infrastructure have more resistance to the global crises that the heavy export sectors like Information Technology and even though, using the weekly data removed the time-zone biases, it erases the patterns of the intraday algorithmic trading.

Future research can be conducted to study how the macroeconomic factors impact the volatility of different sectors in India. Additionally, an advanced Time-Varying Parameter VAR (TVP-VAR) can be used to study how the spillover evolved across multiple decades to identify the long-term market behaviour.

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