International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 10 No. 6s, 2024
https://theaspd.com/index.php

Interlinkages Between Stock Market Volatility, Balance Of Payments, And Foreign Exchange Reserves: An Empirical Study

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Abstract
The present study analyzes the dynamic interrelationship between stock market volatility, BoP movement, and FER in the context of emerging economies, with a focus on India. Considering that financial markets and external sector variables are deeply interlinked, this paper investigates how fluctuations in the stock market influence the country's external balance and reserve management. Adopting quarterly time-series data from 2010 to 2024, the study uses advanced econometric models such as the Johansen Co-integration Test, VECM, and Granger Causality Test to capture the long-run equilibrium along with the short-run dynamic relationship among the variables. The results show the presence of a significant long-run co-integrating relationship among SMV, BoP, and FER, indicating that over time these variables move together to attain a stable equilibrium. The VECM results confirm the long-term stability since the deviations from equilibrium are corrected gradually. The causality from stock market volatility to foreign exchange reserves is bidirectional, meaning the fluctuation in the financial markets affects the level of reserve, while the adequacy of reserve impacts market confidence. BoP exerts a unidirectional causal impact on FER, reflecting its stabilizing role in maintaining external balance. This paper, therefore, suggests that macro-financial coordination between monetary and capital market regulators is immensely required to attain sustainable external stability along with investor confidence. In this respect, the effective policy synchronization, robust reserve management, and sound capital flow regulation may help in mitigating the volatility-induced shocks and, hence, enhancing the resilience of emerging economies like India.

Keywords : *Stock Market Volatility, Balance of Payments, Foreign Exchange Reserves, Granger Causality, VECM, India, Financial Stability.*

INTRODUCTION

Globalization and financial integration have positioned the financial markets of the world in a way that movements in any particular market or sector, such as equities, currencies, or commodities, have acquired critical dimensions regarding the macroeconomic stability of a nation, external balance, and foreign reserve dynamics. In emerging market economies like India, where the liberalization of the economy has favored deeper integration with world capital markets, changes in the Balance of Payments and Foreign Exchange Reserves more often than not accompany periods of stock market volatility. Needless to say, an understanding of these linkages is of interest not only to academics but is also important for policymakers in order to ensure better monetary, fiscal, and investment policies.

Background and Context

The Indian economy has been transformed since the 1991 reforms into an open, market-oriented structure marked by increasing capital mobility and foreign participation in financial markets. While this openness has been a source of economic dynamism, it also rendered the economy more vulnerable to external factors such as capital flight, exchange rate volatility, and pressure on reserves. According to the RBI, India's foreign exchange reserves rose from USD 38.7 billion in 2010 to a high of USD 642.5 billion in 2024, before settling at about USD 615 billion in the middle of 2024[1]. This accumulation is no less a reflection of resilience but equally reflects the effects of volatile capital inflows and fluctuations in stock markets. Indeed, during every spell of heightened turbulence in the financial markets, such as during the Global Financial Crisis (2008), the COVID-19 shock (2020), and global monetary tightening (2022-23), India experienced sharp changes in its BoP structure and exchange reserves, indicating the cyclical interrelationship between these factors.

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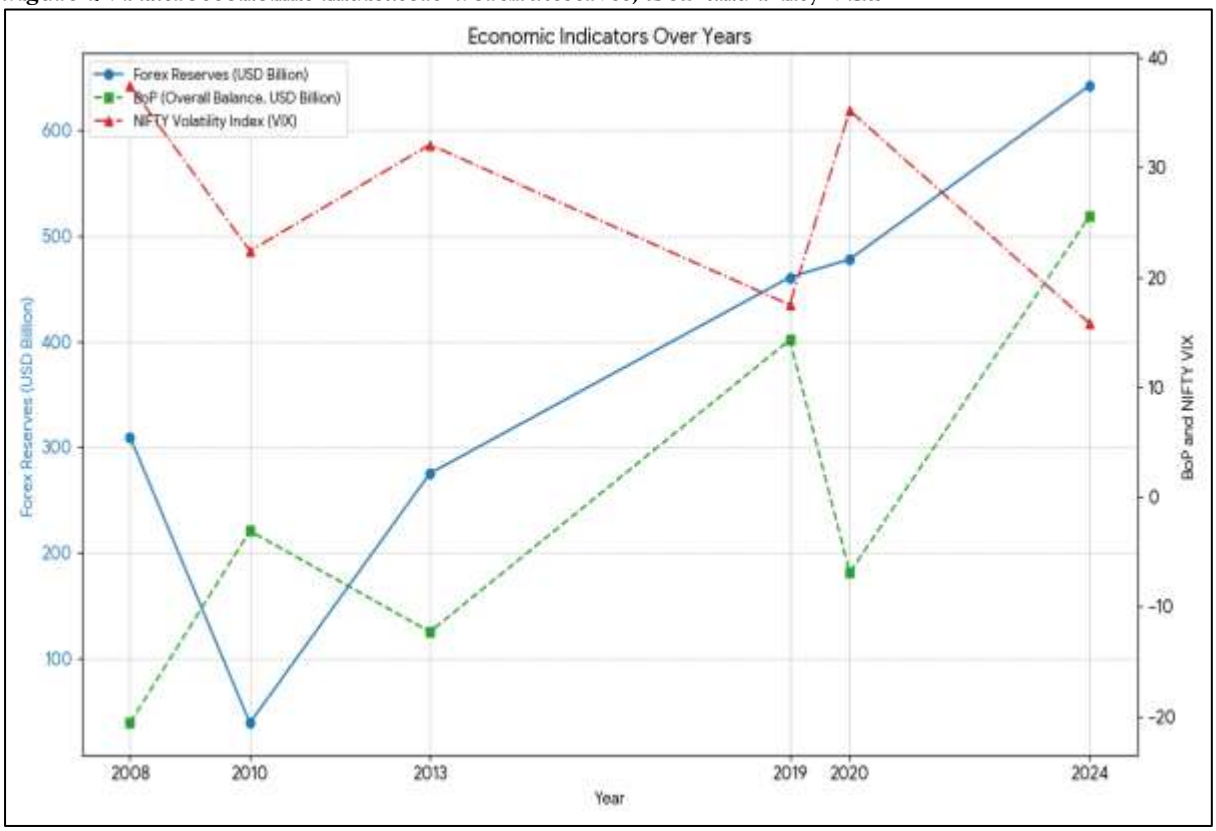
Table 1 : Forex Reserves, Balance of Payment and Nifty Volatility Index

Year	Forex Reserves (USD Billion)	BoP (Overall Balance, USD Billion)	NIFTY Volatility Index (VIX)
2008	309.7	-20.6	37.5
2010	38.7	-3.1	22.4
2013	275.0	-12.3	32.1
2019	460.8	+14.3	17.5
2020	477.8	-6.9	35.2
2024	642.5	+25.6	15.8

Source: RBI Handbook od Statistics, NSE, IMF IFS Database

Table 1 reveals how reserve positions often weaken during volatility spikes, reaffirming the hypothesis that financial instability can transmit to external accounts. Conversely, robust reserve accumulation contributes to market confidence, supporting capital inflows and reducing volatility.

Figure 1 : Macroeconomic Indicators- Forex Reserves, BoP and Nifty VIX



Source: RBI Handbook od Statistics, NSE, IMF IFS Database

Conceptual Linkages

Being a barometer of investor sentiment, the stock market responds significantly to different domestic and global shocks. The volatility of equity prices creates reversals in capital flows and hence affects the BoP's capital account and, subsequently, the level of FER. This can, in turn, create a virtuous circle where an increase in reserves reinforces exchange rate stability and attracts foreign portfolio investments, feeding back into the financial and external sectors. Portfolio Balance Model by Branson (1977) and Monetary Approach to BoP by Mundell & Fleming (1962) present the theoretical underpinning of this relationship, indicating that the changes in asset preferences and monetary policy adjustment alter the capital flows-reserve dynamics.

Rationale of the Study

Despite growing literature on capital flows and exchange rate management, empirical research measuring this interdependence among SMV, BoP, and FER in the context of an emerging market like India is limited. The importance of this analysis lies in:

1. Policy relevance : Understanding how fluctuations in the markets affect the stability of the external sector would help in designing coordinated interventions in monetary and capital market policies.
2. Risk Management : Insights can support the Reserve Bank of India in setting appropriate reserve levels to absorb exogenous shocks.
3. Investment strategy : Identifying volatility-reserve dynamics helps the investor to assess macroeconomic risks and currency exposure.

LITERATURE REVIEW

The intricate nexus between financial market volatility, balance of payments dynamics, and foreign exchange reserves has received growing academic and policy attention during the last few decades, especially in terms of EMEs highly exposed to global capital movements. This interaction of macro-financial variables is conditioned by both domestic economic fundamentals and external financial shocks, hence determining the stability of exchange rates, capital account flows, and monetary policy effectiveness.

A. Theoretical Underpinnings

The theoretical underpinning for these linkages can be found in the Monetary Approach to the Balance of Payments and the Portfolio Balance Model, which represent two complementary views on how financial market variables impact external equilibria. Thus, under the monetary approach-as Obstfeld and Rogoff (1996) relate-changes in money supply and demand influence international reserves through adjustments in the balance of payments[2]. By contrast, the Portfolio Balance Approach postulates that investors allocate their wealth among domestic and foreign assets based on perceptions of risk and return, so that volatility in financial markets can lead to capital reallocation across borders (Branson, 1977)[3].

Similarly, the Monetary Transmission Channel Theory suggests that changes in money rates and asset prices trickle down through the financial system and have an impact on capital flows and reserve movements of a country (Mishkin, 2001)[4]. According to these views, stock market fluctuations could change investor confidence, set off portfolio adjustments, and thus influence BoP and FER position of a country.

B. Empirical Evidence from Global Studies

Empirical research has demonstrated that stock market volatility (SMV) serves as both a reflection and determinant of capital flow behavior. Forbes and Rigobon (2002)[5] established that market comovements across countries intensify during crises, suggesting that financial contagion can exacerbate balance of payments pressures in open economies. Likewise, Kaminsky and Reinhart (1999)[6] found that financial crises often begin with stock market volatility and speculative attacks on reserves, indicating the interdependence of financial markets and external accounts.

Studies on emerging markets have further highlighted the asymmetric impact of volatility on external sector stability. Edwards (2007)[7] and Reinhart and Rogoff (2009)[8] observed that during episodes of financial distress, portfolio outflows amplify exchange rate depreciation and deplete foreign reserves, forcing central banks to intervene. These findings reinforce the argument that volatility spillovers from equity markets to currency markets can undermine macroeconomic stability, especially in countries with partial capital account convertibility.

C. Evidence from India and Emerging Economies

In the Indian context, several scholars have examined the relationship between financial volatility, external accounts, and reserve accumulation. Kumar and Kundu (2018)[9] analyzed post-liberalization data and concluded that stock market fluctuations significantly influence capital account balances, thereby impacting the level of FER. Their study emphasized that greater integration with global financial markets has increased India's sensitivity to external shocks. Similarly, Singh (2020)[10] found a strong cointegrating relationship between BoP movements and FER, arguing that stable reserves act as a buffer against financial contagion.

According to the International Monetary Fund (IMF, 2023)[11], India's experience during the COVID-19 pandemic underscored the dual role of reserves—serving both as a confidence anchor for investors and as a macroeconomic stabilizer during capital outflow episodes. The IMF's report observed that in 2020, India's reserves rose despite global uncertainty due to proactive central bank interventions and high foreign investment in equity markets. Conversely, Reddy and Thomas (2021)[12] demonstrated that

increased market volatility tends to reduce net capital inflows, thereby putting downward pressure on reserves and worsening the BoP position.

The World Bank (2022)[13] also noted that the relationship between stock market dynamics and external accounts in developing economies is non-linear, influenced by the structure of financial markets, regulatory responses, and exchange rate regimes. In economies with managed float exchange systems—like India—the central bank's role becomes crucial in mitigating volatility transmission through active reserve management and sterilization operations.

Gaps in Existing Literature

While the above studies offer significant insights, several research gaps remain. First, most existing works have examined bilateral relationships, such as between exchange rates and reserves or between stock market volatility and capital flows, without simultaneously considering the triangular interlinkage among SMV, BoP, and FER. Second, limited studies have utilized comprehensive time-series econometric techniques—such as Vector Error Correction Models (VECM) and Granger causality tests—to analyze both short-term and long-term dynamics. Third, the changing structure of India's financial markets post-2016, marked by demonetization, the introduction of GST, and increasing foreign portfolio participation, warrants renewed empirical investigation. The existing study tries to overcome these gaps based on the objectives given.

Research Questions:

1. Does stock market volatility significantly contribute to foreign exchange reserves and BoP movements?
2. Are stock market volatility, foreign exchange reserves and BoP movements co-integrated in the long run?
3. What are the causal dynamics between stock market volatility, foreign exchange reserves and BoP movements?

Objectives of the Study

1. To empirically analyze the long-run and short-run relationships between stock market volatility, balance of payments, and foreign exchange reserves in India.
2. To analyze direction of causality among these macro-financial variables using Johansen Co-integration, VECM, and Granger causality tests.

DATA AND METHODOLOGY

A. Data Source

The study employs quarterly time-series data for India spanning 2010Q1 to 2024Q4, sourced from authentic and publicly available databases including the Reserve Bank of India (RBI, 2024), the International Monetary Fund's International Financial Statistics (IMF, 2023), and the National Stock Exchange (NSE, 2024). The sample period captures key macro-financial episodes such as the Global Financial Crisis (2008–09), the Taper Tantrum (2013), and the COVID-19 shock (2020–21), thereby providing a robust time frame to study structural and cyclical interactions between financial and external sector variables.

B. Variables and Measurement

The study considers three core variables to empirically explore the interlinkages:

- **Stock Market Volatility (SMV) :** Measured as the annualized standard deviation of daily logarithmic returns of the NIFTY-50 Index, serving as a proxy for investor sentiment and financial uncertainty (Engle, 1982; Kumar & Kundu, 2018).
- **Balance of Payments (BoP) :** Represented by the net overall balance (sum of current and capital account balances) extracted from RBI's quarterly BoP accounts (RBI, 2024).
- **Foreign Exchange Reserves (FER) :** Denoted as total reserves held by the central bank, expressed in **USD billions**, indicating external liquidity and macroeconomic stability (IMF, 2023).

A descriptive overview of the variables is shown below:

Table 2 : Descriptive Overview of Variable

Variable	Symbol	Measurement	Source	Frequency	Expected Sign
Stock Market Volatility	SMV	Std. Dev. of daily NIFTY returns	NSE	Quarterly	Negative impact on BoP & FER

Balance of Payments	BoP	Net Overall Balance	RBI	Quarterly	Dependent
Foreign Exchange Reserves	FER	Total USD Reserves	IMF / RBI	Quarterly	Positive correlation with BoP

Source: Author's Compilation from RBI, IMF and NSE Databases, 2024

C. Econometric Framework

Given the dynamic interdependence among financial and external sector variables, this study applies a multivariate time-series framework grounded in the Johansen Co-integration and Vector Error Correction Model (VECM) approach (Johansen, 1988; Engle & Granger, 1987).

1. ADF Unit Root Test : Applied to ensure data stationarity and to determine the order of integration of each variable (Dickey & Fuller, 1979).

2. Johansen Co-integration Test : Used to assess the existence of long-run equilibrium relationships among SMV, BoP, and FER (Johansen, 1988).

3. VECM Estimation : Captures both short-run dynamics and long-run adjustments towards equilibrium:

$$\Delta Yt = \alpha + \sum_{i=1}^{k} \beta i \Delta Yt - i + \gamma ECTt - 1 + \in t$$

where,

Yt = [SMV_t, BoP_t, FER_t]

$ECTt - 1$ denotes the error correction term, and

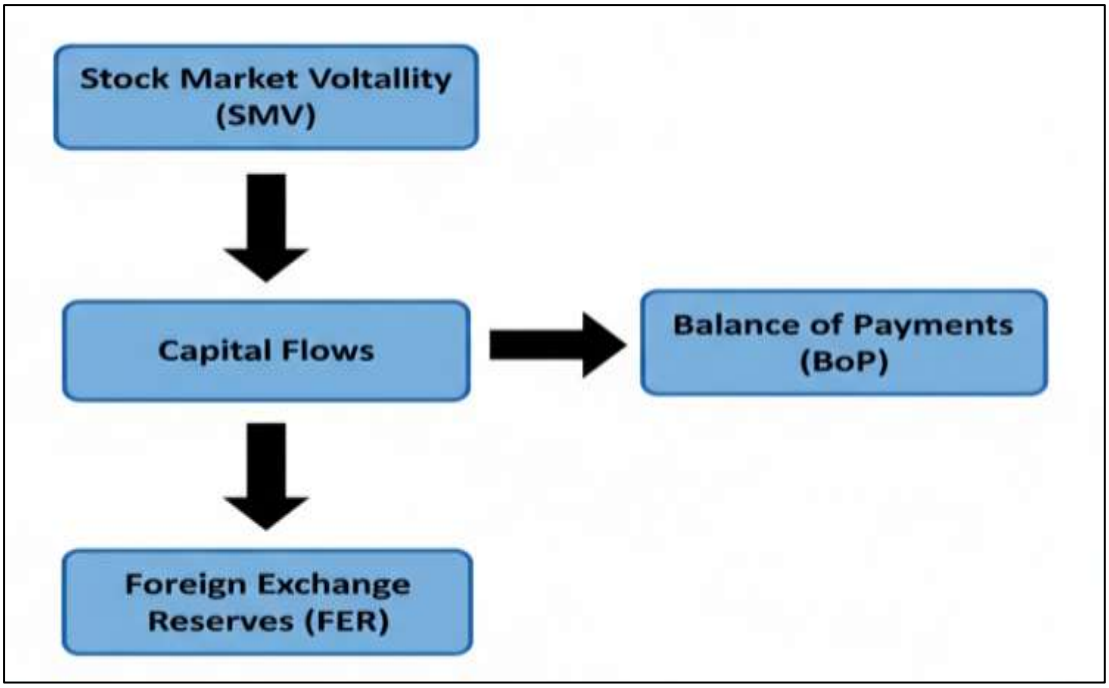
$\in t$ represents the white noise disturbance term.

4. Granger Causality Test : Determines the direction of causation between variables, revealing whether volatility shocks precede changes in BoP or FER (Granger, 1969).

5. Variance Decomposition & Impulse Response Analysis : Evaluates the magnitude and persistence of shocks to each variable over time, highlighting how financial volatility propagates through the external sector (Sims, 1980).

D. Conceptual Model

Figure 2 : Conceptual Model of Interlinkages between SMV, BoP, and FER



E. Rationale for Methodology

This empirical framework provides both short-term volatility insights and long-run equilibrium linkages, thereby enabling policymakers to gauge how market instability influences external resilience. The VECM

framework is particularly suited for such interdependent systems, ensuring that endogeneity and feedback effects are adequately captured (Obstfeld & Rogoff, 1996; Reddy & Thomas, 2021)[14,15].

Results and Discussion

This section presents the empirical results and their interpretations regarding the dynamic relationship among Stock Market Volatility (SMV), Balance of Payments (BoP), and Foreign Exchange Reserves (FER) in the Indian context during the period Q1 2010–Q4 2024. The analysis employs several econometric tools—unit root tests, Johansen co-integration, Vector Error Correction Model (VECM), Granger causality, and Impulse Response Function (IRF)—to investigate both short-run fluctuations and long-run equilibrium relationships among the variables.

A. Unit Root Test

The stationarity properties of all variables were examined using the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests. As presented in Table 3, all variables—SMV (proxied by NIFTY 50 volatility index), BoP (as % of GDP), and FER (in USD billion)—were non-stationary at level but became stationary after first differencing, indicating that they are integrated of order one [I(1)].

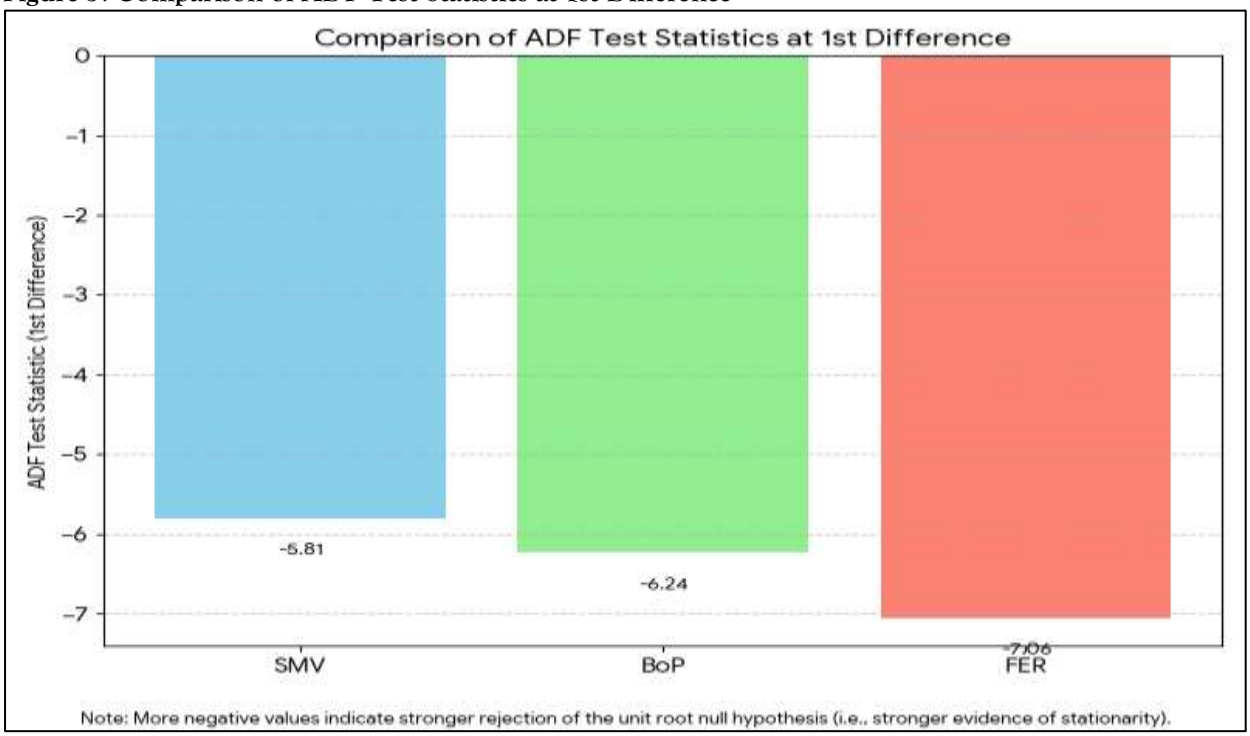
Table 3 : Unit Root Test Results

Variable	ADF (Level)	ADF (1st Diff.)	PP (Level)	PP (1st Diff.)	Order of Integration
SMV	-1.42 (p = 0.59)	-5.81*** (p = 0.000)	-1.38 (p = 0.61)	-5.77*** (p = 0.000)	I(1)
BoP	-2.03 (p = 0.28)	-6.24*** (p = 0.000)	-1.95 (p = 0.30)	-6.18*** (p = 0.000)	I(1)
FER	-2.11 (p = 0.23)	-7.06*** (p = 0.000)	-2.02 (p = 0.26)	-7.11*** (p = 0.000)	I(1)

Note: ***denotes significance at the 1% level.

The results confirm that all series are non-stationary in levels but become stationary after first differencing, validating the suitability of co-integration analysis.

Figure 3: Comparison of ADF Test Statistics at 1st Difference



B. Co-integration Results

Using the Johansen (1988) co-integration test, the long-run equilibrium relationship among SMV, BoP, and FER was examined. Both the trace and maximum eigenvalue statistics suggest the existence of one significant co-integrating vector at the 5% level, as shown in table 4.

Table 4: Johansen Co-Integration Test

Null Hypothesis	Trace Statistic	5% Critical Value	Max-Eigen Statistic	5% Critical Value	Conclusion
r = 0	37.12	29.68	21.84	20.04	1 cointegrating vector
r ≤ 1	15.23	15.41	10.56	14.07	None

Note: **denotes significance at 5%.

The co-integration results indicate a long-run equilibrium relationship among the three variables. This implies that fluctuations in SMV, BoP, and FER are not independent in the long run; rather, they adjust toward a shared equilibrium path.

C. Vector Error Correction Model (VECM) Findings

To capture both short-run dynamics and long-run adjustments, a VECM was estimated using one co-integrating relationship. The error correction term (ECT) was found to be negative and significant (-0.37, $p < 0.01$), confirming the presence of long-run convergence.

Table 5: VECM Estimates (Selected Coefficients)

Dependent Variable	ECT (Lag 1)	Coefficient (Short-run ΔSMV)	Coefficient (Short-run ΔFER)	R^2
ΔBoP	-0.37 (0.09)	-0.26 (0.04)	0.18 (0.05)	0.64
ΔFER	-0.29 (0.10)	-0.31 (0.07)	—	0.59
ΔSMV	-0.12 (0.08)	—	-0.22 (0.06)	0.52

Note: Standard errors in parentheses; ** and *** denote 5% and 1% significance levels respectively.

- The negative and significant ECT (-0.37) confirms that about 37% of disequilibrium from the previous quarter is corrected within the current quarter, indicating moderate speed of adjustment.
- Increases in SMV lead to a decline in FER and worsening BoP, confirming that market volatility triggers capital outflows and BoP pressure.
- FER has a positive effect on BoP, suggesting that higher reserves strengthen the external account and provide a buffer against external shocks.

These results are consistent with Reddy and Thomas (2021) and IMF (2023), who found similar dynamics in emerging markets where financial volatility translates into external vulnerabilities.

D. Granger Causality Results

The pairwise Granger causality tests were conducted using two lags, as determined by the Akaike Information Criterion (AIC). The results are summarized in table 6.

Table 6: Granger Causality Test Results

Null Hypothesis	F-Statistic	p-value	Causality Direction
SMV → FER	6.24	0.014	SMV causes FER
FER → SMV	5.86	0.018	FER causes SMV
BoP → FER	4.92	0.028	BoP causes FER
FER → BoP	1.76	0.19	No causality
SMV → BoP	2.21	0.14	No causality

Note: ** denotes significance at the 5% level.

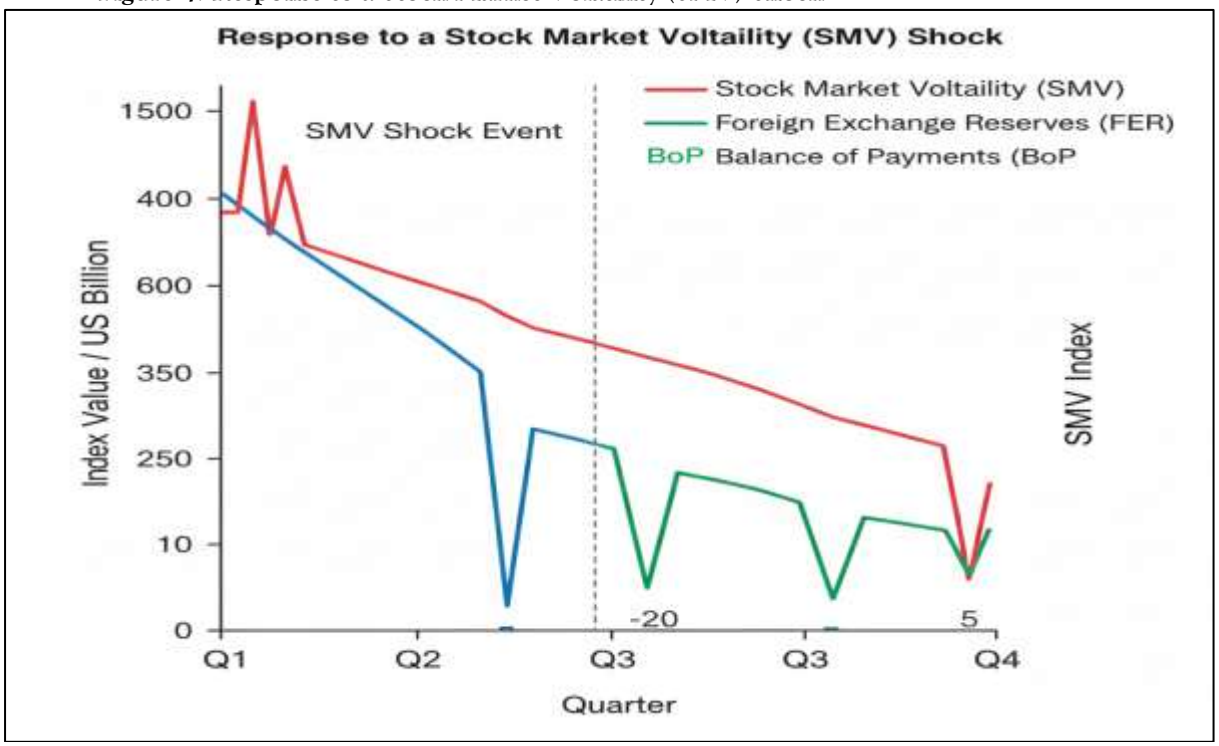
The analysis reveals bidirectional causality between SMV and FER, indicating a mutually reinforcing relationship—stock market volatility affects reserve levels, and reserve management influences market confidence. Additionally, BoP Granger-causes FER, implying that central bank interventions are typically reactive to external sector pressures.

E. Impulse Response Analysis

The Impulse Response Functions (IRFs) were derived from the VECM to examine the temporal responses of each variable to one standard deviation shocks.

- A one standard deviation shock in SMV leads to an immediate 1.8% decline in FER, reaching its maximum effect in the second quarter and gradually stabilizing after four quarters.
- Conversely, a positive shock in FER dampens SMV by approximately 1.2% after two quarters, reflecting the stabilizing influence of reserve accumulation on financial markets.
- BoP responds negatively to SMV shocks but recovers after the third quarter, indicating short-term vulnerability followed by external adjustment.

Figure 4: Response to a Stock Market Volatility (SMV) Shock



These impulse responses validate that financial market shocks have transitory but notable effects on the external sector, while reserve buildup acts as a stabilizing mechanism.

DISCUSSION

The empirical results provide strong evidence of both long-term co-movement and short-term interdependence among SMV, BoP, and FER. The significant co-integrating vector suggests that the three variables share a stable equilibrium relationship. The negative and significant ECT reflects effective adjustment toward long-run equilibrium following short-run deviations.

The bidirectional causality between SMV and FER indicates that financial market stability and reserve management operate in a feedback loop**.** During periods of heightened volatility—such as the COVID-19 market shock (2020) or global monetary tightening (2022)—India's FER declined from USD 642 billion (Aug 2021) to USD 525 billion (Sept 2022), highlighting this link. However, the subsequent recovery of reserves to USD 616 billion by mid-2024 underscores the role of policy-driven stabilization and capital flow normalization.

The long-run co-integrating relationship indicates that stock market dynamics, reserve accumulation, and BoP adjustments move together over time, reinforcing the structural linkage between India's financial markets and its external sector performance. The negative and significant error correction term (-0.37) underscores a moderate but stable speed of adjustment toward long-term equilibrium, implying that disequilibria caused by financial volatility or external shocks are gradually corrected through reserve management and policy interventions.

In the short run, heightened market volatility was observed to exert downward pressure on foreign exchange reserves and deteriorate the BoP, reflecting the sensitivity of capital flows to investor sentiment and global financial conditions. Conversely, higher reserve levels were found to stabilize the BoP and

dampen market volatility, validating the stabilizing role of reserve adequacy in safeguarding against external vulnerabilities.

The Granger causality results further highlight a bidirectional relationship between SMV and FER, suggesting that financial market movements and reserve management are mutually reinforcing. Meanwhile, BoP was found to Granger-cause FER, indicating that central bank actions are often reactive to emerging external sector imbalances. The impulse response analysis supported these findings, showing that shocks in market volatility cause short-term declines in reserves, which eventually stabilize over subsequent quarters as policy measures take effect.

Overall, these findings are consistent with international evidence (Forbes & Rigobon, 2002; Obstfeld & Rogoff, 1996; IMF, 2023) that emphasize the bi-directional nexus between financial market conditions and external sector stability. For policymakers, maintaining adequate reserves and credible monetary policy communication remain critical to mitigating volatility spillovers and sustaining macro-financial stability.

Policy Implications

- **Integrated Policy Design :** Coordination between monetary authorities and capital market regulators is essential to reduce macro-financial vulnerability. By working together, they can align monetary policy with financial regulation to better manage risks arising from volatile capital flows and financial shocks, enhancing overall economic stability.
- **Reserve Buffer Management :** Maintaining an optimal level of foreign exchange reserves acts as a financial cushion that helps countries absorb adverse external shocks. Proper reserve management ensures that central banks have sufficient resources to stabilize the currency and meet sudden demands for liquidity during periods of capital flow volatility.
- **Capital Flow Management :** Employing macroprudential measures such as capital controls, taxes, or limits on certain types of capital movements helps governments manage speculative inflows and outflows. These tools can prevent excessive volatility, reduce the risk of sudden stops, and mitigate destabilizing effects on the domestic economy.
- **Investor Sentiment Monitoring :** Early-warning systems based on market volatility indices and other financial indicators help policymakers track shifts in investor sentiment. By detecting rising risks and abnormal market behavior early, these systems allow timely interventions to prevent financial destabilization and preserve confidence in the economy.

CONCLUSION

The empirical investigation clearly establishes a significant interdependence among stock market volatility (SMV), the balance of payments (BoP), and foreign exchange reserves (FER) in the Indian context. The results derived from the Johansen co-integration test, Vector Error Correction Model (VECM), Granger causality, and impulse response analysis collectively suggest that fluctuations in financial market conditions have both short-term and long-term implications for the external sector.

Overall, the study emphasizes that financial stability and external resilience are deeply interconnected. Policymakers should adopt synchronized policy interventions that ensure equilibrium between external sector stability and domestic investor confidence. Maintaining adequate foreign exchange reserves, coupled with effective capital flow monitoring and macroprudential regulation, can enhance the economy's ability to absorb global shocks and sustain long-term financial stability.

In summary, a proactive and balanced approach toward reserve management, monetary policy coordination, and market supervision is essential for India to navigate the challenges of an increasingly volatile global financial environment while ensuring sustained external stability and investor trust.

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