International Journal of Economic Practices and Theories (IJEPT)
ISSN: 2247-7225
Volume 2026, Issue 1

An Empirical Analysis of Quantile-Based Volatility Spillovers and Macroeconomic Shocks: Evidence from US and Indian Financial Markets

Dr.K.Rajamani[1], Dr.S. Gopi[2], S. Subhadharsini[3]

[1] Associate Professor (Sr. Grade), Mepco School of Management Studies
Mepco Schlenk Engineering College, Sivakasi, Tamil Nadu, India.
[2] Assistant Professor (Sl. Grade), Mepco School of Management Studies
Mepco Schlenk Engineering College, Sivakasi, Tamil Nadu, India.
[3]PG Student, Mepco School of Management Studies
Mepco Schlenk Engineering College, Sivakasi, Tamil Nadu, India.

ABSTRACT

This study examines volatility spillovers and interconnectedness among major financial markets, namely the stock, bond, gold, and crude oil markets, while considering the influence of macroeconomic shocks. To capture differences in market behaviour across various market conditions, the study employs a Quantile Vector Autoregression (QVAR) approach, which allows volatility transmission to be analysed under low, normal, and high volatility regimes. Volatility is derived from return series and Forecast Error Variance Decomposition (FEVD) is used to measure the direction and intensity of spillovers among the markets. The findings show that volatility spillovers are stronger during periods of high market uncertainty. Stock and crude oil markets act as major transmitters of volatility, especially during extreme conditions, while bond and gold markets mainly serve as receivers, with gold displaying safe shaven characteristics during market stress. Macroeconomic shocks, particularly those related to policy uncertainty and geopolitical risk, significantly amplify volatility transmission across markets. These results highlight the importance of considering regime-dependent spillovers and macroeconomic factors in investment decisions and risk management.

Keywords: Volatility Spillovers; Macroeconomic Shocks; Quantile-Based Analysis; Financial Market Connectedness; Stock Market; Bond Market; Gold Market; Crude Oil Market; US Financial Markets; Indian Financial Markets.

1. Introduction

Financial markets play a crucial role in modern economies by facilitating capital allocation, investment decisions, and risk management. Over the past few decades, global financial markets have become increasingly interconnected due to globalization, technological advancements, and financial liberalization. As a result, shocks originating in one market can quickly transmit to other markets, creating volatility spillovers and increasing systemic risk (Francis X. Diebold & Kamil Yilmaz, 2012; Geert Bekaert, Campbell R. Harvey, & Angela Ng, 2005). Understanding how volatility propagates across different asset classes has therefore become an important area of research in financial economics.

Volatility in financial markets is often driven by macroeconomic shocks such as changes in monetary policy, inflation, geopolitical risk, and economic policy uncertainty. These factors can significantly influence investor behaviour and asset prices, leading to fluctuations across multiple financial markets (Ben S. Bernanke & Kenneth N. Kuttner, 2005; Knut Are Aastveit, Gisle James Natvik, & Sindre Sola, 2017). Among major financial assets, stock, bond, gold, and crude oil markets play an important role in the global financial system. These markets are highly sensitive to macroeconomic developments and often exhibit strong volatility spillover effects (Nikolaos Antonakakis, Ioannis Chatziantoniou, & David Gabauer, 2019; Qiang Ji, Elie Bouri, & David Roubaud, 2018).

Previous studies highlight that gold often acts as a safe-haven asset during periods of financial market stress, while oil price shocks can significantly influence inflation and stock market dynamics (Dirk G. Baur & Brian M. Lucey, 2010; Lutz Kilian & Cheolbeom Park, 2009). In addition, macroeconomic uncertainty and financial stress have been shown to intensify volatility spillovers across financial markets (Antonakakis et al., 2019; Appiah et al., 2023). Motivated by this growing interconnectedness, the present study examines volatility spillovers among stock, bond, gold, and crude oil markets in the United States and India. Using a Quantile Vector Autoregression

(QVAR) framework, the study analyzes how volatility transmission varies across different market conditions, namely low, normal, and high volatility regimes. Furthermore, the study incorporates macroeconomic indicators such as economic policy uncertainty, inflation, interest rates, and term spread to evaluate their role in shaping volatility dynamics across financial markets.

The key objective of this study is to examine the quantile-based volatility spillovers among major financial markets, namely stock, bond, gold, and crude oil markets, in the United States and India. The study also aims to analyze how macroeconomic shocks influence the transmission of volatility across these markets under different market conditions. To achieve this objective, the research employs the Quantile Vector Autoregression (QVAR) model to capture the dynamic and asymmetric spillover effects across various volatility regimes. The findings of this study are expected to provide useful insights for investors, policymakers, and financial institutions in understanding market interconnectedness and improving risk management and portfolio diversification strategies.

2 Literature review

2.1 Theoretical Framework on Volatility Spillovers and Macroeconomic Shocks

The concept of volatility spillovers across financial markets has received significant attention in financial economics, particularly in understanding how shocks in one market influence the volatility of other markets. The early foundation of volatility transmission analysis was established by Francis X. Diebold and Kamil Yilmaz (2012), who introduced a spillover index based on forecast error variance decomposition from vector autoregressive (VAR) models. Their framework demonstrated that volatility spillovers are highly dynamic and tend to intensify during periods of financial crises, indicating increased interconnectedness among financial markets. Subsequent studies expanded the theoretical understanding of volatility transmission by incorporating macroeconomic shocks and financial stress indicators. For instance, Nikos Antonakakis, Ioannis Chatziantoniou, and David Gabauer (2019) highlighted the role of macroeconomic uncertainty in amplifying volatility spillovers across financial markets. Their findings suggest that uncertainty shocks significantly alter the direction and magnitude of spillovers, with stock markets often acting as dominant transmitters while bonds and gold markets partially absorb shocks.

Similarly, Lutz Kilian and Cheolbeom Park (2009) examined the impact of oil price shocks on financial market volatility and demonstrated that different sources of oil price fluctuations such as supply shocks, demand shocks, and precautionary demand—have varying effects on financial markets. Their findings indicate that demand-driven oil price shocks have stronger and more persistent effects on stock market volatility than supply shocks. Macroeconomic policy uncertainty has also been identified as a key driver of financial market volatility. Knut Are Aastveit, Gisle James Natvik, and Steffen Sola (2017) showed that uncertainty related to monetary policy significantly increases volatility across asset classes, particularly in stock and bond markets. These findings highlight the important role of macroeconomic policy shocks in shaping volatility transmission across global financial markets.

Furthermore, the literature recognizes the importance of market stress and geopolitical events as sources of volatility spillovers. Allen F. Aysan, Erkan Demir, and Giray Gozgor (2020) found that geopolitical risks significantly increase volatility spillovers, particularly from energy markets to stock markets. In such periods, oil markets act as major transmitters of shocks, while gold markets tend to absorb volatility due to their safe-haven characteristics. Overall, the theoretical literature suggests that volatility spillovers across financial markets are strongly influenced by macroeconomic shocks, financial stress, policy uncertainty, and geopolitical risks. These factors alter the direction and intensity of volatility transmission across asset classes and play a crucial role in shaping financial market interconnectedness.

2.2 Empirical Evidence on Volatility Spillovers Across Financial Markets

A large body of empirical literature has examined volatility spillovers among major financial markets such as stocks, bonds, commodities, and energy markets. Early empirical studies focused on the relationship between oil and stock markets. For example, Fazal Malik and Said Hammoudeh (2007) analyzed volatility transmission between oil and stock markets using a multivariate GARCH framework and found strong bidirectional spillovers,

particularly during periods of geopolitical instability and supply disruptions. Research on financial stress and commodity markets has further emphasized the importance of oil markets in volatility transmission. Qiang Ji, Elie Bouri, and David Roubaud (2018) showed that oil markets act as major transmitters of volatility to financial markets during periods of heightened financial stress.

The role of gold as a hedge or safe-haven asset has also been widely explored in the literature. Studies by Dirk G. Baur and Brian M. Lucey (2010) as well as Juan Carlos Reboredo (2013) found that gold exhibits weak correlation with stock markets during normal periods and negative correlation during market downturns. These findings support the view that gold serves as a safe-haven asset during financial crises and helps reduce portfolio risk. Recent empirical studies have focused on the time-varying and asymmetric nature of volatility spillovers across markets. Juncal Cunado and Rangan Gupta (2024) analyzed volatility spillovers between energy and metal markets using realized volatility data and found that market interconnectedness increased during the COVID-19 pandemic, although the impact was less persistent than during the global financial crisis of 2008.

Similarly, Yongdeng Xu, Bo Guan, Wenna Lu, and Saeed Heravi (2024) examined how macroeconomic shocks influence volatility spillovers across stock, bond, gold, and crude oil markets. Their findings show that stock markets generally act as the main transmitters of volatility, while crude oil markets are the primary receivers. However, when macroeconomic shocks are incorporated into the analysis, the volatility dynamics change significantly, with crude oil markets becoming more sensitive to macroeconomic disturbances. In addition, studies have highlighted the importance of extreme market conditions in shaping volatility spillovers. Michael Appiah et al. (2023) used a quantile-VAR framework to analyze volatility transmission among global financial markets and found that spillovers become significantly stronger during extreme market conditions compared to normal periods. Their results indicate that energy shocks and inflation play a critical role in amplifying financial market volatility.

3. Data and Empirical model

3.1 Sample and data

This study examines the volatility spillovers among four major financial markets: stock, bond, gold, and crude oil markets. The analysis uses daily data for financial market prices collected from reliable financial databases. The sample period covers several years to capture different market conditions, including periods of economic uncertainty and financial instability. The financial market variables include stock market indices, government bond yields, gold prices, and crude oil prices. Daily returns are calculated using logarithmic differences of price series to measure market volatility and ensure stationarity of the data.

In addition to financial market variables, the study incorporates key macroeconomic indicators that may influence financial market volatility. These indicators include Economic Policy Uncertainty (EPU), Term Spread, Inflation Rate, and Interest Rate. These variables are selected because they capture major macroeconomic conditions affecting investor expectations, monetary policy stance, and economic stability.

3.2 Macro economic Indicator

To examine the influence of macroeconomic shocks on volatility spillovers, the study includes a set of macroeconomic indicators. These variables capture important macroeconomic conditions that may affect financial market volatility.

Economic Policy Uncertainty (EPU)

Economic Policy Uncertainty measures the level of uncertainty regarding government economic policies, including fiscal policy, monetary policy, and regulatory changes. Higher policy uncertainty often increases market volatility as investors become uncertain about future economic conditions and policy actions.

Term Spread (TS)

Term spread is defined as the difference between long-term government bond yields and short-term interest rates. It reflects expectations about future economic activity and the direction of monetary policy. A larger term spread generally indicates expectations of economic growth, while a narrow or negative spread may signal potential

economic slowdown.

Inflation Rate (INF)

Inflation represents the rate at which the general price level of goods and services increases over time. Inflation shocks can significantly influence financial markets by affecting purchasing power, interest rates, and investor expectations. Rising inflation may lead to increased volatility in both financial and commodity markets.

Interest Rate (IR)

The interest rate represents the monetary policy stance set by the central bank. Changes in interest rates influence borrowing costs, investment decisions, and capital flows across financial markets. Interest rate fluctuations often lead to changes in asset prices and volatility spillovers between markets.

3.3 Methodology Framework

This study employs a Quantile Vector Autoregression (QVAR) framework to examine volatility spill overs among major financial markets, including stock, bond, gold, and crude oil markets, while incorporating key macroeconomic indicators such as Economic Policy Uncertainty (EPU), term spread, inflation rate, and interest rate. The QVAR approach allows the analysis of dynamic relationships across different volatility regimes, capturing market behaviour under low, normal, and high volatility conditions. Low, normal, and high volatility market conditions are represented through different quantile levels in the analysis. Specifically, Q10 represents the low volatility regime**,** Q50 represents normal market conditions**,** and Q90 represents the high volatility regime, capturing periods of increased market stress and uncertainty.

Market volatility is first computed from asset return series to measure time-varying uncertainty in financial markets. The estimated QVAR model is then used to analyse the interdependence among the selected variables. To quantify the transmission of shocks across markets, Forecast Error Variance Decomposition (FEVD) is applied. This method decomposes the forecast error variance of each variable into contributions from its own shocks and shocks originating from other markets and macroeconomic variables.

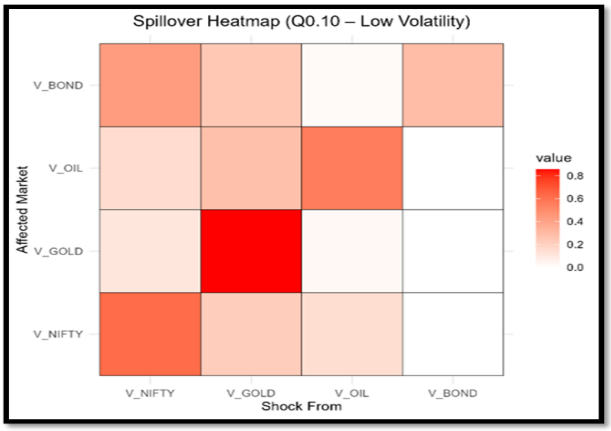
Based on the FEVD results, a volatility spillover index is constructed to measure the overall degree of interconnectedness among the markets. Furthermore, directional spillover measures are calculated to identify the extent to which each market acts as a transmitter or receiver of volatility shocks. By incorporating macroeconomic indicators into the QVAR framework, the model also evaluates the influence of macroeconomic shocks on financial market volatility across different quantile regimes.

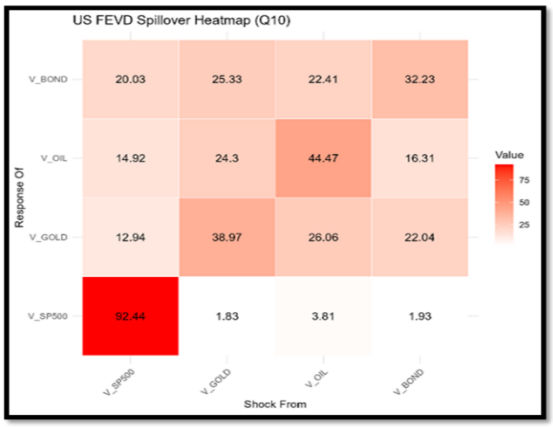
4. Empirical Results

4.1 Market-to-Market Volatility Effects

Market-to-market volatility effects refer to the transmission of volatility shocks from one financial market to another, reflecting the interconnected nature of financial systems. Fig 4.1.1 refers to the Q10 quantile represents periods of low market volatility characterized by relatively stable financial conditions and lower uncertainty. During this phase, volatility spillovers among markets are generally weaker, indicating limited transmission of shocks across financial markets includes stock, gold, silver and bond. Fig 4.1.2 represents the Q50 quantile represents normal market conditions where financial markets operate under moderate volatility levels. During this phase, volatility spillovers among markets are more balanced, reflecting typical interactions and moderate transmission of shocks across markets. Fig 4.1.3 represents the Q90 quantile represents periods of high market volatility characterized by increased uncertainty and financial stress. During this phase, volatility spillovers across markets tend to intensify, indicating stronger transmission of shocks and higher interconnectedness among financial markets.

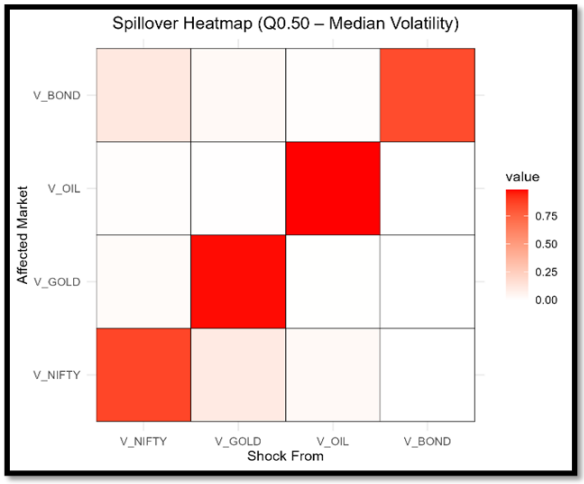
4.1.1 Low Volatility Market Phase (Q10) – (INDIA & USA)

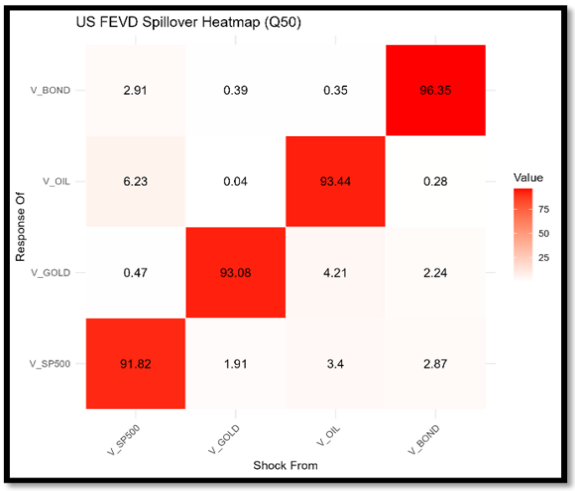




INDIA **USA**

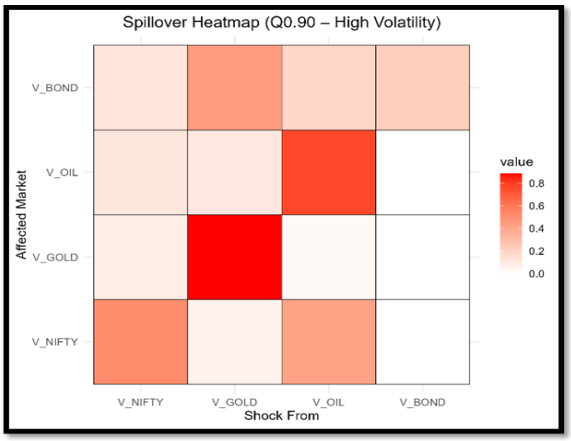
4.1.2 Normal Market Phase (Q50) – (INDIA & USA)

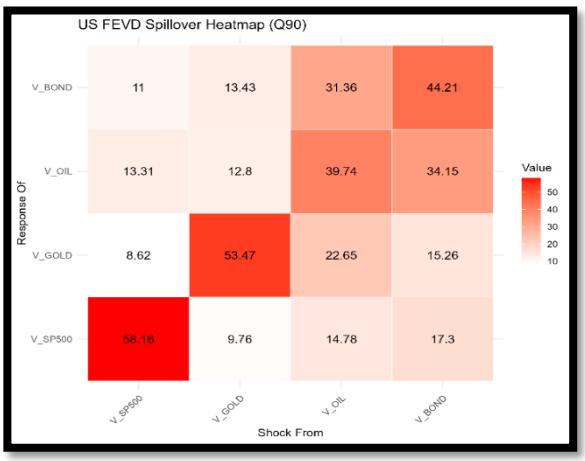




INDIA **USA**

4.1.3 High Volatility Market Phase (Q90) – (INDIA & USA)



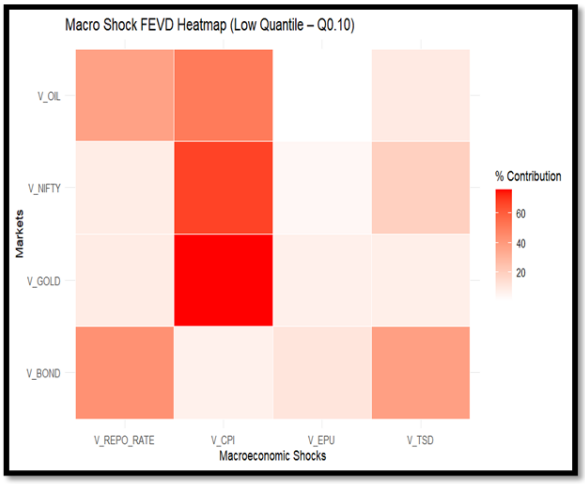


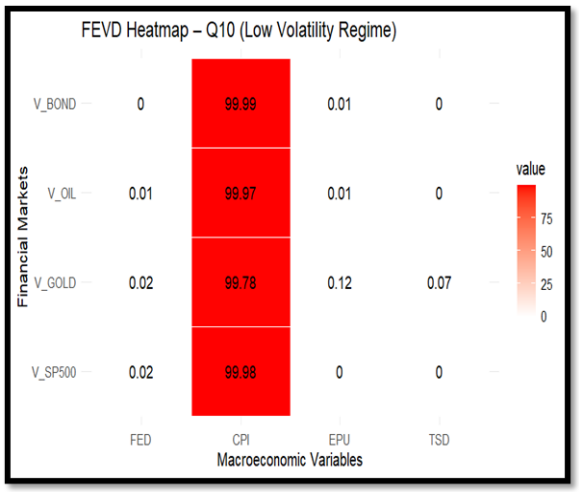
INDIA **USA**

4.2 Macroeconomic Influence on Market Volatility

Macroeconomic factors such as Economic Policy Uncertainty, term spread, inflation, and interest rate play a significant role in influencing financial market volatility. These variables help explain how economic shocks affect the transmission of volatility across financial markets. Fig 4.2.1 represents during the low volatility regime (Q10), the impact of macroeconomic shocks on market volatility remains relatively moderate in both India and the USA. The results indicate that stable macroeconomic conditions contribute to limited volatility transmission and relatively calm market behavior. Fig 4.2.2 represents the Q50 quantile represents normal market conditions where macroeconomic shocks moderately influence financial market volatility. During this phase, the transmission of volatility across markets reflects balanced interactions under typical economic conditions. Fig 4.2.3 represents the Q90 quantile represents periods of high market volatility where macroeconomic shocks significantly influence financial markets. During this phase, volatility spillovers intensify, indicating stronger transmission of shocks and heightened interconnectedness among markets.

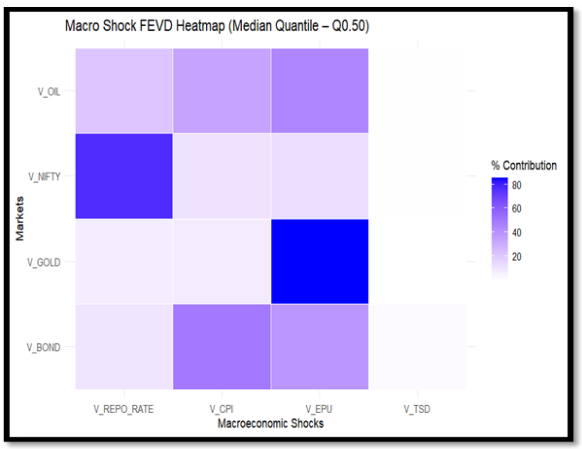
4.2.1 Low Volatility Market Phase with Macroeconomic Shocks (Q10) – (INDIA & USA)

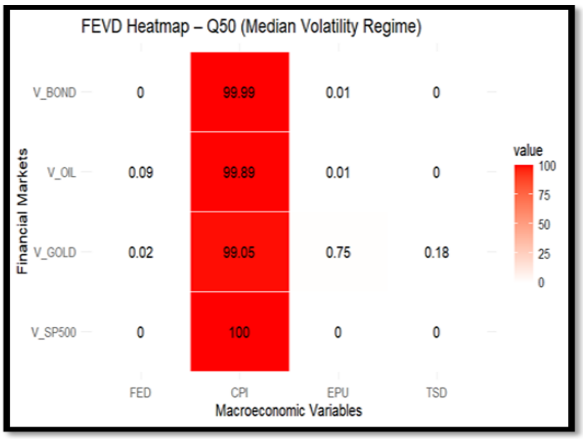




INDIA **USA**

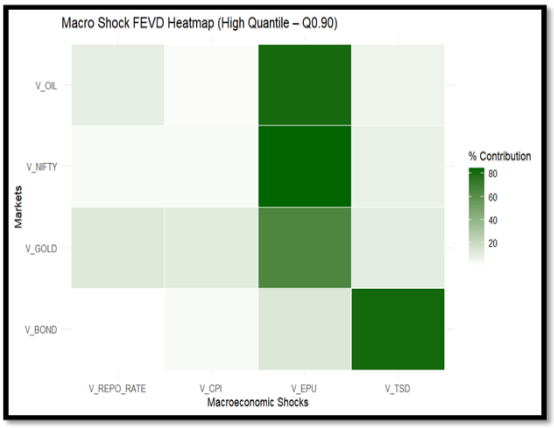
4.2.2 Normal Market Phase with Macroeconomic Shocks (Q50) – (INDIA & USA)

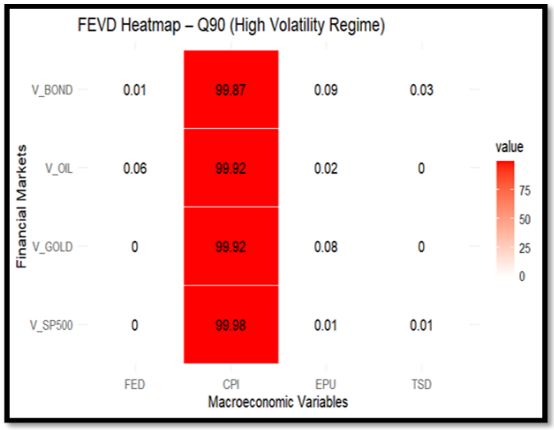




INDIA **USA**

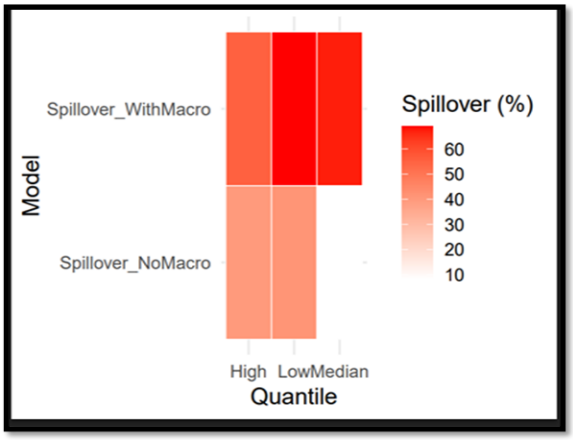
4.2.3 High Volatility Market Phase with Macroeconomic Shocks (Q90) – (INDIA & USA)

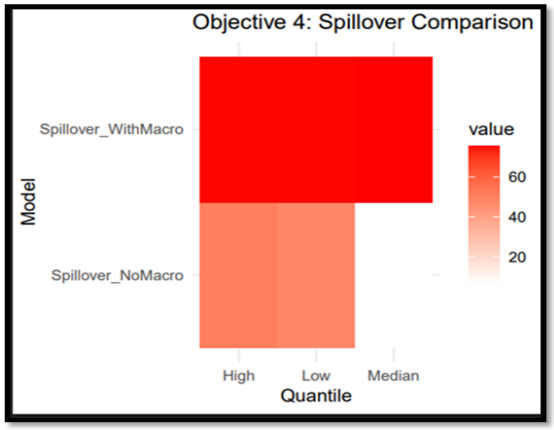




INDIA **USA**

4.3 Comparison of Spillovers with and without Macroeconomic Shocks – (INDIA & USA)





INDIA **USA**

5. Discussion of Results:

The empirical results provide important insights into the volatility spillover dynamics among the stock, bond, gold, and crude oil markets and the role of macroeconomic indicators in influencing these interactions. The findings indicate that financial markets are highly interconnected, with volatility shocks transmitted across markets under different volatility regimes. The Quantile Vector Autoregression (QVAR) results reveal that spillover effects vary across quantiles, suggesting that market relationships differ during periods of low, normal, and high volatility. In particular, the upper quantile results indicate stronger spillover effects, reflecting heightened market sensitivity during periods of financial stress. The Forecast Error Variance Decomposition (FEVD) analysis further highlights the contribution of shocks from each market and macroeconomic variable to overall volatility dynamics. The results show that certain markets act as dominant transmitters of volatility, while others primarily function as receivers of shocks. The inclusion of macroeconomic variables such as Economic Policy Uncertainty, term spread, inflation, and interest rate provides additional insights into the role of macroeconomic shocks in shaping financial market volatility.

6. Conclusion

This study investigates volatility spillovers among major financial markets, including the stock, bond, gold, and crude oil markets, while incorporating key macroeconomic indicators such as Economic Policy Uncertainty

(EPU), term spread, inflation rate, and interest rate. Using the Quantile Vector Autoregression (QVAR) framework, the study examines the dynamics of volatility transmission across different market conditions, namely low, normal, and high volatility regimes. The empirical results indicate the presence of significant volatility spillovers among the selected financial markets, highlighting the interconnected nature of global financial systems. The findings reveal that the strength and direction of spillover effects vary across different quantiles, suggesting that market relationships become stronger during periods of heightened uncertainty and financial stress.

The analysis further shows that macroeconomic variables play an important role in influencing volatility dynamics across markets. Economic policy uncertainty, interest rate fluctuations, inflation changes, and variations in the term spread contribute to volatility transmission and affect the stability of financial markets. Overall, the study provides important insights into the interaction between macroeconomic conditions and financial market volatility. The results emphasize the need for investors, policymakers, and financial institutions to closely monitor macroeconomic developments and market interconnections when assessing financial risks and making investment decisions.

7. Policy Implication

The findings of this study provide several important policy implications for policymakers, financial regulators, and market participants. The presence of significant volatility spillovers among stock, bond, gold, and crude oil markets indicates a high level of interconnectedness within the financial system. This interconnectedness suggests that shocks originating in one market can quickly transmit to other markets, potentially increasing systemic risk. From a policy perspective, regulators should closely monitor cross-market volatility transmission in order to maintain financial stability. The results highlight the importance of implementing effective risk management frameworks and regulatory policies that can mitigate the adverse effects of market shocks.

Furthermore, the analysis demonstrates that macroeconomic indicators such as Economic Policy Uncertainty, interest rate changes, inflation fluctuations, and variations in the term spread significantly influence financial market volatility. Therefore, policymakers should consider the impact of macroeconomic policy decisions on financial market stability. Transparent and consistent economic policies may help reduce uncertainty and limit excessive volatility in financial markets.

For investors and financial institutions, understanding volatility spillovers across markets can assist in improving portfolio diversification and risk management strategies. By considering the influence of macroeconomic shocks and market interconnectedness, investors can make more informed investment decisions and better manage potential risks. Overall, the study emphasizes the importance of coordinated policy actions and effective monitoring of financial markets to reduce systemic risks and enhance market stability.

References

[1] Antonakakis, N., Chatziantoniou, I., & Gabauer, D. (2019). Macroeconomic uncertainty and volatility spillovers across financial markets. Journal of International Financial Markets, Institutions and Money, 61, 104–123.

[2] Antonakakis, N., Gabauer, D., & Gupta, R. (2020). Time-varying connectedness between stock and bond markets. International Review of Financial Analysis, 71, 101534.

[3] Antonakakis, N., & Kizys, R. (2015). Global financial stress and volatility spillovers across asset classes. International Review of Financial Analysis, 41, 98–117.

[4] Appiah, M., Mensi, W., Hammoudeh, S., & Kang, S. H. (2023). Financial markets, energy shocks, and extreme volatility spillovers. Energy Economics, 117, 106457.

[5] Arnell, S., Engström, C., Uddin, G. S., et al. (2023). Volatility spillovers, structural breaks, and uncertainty in technology sector markets. Finance Research Letters, 52, 103437.

[6] Aastveit, K. A., Natvik, G. J., & Sola, S. (2017). Monetary policy uncertainty and volatility spillovers across asset classes. Journal of International Money and Finance, 76, 53–67.

[7] Aysan, A. F., Demir, E., & Gozgor, G. (2020). Geopolitical risk and volatility transmission across global financial markets. Energy Economics, 87, 104739.

[8] Baele, L., Bekaert, G., & Inghelbrecht, K. (2010). Stock–bond return and volatility spillovers under economic regimes. Journal of Financial Economics, 97(3), 514–535.

[9] Baur, D. G., & Lucey, B. M. (2010). Gold as a safe haven: Evidence from financial market stress periods. Financial Review, 45(2), 217–229.

[10] Bekaert, G., Harvey, C. R., & Ng, A. (2005). Market integration and contagion. Journal of Business, 78(1), 39–69.

[11] Bernanke, B. S., & Kuttner, K. N. (2005). What explains the stock market's reaction to Federal Reserve policy? Journal of Finance, 60(3), 1221–1257.

[12] Bouri, E., Jain, A., Biswal, P. C., & Roubaud, D. (2021). Inflation shocks and volatility connectedness among asset markets. Finance Research Letters, 38, 101447.

[13] Chatziantoniou, D., Filis, G., & Floros, C. (2017). Oil and stock market linkages: Evidence from quantile regressions. Energy Economics, 62, 100–112.

[14] Cunado, J., & Gupta, R. (2024). Realized volatility spillovers between energy and metal markets. Energy Economics, 126, 106872.

[15] Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. International Journal of Forecasting, 28(1), 57–66.

[16] Elder, J., & Serletis, A. (2010). Oil price uncertainty and the Canadian economy. Energy Economics, 32(1), 1–9.

[17] Goodell, J. W., & Goutte, S. (2021). Co-movement of COVID-19 and financial markets: Evidence from dynamic connectedness analysis. Finance Research Letters, 38, 101832.

[18] Ji, Q., Bouri, E., & Roubaud, D. (2018). Financial stress, oil price volatility, and market spillovers. Energy Economics, 74, 392–406.

[19] Kilian, L., & Park, C. (2009). The impact of oil price shocks on the U.S. stock market. International Economic Review, 50(4), 1267–1287.

[20] Malik, F., & Hammoudeh, S. (2007). Shock and volatility transmission in the oil, US, and Gulf equity markets. International Review of Economics & Finance, 16(3), 357–368.

[21] Mensi, W., Hammoudeh, S., Shahzad, S. J. H., & Shahbaz, M. (2017). Modelling systemic risk and dependence structure between oil and stock markets using a vine copula approach. Journal of Banking & Finance, 75, 1–17.

[22] Reboredo, J. C. (2013). Is gold a haven or a hedge for the U.S. dollar? Economic Modelling, 32, 26–33.

[23] Sánchez García, J., & Cruz Rambaud, S. (2023). Volatility spillovers between oil and financial markets during crises. Energy Economics, 116, 106357.

[24] Xu, Y., Guan, B., Lu, W., & Heravi, S. (2024). Macroeconomic shocks and volatility spillovers between stock, bond, gold, and crude oil markets. International Review of Financial Analysis, 90, 102782.