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Dynamic Volatility Connectedness Among NSE Thematic Indices

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Abstract
Thematic indices have gained popularity in recent years which has led to a need of understanding volatility dynamics and interconnectedness among them. This study examines how the three selected thematic indices of NSE - NIFTY Energy, NIFTY Infrastructure and NIFTY India Consumption Index interact. The study used daily closing price data from 1st January 2020 to 31st March 2026 obtained from official website of National Stock Exchange (NSE) of India. The paper analyses the volatility persistence, dynamic correlations and spillovers among these indices using GARCH (1,1), DCC-GARCH (Dynamic Conditional Correlation) and Diebold-Yilmaz connectedness index. The empirical findings highlight significant volatility persistence across all thematic indices with Nifty Consumption index exhibiting highest persistence. The DCC-GARCH results reveal strong conditional correlations among the indices, in particular between Energy and Infrastructure, indicating the increased synchronization in their behaviour over time. The spillover analysis also confirms that there are substantial volatility spillovers among the indices, with infrastructure emerging as net transmitter of volatility to the other themes. Our study concludes that the selected thematic indices of NSE have become increasingly interconnected which has limited opportunities of diversification during periods of uncertainty. These insights provide strategic implications for policymakers and investors regarding thematic portfolio and risk management strategies.

Keywords: Thematic Indices, Volatility Persistence, DCC-GARCH, Spillover Effects, Connectedness Analysis

1. Introduction

The relevance of thematic indices has increased in the Indian equity market in recent years. These indices track companies associated with various sectors but have same themes and provide a focused view of market performance beyond sectoral or benchmark indices. On the National Stock Exchange (NSE), thematic indices linked to Energy, Infrastructure, and Consumption, among others, have become significant to understand market trends.

The Nifty Energy Index represents companies associated with energy production and distribution activities. The Nifty Infrastructure Index captures firms linked to infrastructure development and capital-intensive sectors, while the Nifty India Consumption Index reflects companies driven by domestic demand and consumer spending patterns. Although these indices differ in composition, they remain economically connected through industrial activity, investment cycles, policy conditions, and investor sentiment.

The period under consideration i.e., January 2020 to March 2026 witnessed considerable fluctuations in financial markets due to disruptions related to pandemic, inflationary pressures, geopolitical uncertainty,

and changing monetary conditions. These developments altered volatility behaviour across thematic sectors and influenced market interconnectedness within the Indian equity market.

Volatility persistence and spillover transmission remain important areas in financial market research. Financial markets tend to exhibit stronger connectedness during periods of uncertainty and market stress (Diebold & Yilmaz, 2009). Earlier studies also reported significant spillovers between India and major Asian equity markets (Mukherjee & Mishra, 2010). Similar evidence of rising market interconnectedness during uncertainty has been seen across developed as well as emerging markets (Ari et al., 2025; Dang et al., 2024).

Thematic indices have also become popular in academic research. Thematic portfolios often bring out distinct risk-return characteristics compared to conventional benchmark indices (Blitz, 2021). Dynamic relationships among global thematic indices have been observed during periods of high volatility caused by uncertainty or stress (Gabriel, 2018). Within the Indian context, increasing co-movement and volatility spillovers among thematic indices have also been identified (Majumder, 2021). The growing role of thematic indices in portfolio allocation and investment strategies has received further attention in recent literature (Sen et al., 2024).

Despite the growing relevance of thematic indices, empirical evidence focusing specifically on NSE thematic indices remains limited. Most studies primarily examine broad market indices, sectoral indices, or international spillovers. Relatively fewer studies investigate volatility persistence and connectedness among thematic indices representing Energy, Infrastructure, and Consumption within the Indian equity market.

Against this background, the present study examines volatility persistence, dynamic correlations, and spillover transmission among selected NSE thematic indices using GARCH (1,1), DCC-GARCH, and Diebold–Yilmaz spillover index.

2. Literature Review

2.1.Volatility Persistence

Volatility persistence has remained an important area in financial markets research for several decades. When in index return series, the periods of high volatility are followed by further instability it leads to volatility clustering. The ARCH model introduced by Engle and GARCH frameworks developed by Bollerslev are used widely for financial volatility analysis (Bollerslev, 1986; Engle, 1982).

Several studies have used GARCH-based models to study stock market volatility under uncertain conditions. Volatility persistence has been observed in both Indian and global equity markets under changing economic conditions. GARCH models were found effective in capturing volatility persistence in stock markets of emerging economies including India and China during post-pandemic period (Ali et al., 2022; Bhattacharjee et al., 2025; Gupta et al., 2025; Wang et al., 2022).

Asymmetric volatility behaviour within the Indian infrastructure sector was observed during the pandemic period (Sharma & Sunita, 2022). Comparable findings for persistence and asymmetry were also observed across developed international markets during uncertainty (Kayani et al., 2024; Xu, 2025).

2.2.Spillover Transmission and Connectedness

Research on spillovers and market connectedness has expanded considerably with increasing financial integration across markets. Diebold and Yilmaz's framework is used to measure volatility spillovers across financial system and has reported that connectedness becomes stronger during periods of crisis or market stress. Empirical studies observed spillovers between India and major Asian markets, where volatility

spillovers increased during unstable market conditions (Mukherjee & Mishra, 2010). Similar results were also seen among growth-leading emerging economies was identified in recent studies (Ari et al., 2025; Dang et al., 2024). Asymmetric spillover between traditional and sustainable investments has also been observed in emerging connectedness research (He & Hamori, 2024).

Persistent global spillover behaviour during pandemic and geopolitical tensions has been highlighted in Indian as well as global markets (Abdelaziz Eissa & Al Refai, 2024; Phan et al., 2025). Strong spillover transmission between changes in oil price and stock markets during Ukraine - Russia war was also observed (Lei et al., 2023). This suggests that volatility shocks can rapidly transmit across interconnected financial segments, particularly during periods of uncertainty and market instability.

2.3.Thematic Indices and Market Behaviour

Thematic indices represent specialized market segments associated with specific economic themes such as energy, infrastructure, and consumption. Unlike broad market indices, thematic indices focus on companies linked to targeted dimensions of economic activity.

Thematic indices often display distinct risk-return behaviour compared to traditional benchmark indices because of their concentrated exposures to specific sectors and economic themes (Blitz, 2021). Research on global thematic indices also found stronger co-movements during market volatility, suggesting thematic indices often respond similarly to broader market movement (Gabriel, 2018). These findings indicate increasing interconnectedness among thematic investment categories.

Within the Indian context, studies on return and volatility spillovers among thematic indices reported significant interconnectedness among thematic categories (Majumder, 2021). The growing role of thematic indices in portfolio allocation and sectoral investment strategies has also received increasing investor attention around the world (Lamont et al., 2024; Sen et al., 2024). These studies suggest that thematic indices may exhibit significant co-movement due to common macroeconomic influences and changing investor sentiment.

2.4.Research Gap

The above literature provides evidence that volatility persistence and spillover transmission across markets exists. Most studies primarily examine broad market indices or international spillovers. However, empirical studies focusing specifically on NSE thematic indices volatility persistence and connectedness remains limited. Relatively fewer studies jointly investigate thematic indices representing Energy, Infrastructure, and Consumption within the Indian equity market.

Hence, we attempt to address this gap by examining volatility persistence, dynamic correlations, and spillover transmission among selected NSE thematic indices using daily closing price from 1st January 2020 to 31st March 2026 using econometric models.

3. Theoretical Framework

The study is primarily guided by Financial Contagion Theory and Market Interdependence Theory. These theories explain how volatility and shocks transmit across interconnected financial markets and investment categories.

3.1.Financial Contagion Theory

This theory demonstrates how shocks are transmitted from one market segment to the other during periods of uncertainty and market stress. Financial markets often become highly interconnected due to information flow, investor behaviour, liquidity movement, and changing risk perception. As a result, volatility originating in one segment may spread rapidly across related financial assets (Diebold & Yilmaz, 2009).

Within the present study, thematic indices representing Energy, Infrastructure, and Consumption may exhibit interconnected volatility behaviour because these sectors are economically linked. Changes in industrial activity, investment conditions, or market sentiment may therefore influence volatility across thematic categories simultaneously.

3.2.Market Interdependence Theory

Market interdependence theory suggests that financially and economically connected sectors tend to exhibit synchronized movement due to common macroeconomic factors and market conditions. Increasing integration within financial systems often reduces the independence of sectoral and thematic market behaviour.

Thematic indices linked to Energy, Infrastructure, and Consumption remain connected through broader economic activity. Infrastructure development influences industrial production and energy demand, while consumption patterns affect business activity and investment expectations. Consequently, shocks affecting one thematic segment may influence the behaviour of other thematic indices. Previous studies have also reported increasing co-movement and spillover transmission among thematic and sectoral investment categories (Majumder, 2021; Dang et al., 2024).

3.3.Conceptual Basis of the Study

The present study assumes that volatility persistence and dynamic connectedness exist among selected NSE thematic indices due to common macroeconomic influences and financial market integration. Volatility shocks originating in one thematic category may therefore transmit across related thematic sectors through spillover effects and changing investor sentiment. Based on this framework, the study examines volatility persistence using the GARCH (1,1), dynamic correlations using the DCC-GARCH, and spillover transmission using the Diebold–Yilmaz connectedness framework.

4. Objectives of the Study

Our objective is to examine volatility behaviour and interconnectedness among selected NSE thematic indices specifically volatility persistence, dynamic correlations among and volatility spillover transmission.

5. Hypotheses of the Study

To fulfil the objectives, we framed hypotheses as under:

H_{01}: Significant volatility persistence is not seen among selected NSE thematic indices.

H_{02}: Significant dynamic correlation among selected NSE thematic indices does not exist.

H_{03}: No significant volatility spillover transmission among selected NSE thematic indices.

6. Research Methodology

6.1.Design

We use quantitative research design for time-series econometric analysis. The study examines volatility persistence, dynamic correlations, and spillover transmission among selected NSE thematic indices.

6.2.Selection of Indices

The study considers the following thematic indices of NSE - **Nifty Energy, Nifty Infrastructure** and **Nifty India Consumption Index**. These indices represent important dimensions of economic activity within the Indian economy and exhibit substantial market relevance.

6.3.Secondary Source

Daily index closing prices were obtained from the NSE official website.

6.4.Study Period

The period from 1st January 2020 to 31st March 2026 captures phases of market uncertainty, changing macroeconomic conditions, and evolving thematic market behaviour.

6.5.Computation of Returns

Daily logarithmic returns were computed using the following formula:

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \times 100$$

Where:

- R_t = logarithmic return at time t
- P_t = closing price at time t
- P_{t-1} = closing price at time $t-1$

6.6.Analytical Techniques

The analysis of time series data was carried on using descriptive statistics to examine the distributional characteristics of the return series. Stationarity was checked with Augmented Dickey-Fuller test and Phillips-Perron test. Volatility persistence was examined through GARCH model. Time-varying correlations were understood by employing Dynamic Conditional Correlation. Using Diebold–Yilmaz spillover index we analysed spillover transmission and connectedness among thematic indices.

6.7.Software Used

The analysis was carried out using R Studio.

6.8.Scope of the Study

The study is limited to the selected NSE thematic indices and focuses specifically on volatility persistence, dynamic correlations, and spillover transmission within the Indian equity market.

7. Results and Discussion

7.1.Descriptive Statistics

Table 1: Descriptive Statistics of NSE Thematic Indices Returns

Index	Mean	Standard Deviation	Minimum	Maximum	Skewness	Kurtosis
Energy	0.0503	1.4256	-13.3134	8.2818	-1.0033	10.434
Infrastructure	0.0622	1.2427	-12.8356	6.9284	-1.517	15.9645
Consumption	0.0474	1.0434	-12.0516	8.3808	-1.0784	17.3127

(Source: R Studio)

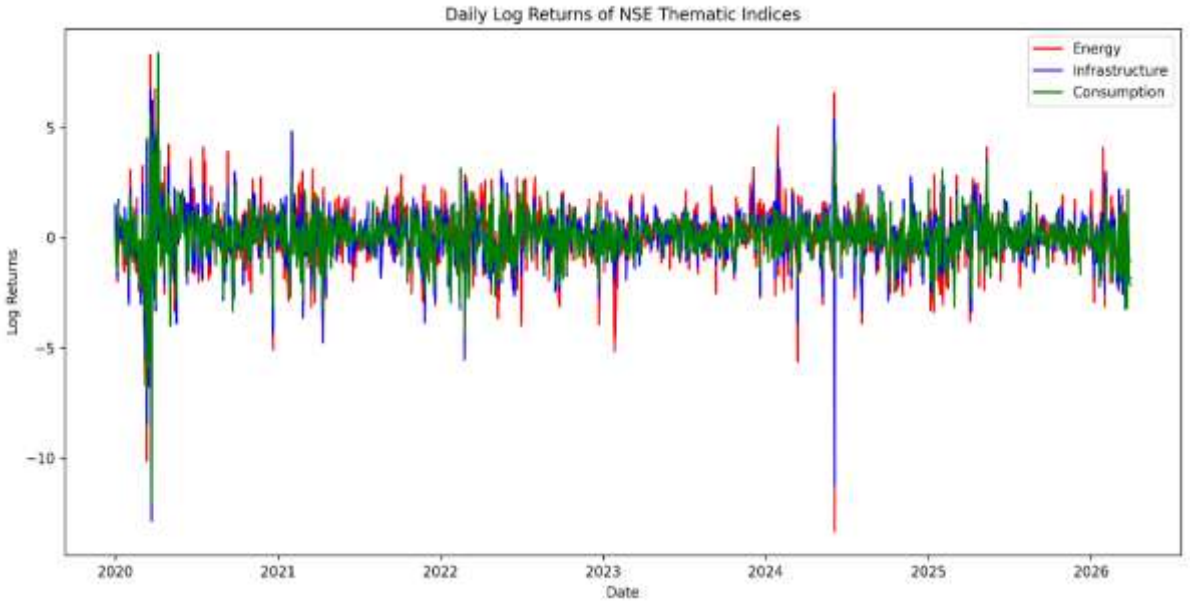

Figure 1: Price Movement of Selected NSE Thematic Indices (Source: R Studio)

We find positive mean returns for all thematic indices with Nifty Infrastructure having the highest average return (0.0622). The findings suggest relatively better return performance in the infrastructure segment during the selected period. Volatility levels varied across thematic indices. Highest standard deviation (1.4256) was observed for Nifty Energy, which means relatively higher return fluctuations compared to other indices.

All return series exhibited negative skewness, which means extreme market crashes or booms happened frequently than normal. We also find excess kurtosis values (greater than 3) i.e., distribution has heavy tails. Nifty India Consumption recorded the highest kurtosis value (17.3127). This indicates thematic indices have leptokurtic distributions and volatility clustering within their returns. Overall, the return series exhibit non-normal characteristics commonly associated with financial market data.

7.2.Correlation Analysis

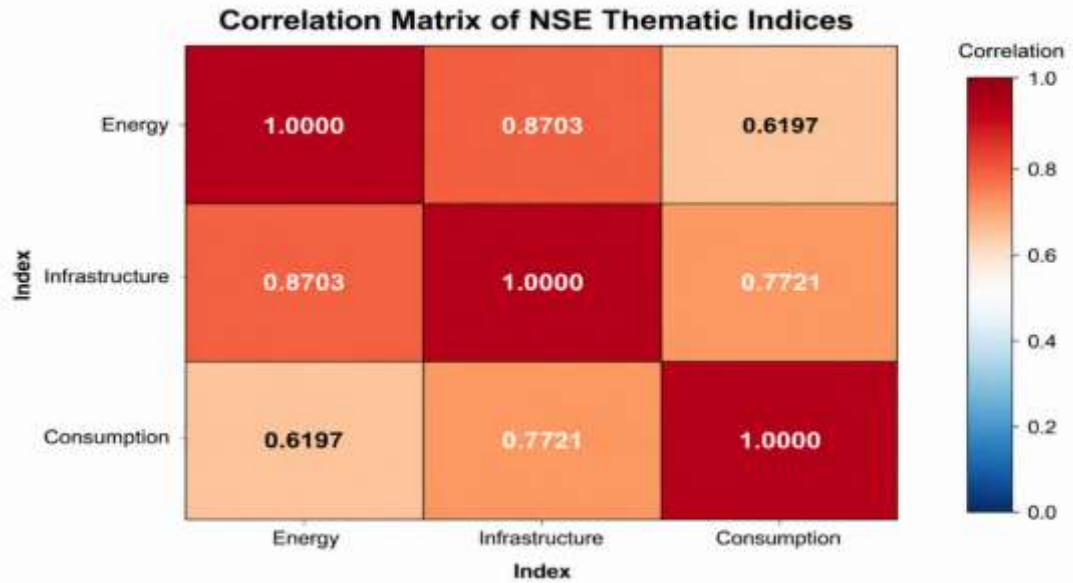

Figure 2: Correlation Heatmap (Source: R Studio)

The figure above clearly shows that there is strong positive correlation across all thematic indices. Nifty Energy and Nifty Infrastructure (0.8703) showed highest correlation indicating there is substantial co-movement between them. Infrastructure and Consumption also exhibited a strong positive correlation (0.7721), while the Energy and Consumption had moderate correlation compared to others (0.6197). This showcases the increasing interconnectedness among the themes within the Indian equity market.

7.3.Stationarity Analysis

ADF i.e., Augmented Dickey-Fuller along with Phillips-Perron (PP) test was employed to check stationarity of the return series.

Table 2: ADF and PP Unit Root Test Results

Index	ADF Test Statistic	ADF p - value	PP Test Statistic	PP p - value
Energy	-10.0848	< 0.01	-1722.16	< 0.01
Infrastructure	-10.4309	< 0.01	-1746.38	< 0.01
Consumption	-10.7292	< 0.01	-1717.76	< 0.01

(Source: R Studio)

The ADF statistics for Energy (-10.0848), Infrastructure (-10.4309), and Consumption (-10.7292) were found to be significant statistically at the 1% LOS. Similar results were obtained from the PP test, where all test statistics were significant with p-values < 0.01. Thus, the null hypothesis of unit roots was rejected i.e., log-returns are stationary and suitable for further econometric analysis.

7.4.Normality Test

The Jarque-Bera (JB) statistics for all thematic indices were significant, with p-values equal to zero. Nifty India Consumption recorded the highest Jarque-Bera statistic (19657.88), followed by Infrastructure (17054.61) and Energy (7291.03).

Table 3: JB Normality Test Results

Index	Test Statistic	p – value
Energy	7291.036	0.0000
Infrastructure	17054.61	0.0000
Consumption	19657.89	0.0000

(Source: R Studio)

The results indicate rejection of the null hypothesis of normal distribution. Thus, time-series is non-normal with excess kurtosis, and volatility clustering within thematic index returns.

7.5.Volatility Persistence Analysis

Table 4: GARCH (1,1) Estimation Results

Index	Omega (ω)	Alpha (α)	Beta (β)	Alpha + Beta (α + β)
Energy	0.2137	0.1962	0.6965	0.8927
Infrastructure	0.1246	0.1886	0.7259	0.9145

Consumption	0.0222	0.1093	0.8722	0.9814

The estimated Alpha and Beta coefficients were positive across all thematic indices, indicating the presence of volatility persistence. The **α + β** values remained close to unity for all indices. Nifty India Consumption has the highest persistence with an **(α + β)** value of 0.9814. Infrastructure recorded a persistence value of 0.9145, while Energy reported 0.8927. The findings indicate that overtime the volatility shocks remain persistent within thematic index returns. **Accordingly, the null hypothesis H_{01} is rejected.**

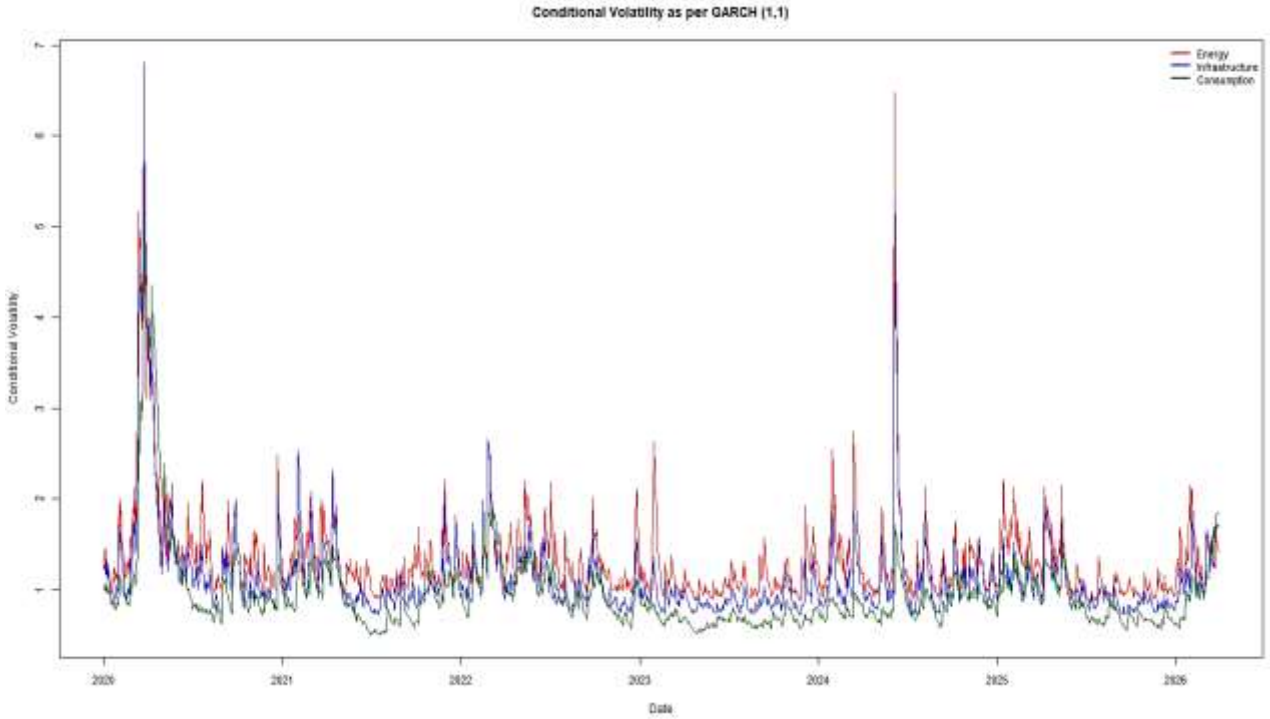

Figure 3: Conditional Volatility of NSE Thematic Indices (Source: R Studio)

7.6.Dynamic Conditional Correlation Analysis

Table 5: Dynamic Conditional Correlation Matrix using DCC-GARCH

Index	Energy	Infrastructure	Consumption
Energy	1	0.8703	0.6197
Infrastructure	0.8703	1	0.7721
Consumption	0.6197	0.7721	1

(Source: R Studio)

The results indicate strong dynamic correlations among the selected thematic indices. The highest dynamic correlation was observed between Nifty Energy and Nifty Infrastructure (0.8703). Infrastructure and Consumption also exhibited a relatively high correlation (0.7721), while Energy and Consumption recorded a comparatively lower but still significant correlation (0.6197). The findings indicate substantial co-movement among thematic indices during the study period. Accordingly**, H_{02}**: significant dynamic correlation among selected NSE thematic indices does not exist, **this null hypothesis is rejected**.

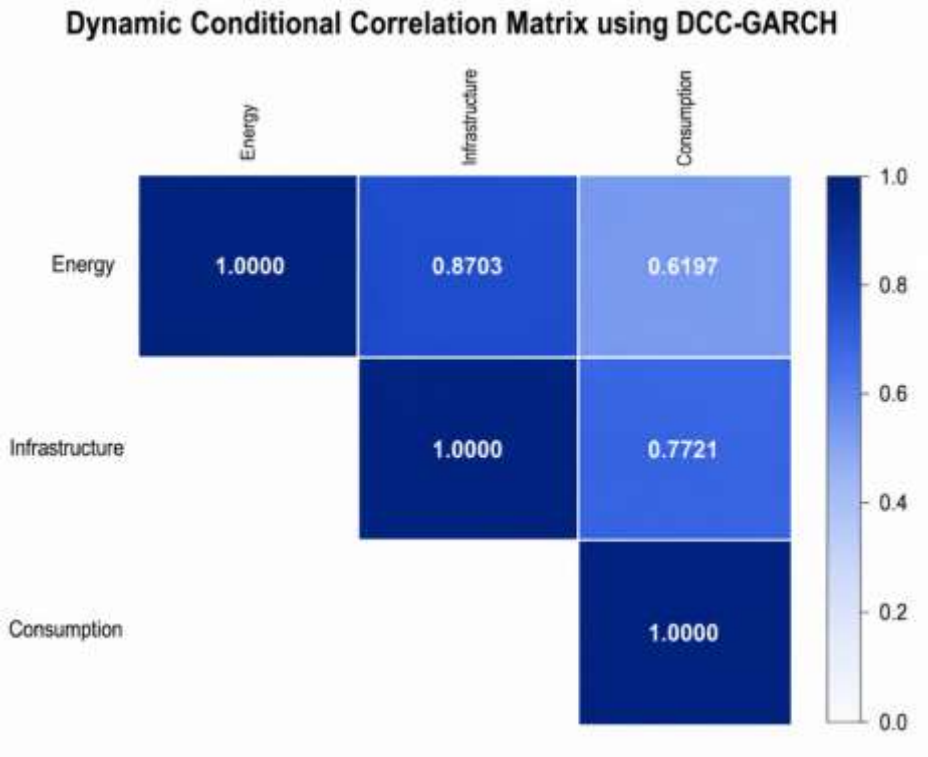

Figure 4: Heatmap of Dynamic Conditional Correlations (Source: R Studio)

7.7.Diebold–Yilmaz Spillover Analysis

Table 7: Diebold–Yilmaz Volatility Spillover Matrix

Index	Energy	Infrastructure	Consumption	FROM
Energy	46.25	35.79	17.96	53.75
Infrastructure	32.6	42.26	25.14	57.74
Consumption	20.28	30.19	49.53	50.47
TO	52.88	65.98	43.1	161.96
Inc. Own	99.13	108.24	92.63	cTCI /TCI
NET	-0.87	8.24	-7.37	80.98/53.99

Volatility spillovers among thematic indices were clearly established from the results. Nifty Infrastructure with +8.24 net spillover emerged as the transmitter of volatility while Nifty Energy (-0.87) and Nifty India Consumption (-7.37) are net receivers of the spillover. In other words, volatility originating in Infrastructure significantly influences the behaviour of other thematic indices. Thus, there is strong interconnectedness among themes. The total connectedness figures show that thematic indices in India exhibit substantial volatility transmission during the study period. **Accordingly, the null hypothesis H03 is rejected.**

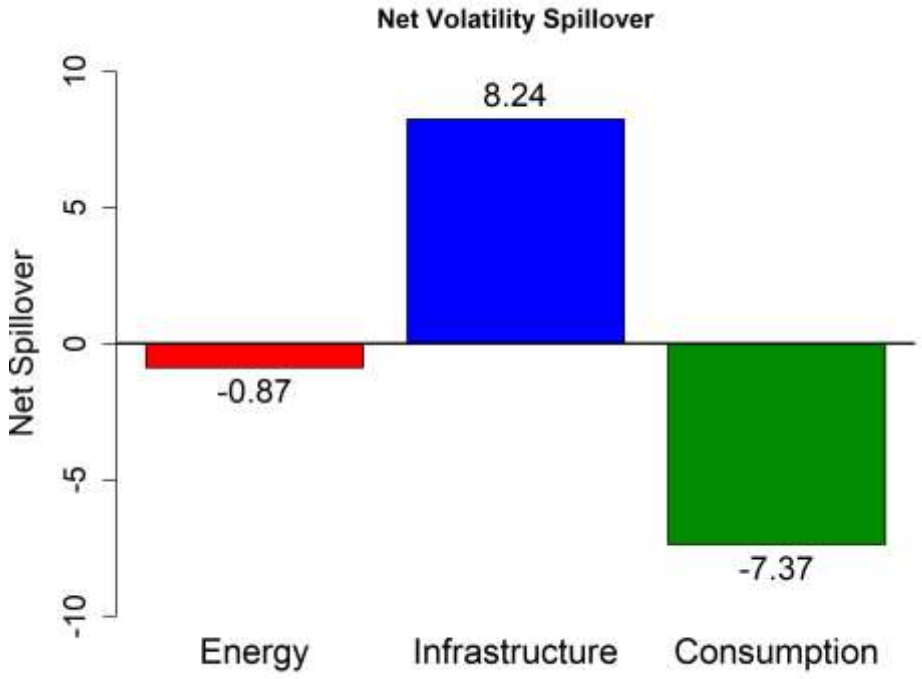

Figure 5: Net Volatility Spillover Plot among NSE Thematic Indices (Source: R Studio)

8. Conclusion

The present study examined volatility persistence, dynamic correlations, and spillover transmission among Nifty Energy, Nifty Infrastructure, and Nifty India Consumption using daily data from 1st January 2020 to 31st March 2026. The study employed GARCH (1,1), DCC-GARCH, and Diebold–Yilmaz Spillover index to understand volatility behaviour and inter-connectedness among thematic indices in India.

We found significant volatility persistence across all thematic indices in which Nifty India Consumption exhibited the highest persistence, indicating that consumption segment had prolonged effect of shocks. The results also indicated strong dynamic correlations among thematic indices, particularly between Energy and Infrastructure, suggesting substantial cointegration across these themes.

The Diebold–Yilmaz spillover analysis confirmed the existence of significant volatility transmission among thematic indices. Nifty Infrastructure emerged as the dominant transmitter of volatility within the connectedness framework, while Energy also contributed substantially to spillover transmission. The findings therefore indicate increasing interconnectedness among thematic sectors within the Indian equity market.

We observed that thematic indices reduce benefits of diversification during market uncertainty as strong integration and spillover behaviour increases. These findings are relevant for investors and portfolio managers involved in thematic investment and risk management decisions. Overall, our study adds to the growing literature on thematic indices and financial connectedness by providing empirical evidence from the Indian equity market.

9. Limitations of the Study

First, the analysis uses three NSE thematic indices out of the many indices available due to data unavailab-

ility from 1st January 2020. Second, we focused on volatility persistence and connectedness in Indian thematic indices and ignored international spillover effects or any macroeconomic variables. Finally, the above results are dependent on the selected econometric techniques and study period.

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