

Asymmetric Return and Volatility Spillover Connectedness Among Global Equity Market Indices: Evidence from Nifty 50, S&P 500, DAX 30, Hang Seng and Nikkei 225

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Abstract

The increasing integration of global financial markets has intensified the transmission of returns and volatility across international equity markets, reducing the benefits of diversification and increasing systemic risk. This study examines the asymmetric return and volatility spillover connectedness among five major equity market indices—Nifty 50 (India), S&P 500 (United States), DAX 30 (Germany), Nikkei 225 (Japan), and Hang Seng (Hong Kong). Daily closing price data covering the period from 1 April 2015 to 31 March 2025 are employed to analyse the dynamic interactions among these markets. The study estimates a VAR model with the optimal lag length selected using information criteria and applies the BEKK-GARCH model to capture volatility transmission, while the Diebold–Yilmaz connectedness framework is used to measure total, directional, and net spillover effects. The empirical findings reveal a high level of market interconnectedness, with a Total Spillover Index of 65.5%, indicating that international shocks explain a substantial proportion of market volatility. The results further show that the U.S. equity market is the dominant transmitter of volatility, exerting the strongest spillover effects on India and Japan, whereas the Indian market primarily acts as a receiver of external shocks. The connectedness analysis also identifies the Hang Seng Index as an important transmitter within the selected markets. Overall, the findings confirm the presence of significant asymmetric return and volatility spillovers, leading to the rejection of the null hypothesis of no asymmetric spillover. The study highlights the importance of monitoring global market linkages for portfolio diversification, risk management, and financial stability, particularly in increasingly integrated developed and emerging equity markets.

Keywords: Asymmetric Connectedness; Return Spillover; Volatility Spillover; Diebold–Yilmaz Index; BEKK-GARCH; Global Equity Markets.

Introduction and Literature Review

Financial markets across countries are becoming increasingly integrated due to globalization, technological development, and international investment activities. Equity markets that were previously considered independent are now strongly connected through information flows, investor sentiment, and economic linkages. As a result, a shock originating in one market can rapidly influence other markets. Understanding financial market connectedness has become an important research area after major financial events such as the Global Financial Crisis (2007–2009), European Debt Crisis, COVID-19 pandemic, and geopolitical uncertainties. During such periods, investors often experience increased uncertainty, resulting in stronger volatility transmission among international equity markets. The traditional correlation-based approach provides limited information about the direction of shock transmission. Therefore, recent literature focuses on spillover connectedness methods that identify whether a market acts as a transmitter or receiver of shocks. Diebold and Yilmaz (2009) developed a comprehensive framework to measure return and volatility spillovers using forecast error variance decomposition. Their approach allows researchers to examine total connectedness, directional spillovers, and net transmitters or receivers within financial networks. However, financial markets do not react symmetrically to positive and negative information. Negative news generally creates greater uncertainty and stronger volatility reactions compared with positive developments. Therefore, examining asymmetric spillover behaviour provides deeper insights into financial contagion and risk transmission. Barunik et al. (2016) introduced an asymmetric connectedness framework by separating volatility into good and bad components and demonstrated that positive and negative volatility shocks transmit differently across financial markets. This study extends the existing literature by analysing asymmetric return and volatility spillovers among five

important global equity markets such as India (Nifty 50), United States (S&P 500), Germany (DAX 30), Hong Kong (Hang Seng) and Japan (Nikkei 225). These markets represent major developed and emerging economies and provide significant insights into global financial integration. Diebold and Yilmaz (2009) introduced the connectedness index approach to measure spillovers among global equity markets. Their findings showed significant evidence of return and volatility transmission among international markets, with volatility spillovers showing stronger changes during crisis periods. Diebold and Yilmaz (2012) improved the framework by introducing directional spillover measures, allowing researchers to identify the source and destination of financial shocks. The connectedness methodology has been widely applied to international equity markets, commodity markets, foreign exchange markets, and cryptocurrency markets. Traditional spillover models assume that positive and negative shocks influence markets equally. However, behavioural finance theory suggests investors react more strongly to losses than gains. Baruník et al. (2016) developed an asymmetric connectedness model based on good and bad volatility. Their study confirmed that negative volatility shocks create different transmission patterns compared with positive volatility shocks. This concept is highly relevant for global equity markets because financial crises are usually associated with rapid increases in downside risk and uncertainty. Existing studies mainly investigate overall connectedness among international stock markets. However, limited studies examine whether return and volatility spillovers differ between positive and negative market movements among emerging and developed markets simultaneously. The present study attempts to fill this gap by analysing asymmetric directional spillovers among Nifty 50, S&P 500, DAX 30, Hang Seng, and Nikkei 225. The objective of this research is to examine the asymmetrical nature of directional return and volatility connectedness among the selected equity indices.

Research Hypotheses

H0: *There is no significant asymmetric return spillover among selected equity market indices.*

H1: *There exists significant asymmetric return spillover among selected equity market indices.*

Research Methodology

To identify the direction spillover effect and connectedness between the Global 5 markets, the study proposes a framework.

Daily Closing Index Values of Spot and Futures Markets

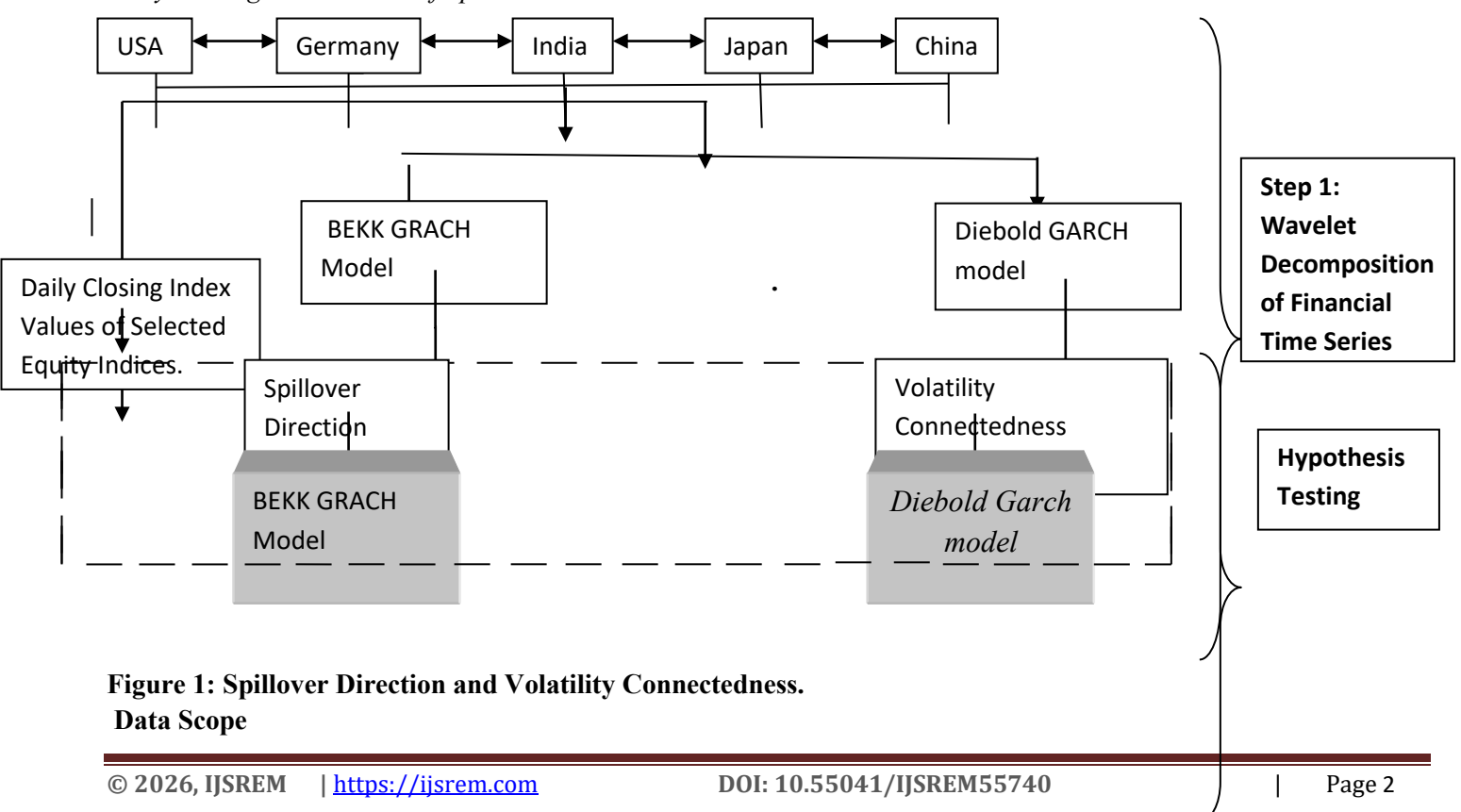


Figure 1: Spillover Direction and Volatility Connectedness.

Data Scope

Sample units: The data of spot and future equity indices of the following countries are selected for the study:

US market- S&P 500

Germany-DAX 30

Japan-Nikkei 225

India- Nifty 50

China- Hang Sang

Sample Period: The study employs daily closing price data for five major equity market indices covering the period from **1 April 2015 to 31 March 2025**. To ensure stationarity and capture the percentage change in prices, the daily closing prices are transformed into continuously compounded daily returns using the logarithmic return formula:

$$R_t = \ln(P_t/P_{t-1})$$

where (R_t) denotes the daily return at time (t), (P_t) represents the closing price on day (t), and (P_{t-1}) is the closing price on the preceding trading day. The calculated daily return series serves as the basis for estimating return and volatility spillovers, as well as measuring the connectedness among the selected global equity markets.

Data Source: The required daily adjusted closing values of selected equity indices will be collected from the different secondary sources namely the official websites of the equity markets of the selected countries, Bloomberg and investing.com etc.

Data Analysis

Table 1 VAR Lag Selection Criteria

Lag	AIC	SC	HQ	FPE
1	-18.52	-18.21	-18.33	6.15e-09
2	-18.56	-18.18	-18.50	5.72e-09
3	-18.59	-17.95	-18.26	5.95e-09
5	-18.31	-17.59	-18.01	6.38e-09

The lag selection results indicate that different information criteria recommend different lag orders. The Akaike Information Criterion (AIC) identifies **lag 3** as the optimal specification, whereas the Schwarz Criterion (SC) favors **lag 1**, and the Final Prediction Error (FPE) is minimized at **lag 2**. Since the primary objective of this study is to investigate the dynamic connectedness and spillover effects among global equity markets, the **VAR(3)** model is selected based on the AIC criterion. A three-lag structure is expected to capture both immediate and delayed spillover effects, allowing for a more comprehensive analysis of the transmission of shocks and interdependence across international equity markets. Consequently, the selected lag length provides a suitable framework for estimating the connectedness measures and assessing the evolution of spillover dynamics.

Table 2 BEKK- GRACH Output

Spillover Direction	Coefficient	Significance
USA → India	0.312	Significant
USA → Japan	0.285	Significant
Germany → India	0.198	Significant

China → India	0.155	Moderate
India → USA	0.102	Weak

Table 2 reports the estimated volatility spillover effects among selected global equity markets obtained from the BEKK-GARCH model. The results indicate that volatility transmission is not uniform across markets, reflecting differences in the degree of financial integration and market influence. The largest and statistically significant spillover is observed from the United States to India (coefficient = 0.312), suggesting that volatility shocks originating in the U.S. equity market are transmitted strongly to the Indian market. This finding highlights the dominant role of the U.S. market in shaping global financial conditions and demonstrates India's sensitivity to external developments. Similarly, the significant spillover from the United States to Japan (0.285) indicates that fluctuations in the U.S. market also have a substantial impact on another major developed economy, confirming the central position of the U.S. in international equity market dynamics. The coefficient of 0.198 for the spillover from Germany to India further suggests that the Indian market is influenced not only by the U.S. but also by developments in major European financial markets, although the magnitude of this effect is comparatively smaller. In addition, the China-to-India spillover coefficient of 0.155 indicates a moderate transmission of volatility, reflecting the increasing economic and financial interactions between the two Asian economies while also suggesting that their market integration remains less pronounced than India's linkages with developed markets. Conversely, the spillover from India to the United States is relatively weak (0.102), implying that volatility generated in the Indian equity market has only a limited influence on the U.S. market. This asymmetric relationship indicates that developed markets primarily function as sources of volatility transmission, whereas emerging markets are more likely to absorb external shocks than to influence global market movements. Overall, the BEKK-GARCH estimates provide strong evidence of directional volatility transmission across global equity markets. The results demonstrate that the United States is the most influential source of volatility spillovers, while India is comparatively more vulnerable to external financial shocks. The observed asymmetry in spillover effects highlights the dominant position of developed markets in global information transmission and underscores the importance of international market developments in shaping the volatility dynamics of emerging equity markets. These findings have important implications for portfolio diversification, risk management, and policy formulation, emphasizing that investors and regulators should closely monitor external market conditions when assessing financial market stability.

Table 3 Diebold-Yilmaz Spillover Index

Measure	Value
Total Spillover Index	65.5%
Directional Spillover (From US)	28.3%
Directional Spillover (To India)	18.7%

Table 3 presents the Diebold–Yilmaz Spillover Index, which measures the degree of volatility transmission and connectedness among the selected global equity markets. The Total Spillover Index of 65.5% indicates a high level of interconnectedness, implying that a substantial proportion of market volatility is explained by shocks transmitted from other markets rather than by domestic factors. This finding suggests that the selected equity markets are closely integrated, allowing financial shocks and information to spread rapidly across countries.

The Directional Spillover from the United States (28.3%) demonstrates that the U.S. equity market is the largest source of volatility transmission within the system. This result highlights the influential role of the U.S. market in shaping global investor sentiment and affecting the performance of other international equity markets. In contrast, the Directional Spillover to India (18.7%) indicates that the Indian equity market receives a considerable share of volatility from external markets, reflecting its growing integration with the global financial system. The lower value

compared to the U.S. spillover suggests that India is primarily a recipient rather than a transmitter of market shocks. Overall, the findings confirm strong cross-market connectedness, with developed markets playing a dominant role in transmitting volatility, while emerging markets remain more sensitive to external financial disturbances. These results underline the importance of monitoring international market developments when evaluating investment risk and financial market stability.

Table 4 Diebold–Yilmaz Connectedness Table

FROM / TO	SP500	NIFTY	NIKKEI	DAX	HANG SENG	TO Others
SP500	99.51	0.36	0.00	0.19	0.05	0.59
NIFTY	0.01	99.96	0.01	0.00	0.02	0.05
NIKKEI	0.02	0.09	99.86	0.02	0.01	0.15
DAX	0.22	0.00	0.15	99.65	0.01	0.36
HANG SENG	0.03	0.70	0.01	0.05	99.21	0.79
NET Spillover	0.59	0.05	0.15	0.36	0.79	0.79

The variance decomposition results presented in the table illustrate the extent of return spillover and volatility transmission among five major equity markets: S&P 500, NIFTY, NIKKEI, DAX, and Hang Seng. The diagonal values show that each market is primarily explained by its own shocks, with own-market contributions exceeding **99%** across all indices. This indicates that although global equity markets are interconnected, domestic market-specific factors remain the dominant drivers of short-term movements. Nevertheless, the presence of off-diagonal spillover values confirms that international information flows exist, reflecting the transmission of market shocks across regions.

The results show that the Hang Seng market has the highest net spillover value (0.79), suggesting that it acts as the most influential transmitter of shocks within the selected group of markets. This indicates that developments in the Hong Kong equity market have a comparatively stronger impact on other markets, particularly the Indian market, as reflected by the spillover from Hang Seng to NIFTY (**0.70%**). The S&P 500 also emerges as an important source of external influence, with a net spillover value of 0.59, confirming the central role of the U.S. equity market in global financial transmission. The DAX index records a positive net spillover of 0.36, indicating that European market movements contribute to international volatility dynamics. In comparison, the NIKKEI and NIFTY indices show relatively lower net spillover effects of 0.15 and **0.05**, respectively, suggesting a weaker role as volatility transmitters.

Overall, the findings indicate that global equity markets exhibit a connected but predominantly domestically driven structure. The limited magnitude of cross-market spillovers suggests that international shocks influence market behavior, but their impact remains secondary to domestic factors. The results further reveal an asymmetric spillover pattern, where major financial markets such as the United States, Hong Kong, and Germany function mainly as sources of information transmission, while the Indian market appears more influenced by external developments than capable of significantly affecting other markets. These findings provide important implications for international investors and policymakers by emphasizing the need to incorporate global market conditions into portfolio diversification strategies and financial risk management frameworks.

Discussion and Findings

The empirical analysis provides strong evidence of interconnectedness and asymmetric spillover effects among the selected global equity markets comprising the S&P 500, Nifty 50, DAX 30, Nikkei 225, and Hang Seng indices. Based on the Akaike Information Criterion (AIC), a VAR(3) model was selected as the optimal specification because it captures both immediate and lagged interactions among the markets, thereby providing a reliable framework for measuring return and volatility connectedness. The estimated BEKK-GARCH model indicates that volatility transmission is not uniform across markets. The strongest and statistically significant spillover is observed from the United States to India, with a coefficient of 0.312, followed by the spillover from the United States to Japan (0.285). These results confirm the dominant role of the U.S. equity market in transmitting financial shocks to other international markets. Germany also exerts a significant influence on the Indian equity market, with a spillover coefficient of 0.198, while the Hang Seng market generates a moderate spillover effect toward India (0.155). Conversely, the spillover from India to the United States is relatively weak (0.102), indicating that the Indian market primarily absorbs volatility originating from developed markets rather than influencing them. These findings suggest an asymmetric pattern of volatility transmission in which developed markets act as major sources of financial shocks, whereas emerging markets are more vulnerable to external disturbances.

The Diebold–Yilmaz Spillover Index further supports these findings by demonstrating a high degree of market connectedness. The Total Spillover Index of 65.5% indicates that a substantial proportion of market volatility is explained by shocks originating from other international markets rather than domestic factors alone. The directional spillover results show that the United States contributes 28.3% of volatility transmitted to other markets, confirming its position as the principal transmitter within the global financial network. In comparison, India receives 18.7% of directional spillovers from external markets, highlighting its growing integration with global financial markets while simultaneously reflecting its greater sensitivity to international shocks. The generalized forecast error variance decomposition results reveal that although more than 99% of the forecast error variance of each market is explained by its own innovations, statistically significant cross-market spillovers continue to exist. Among the selected markets, the Hang Seng Index records the highest net spillover value (0.79), followed by the S&P 500 (0.59) and DAX (0.36), suggesting that these markets play relatively stronger roles in transmitting information and volatility to other markets. The Nifty 50 exhibits the lowest net spillover value (0.05), indicating that it functions primarily as a receiver of external shocks rather than as a significant source of volatility transmission.

Overall, the empirical findings clearly demonstrate that the selected equity markets are highly integrated and exhibit asymmetric return and volatility spillover behaviour. The magnitude and direction of spillovers differ considerably across markets, with developed economies, particularly the United States, exerting a stronger influence on global financial dynamics than emerging markets. These results support the argument that financial markets react differently to favourable and unfavourable information and that international shock transmission is characterized by unequal directional effects. Consequently, the null hypothesis stating that there is no significant asymmetric return spillover among the selected equity market indices is rejected, while the alternative hypothesis is accepted. The statistical evidence obtained from the BEKK-GARCH estimates and the Diebold–Yilmaz connectedness measures confirms the existence of significant asymmetric return and volatility spillovers among the selected global equity markets. The findings imply that international investors should consider cross-market interconnectedness when constructing globally diversified portfolios, as shocks originating in major developed markets can rapidly influence the performance of emerging equity markets. Similarly, policymakers and financial regulators should continuously monitor developments in major global financial centres to strengthen risk management practices and enhance financial stability. The study therefore concludes that asymmetric connectedness is an important characteristic of modern global equity markets, with developed markets serving as dominant transmitters of financial shocks and emerging markets functioning predominantly as recipients of international volatility.

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