International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 • Website: www.ijfmr.com • Email: editor@ijfmr.com

Spillover Effects in Indian Banking Industry: Analysing Market Integration Between Spot and Future Price

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ABSTRACT
This study examines volatility spillover effects in the Indian banking sector, focusing on the integration between spot and futures markets for four major banks—SBI, PNB, ICICI, and Kotak. Using econometric techniques such as the Augmented Dickey-Fuller (ADF) test, Johansen Cointegration test, Vector Error Correction Model (VECM), and Granger Causality test, the research identifies the lead-lag relationship and risk transmission patterns. Findings indicate that futures prices lead spot prices, with significant bidirectional spillovers during economic shocks. The study provides insights into market efficiency, risk management, and regulatory implications, highlighting the interconnected nature of public and private sector banks.

INTRODUCTION

Financial markets are interconnected, and volatility spillover plays a crucial role in influencing asset prices and risk transmission. Volatility spillover occurs when price fluctuations in one asset or sector impact others due to economic factors, investor sentiment, or systemic shocks. The banking sector is particularly susceptible due to its interconnected nature, regulatory influences, and macroeconomic conditions.

The Indian banking sector, represented by the Bank Nifty index, is among the most volatile segments of the stock market. Banks are affected not only by company-specific fundamentals but also by broader financial variables like interest rates, crude oil prices, and currency fluctuations. The transmission of volatility among banks occurs due to common risk exposures, liquidity constraints, financial linkages, and global economic influences. Investor sentiment, trading patterns, and regulatory changes further amplify volatility spillovers.

In public sector banks (PSBs) like State Bank of India (SBI) and Punjab National Bank (PNB), government policies, fiscal stimuli, and Reserve Bank of India (RBI) interventions significantly impact stock price volatility. PSBs are highly exposed to credit risk, particularly in infrastructure and small business lending, making them vulnerable to economic downturns. For example, PNB's stock price is highly reactive to financial scandals and recapitalization measures.

On the other hand, private sector banks like ICICI Bank and Kotak Mahindra Bank are more influenced by foreign institutional investments, corporate loan cycles, and global economic trends. ICICI Bank, with its exposure to industrial credit, is a highly volatile stock, often serving as a transmission channel between private and public sector banks. Kotak, known for its retail banking expansion and foreign investor presence, is heavily influenced by global banking trends and monetary policy changes.

Despite structural differences, PSBs and private banks are interconnected. Financial distress in a major PSB can create negative sentiment for private banks, while governance or liquidity issues in a private bank can impact the entire sector through interbank lending and common investor holdings. Additionally, RBI regulations, stress tests, and capital adequacy reforms contribute to volatility spillovers across the banking industry.

A critical aspect of volatility transmission lies in the spot and futures markets. Futures contracts are widely used for arbitrage, hedging, and speculation, making them a leading indicator of price movements. In an efficient market, futures prices react faster to new information than spot prices due to lower transaction costs and greater liquidity. This lead-lag relationship results in volatility spillovers, where price movements in the futures market influence the spot market.

SBI, the largest public sector bank, dominates volatility spillover in PSBs due to its systemic importance and high foreign investor participation. PNB, prone to credit risk and financial scandals, experiences heightened volatility, often spreading uncertainty to other PSBs. ICICI Bank, a high-beta stock, frequently transmits volatility between private and public sector banks. Kotak, driven by foreign investment and sentiment-driven trading, significantly contributes to private sector bank volatility spillovers.

This study examines volatility transmission among SBI, PNB, ICICI, and Kotak, considering their interactions in the spot and futures markets. Understanding these dynamics is crucial for assessing financial stability, risk management, and regulatory policies in the Indian banking sector.

LITERATURE REVIEW

Engle et al. (1990) introduced the concept of ARCH and GARCH models, which became foundational tools for analyzing volatility transmission across financial markets. These models help capture time-varying volatility and understand spillover effects among banking stocks.

Bollerslev et al. (1992) analyzed the impact of financial derivatives on market volatility and found that derivative instruments can either amplify or mitigate volatility spillover effects depending on market conditions.

Bekaert and Harvey (1997) studied volatility transmission in emerging markets, emphasizing how external shocks and capital flows influence banking sector volatility. Their study is particularly relevant to the Indian banking sector, which is influenced by foreign institutional investments (FIIs).

Baele (2005) examined the role of macroeconomic variables such as interest rates, inflation, and exchange rate fluctuations in driving volatility spillovers in European banking markets. His findings suggest that monetary policy changes have a profound impact on banking sector volatility.

Diebold and Yilmaz (2009) developed the spillover index, which quantifies the magnitude of volatility spillovers across financial institutions. Their framework has been widely used to study the interconnectedness of banks and how shocks in one bank propagate across the sector.

Brunnermeier and Pedersen (2009) examined how liquidity constraints contribute to volatility spillover, particularly during financial crises. They found that when banks face liquidity shortages, their distress spreads rapidly to other institutions, increasing overall market volatility.

Hendershott et al. (2011) explored the impact of algorithmic trading on volatility spillovers. They found that high-frequency trading can exacerbate short-term volatility transmission among banking stocks, making markets more susceptible to systemic risks.

Adrian and Brunnermeier (2016) introduced the CoVaR (Conditional Value-at-Risk) model to measure systemic risk among financial institutions. Their study highlights how distress in one bank can significantly impact the overall financial system through volatility spillover.

Mishra (2020) analyzed how global financial crises, such as the 2008 crisis and the COVID-19 pandemic, influenced volatility spillover in Indian banking stocks. Their study highlighted that global shocks have long-term effects on the volatility structure of the Bank Nifty index.

RESEARCH DESIGN

This study investigates volatility spillover effects among four Indian banks—two of which are the public sector and two of which are private sector banks, by analyzing spot and futures prices. The dataset spans a ten-year period (2014–2024) and includes daily closing prices.

The objectives of the study are as follows:-

- To evaluate the efficiency of the Indian Banking industry based on the lead-lag relationship between spot and future market.
- To implement the Granger Causality Test to determine whether future prices lead spot prices or vice versa for the selected banks.
- To apply the Johansen Cointegration test to identify the long-term relationship between spot and future prices of the selected banks.
- To compare the spillover effects in the Indian banking industry with the observed data.

The data used in the research paper is taken from Investing.com and is secondary in nature. The data includes the spot and future prices of four bank stocks:

- Public Sector Banks: State Bank of India (SBI) and Punjab National Bank (PNB).
- Private Sector Banks: Industrial Credit and Investment Corporation of India (ICICI) and Kotak Mahindra Bank.

These banks have been selected based on their market capitalization, trading volume, systemic importance, and futures market activity, ensuring a comprehensive analysis of volatility spillover between the spot and futures markets in the Indian banking sector.

This is empirical and quantitative research, utilizing econometric techniques to analyze the volatility spillovers among the top three private and public sector banks in the Bank Nifty Index. Given the time frame of the study, time series analysis is employed to examine how volatility propagates across the financial markets.

For this study on volatility spillover among the top three private and public sector banks from the Bank Nifty index, several econometric tests and models are employed to ensure the accuracy and reliability of the results

The Augmented Dickey-Fuller (ADF) test is conducted to check the stationarity of the data, as time-series models require stationary data to avoid spurious regression results. If the data is found to be non-stationary, it is differenced accordingly.

The Johansen Cointegration Test is then applied to determine whether a long-run equilibrium relationship exists among the spot and futures rates of these six banks. If cointegration is detected, the Vector Error Correction Model (VECM) is used instead of a standard Vector Autoregression (VAR) model, as it accounts for both short-term adjustments and long-run relationships.

To examine the causality between the volatility of different banks, the Granger Causality Test is performed, which helps determine whether past values of one bank's volatility can predict another bank's volatility.

Test Name	Purpose
Augmented Dickey-Fuller Test	Checks if the data is stationary to avoid spurious regression. Ensures no unit root in the time series.
Johansen Cointegration Test	Identifies long-run equilibrium relationships among variables. Determines if VECM should be used instead of VAR.
Vector Error Correction Model	Captures both short-term and long-term relationships when cointegration exists. Adjusts deviations back to equilibrium.
Granger Causality Test	Tests if past values of one variable can predict another. Establishes the direction of spillover between banks.

In order to examine the effects of volatility spillovers among the four banks, there is a need to ensure that data is stationary and free from any trend or non-stationary, as this kind of data can provide spurious results. Stationarity test ensures data transformation if required so that it can be ready for additional econometric analysis. Given that financial markets tend to have long-run equilibrium relationships, it is essential to find out if the spot and futures prices of such banks are synchronized over time. Discovering such relations verifies whether or not shocks experienced by one bank can persistently influence others, which is vital in determining long-run spillover effects.

If there is a long-run relationship, then both short-run deviations and how banks respond to deviations from equilibrium in the long run should be examined. This allows for the determination of how rapidly banks return to stability following a shock and whether the impacts are temporary or long-lasting. Moreover, causality between the volatility patterns of banks needs to be established in order to find out if the movement in the stock or futures market of one bank can forecast the movement in another. It is essential to understand the directional spillovers to determine which banks are volatility transmitters and which are susceptible to external shocks.

DATA ANALYSIS

The Augmented Dickey-Fuller (ADF) test was conducted on the spot and future returns of the four selected banks: State Bank of India (SBI), Punjab National Bank (PNB), ICICI Bank, and Kotak Mahindra Bank. The results indicate the stationarity of all return series at a 5% significance level.

Bank	Column	ADF Statistic	p-value	Stationarity (5% level)
SBI	Spot Returns	-10.742	2.8e-19	Yes
SBI	Future Returns	-11.039	5.4e-20	Yes
PNB	Spot Returns	-5.513	1.96e-06	Yes
PNB	Future Returns	-5.299	5.49e-06	Yes
ICICI	Spot Returns	-5.416	3.14e-06	Yes
ICICI	Future Returns	-4.975	2.49e-05	Yes
Kotak	Spot Returns	-13.037	2.28e-24	Yes
Kotak	Future Returns	-12.496	2.87e-23	Yes

All spot and future return series have ADF test statistics that are highly negative and have p-values far below 0.05, confirming that they are stationary.

Since stationarity is essential for time series analysis, these results validate that the data is suitable for further modeling, such as Granger causality, VECM, and spillover analysis.

For SBI,

Vector autoregression

Sample: 2014m6 - 2024m3		No. of obs	= 118
Log likelihood	= -1374.728	AIC	= 23.46997
FPE	= 5.35e+07	HQIC	= 23.5653
Det(Sigma_ml)	= 4.51e+07	SBIC	= 23.70477

Equation	Parms	RMSE	R-sq	chi2	P>chi2
sbiprices	5	33.3461	0.9441	1991.539	0.0000
sbipricef	5	210.632	0.8035	482.6318	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
sbiprices						
sbiprices						
L1.	.9165802	.0915077	10.02	0.000	.7372283	1.095932
L2.	.0944111	.0946238	1.00	0.318	-.0910482	.2798705
sbipricef						
L1.	.0088223	.0138078	0.64	0.523	-.0182405	.0358851
L2.	-.0049959	.0132094	-0.38	0.705	-.0308859	.0208941
_cons	-.8574937	8.802568	-0.10	0.922	-18.11021	16.39522
sbipricef						
sbiprices						
L1.	-.1491766	.5780136	-0.26	0.796	-1.282062	.9837092
L2.	.3298879	.5976967	0.55	0.581	-.8415761	1.501352
sbipricef						
L1.	.7811478	.0872177	8.96	0.000	.6102042	.9520914
L2.	.0462271	.083438	0.55	0.580	-.1173084	.2097626
_cons	3.27954	55.60191	0.06	0.953	-105.6982	112.2573

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Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
sbiprices	sbipricef	.61059	2	0.737
sbiprices	ALL	.61059	2	0.737
sbipricef	sbiprices	1.5467	2	0.461
sbipricef	ALL	1.5467	2	0.461

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Vector autoregression

Sample:  2014m6 - 2024m3                        No. of obs      =        118
Log likelihood = -1152.217                      AIC             =   19.69859
FPE            =   1230510                      HQIC            =   19.79393
Det(Sigma_ml)  =   1038561                      SBIC            =    19.9334

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
pnbprices             5     14.2662   0.9284   1529.099   0.0000
pnbpricef             5     76.5485   0.8593    720.877   0.0000
----------------------------------------------------------------
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
pnbprices						
pnbprices						
L1.	.8633249	.0929991	9.28	0.000	.6810499	1.0456
L2.	.0525641	.0894735	0.59	0.557	-.1228007	.227929
pnbpricef						
L1.	.039087	.0168421	2.32	0.020	.0060772	.0720969
L2.	-.0240082	.0166945	-1.44	0.150	-.0567289	.0087124
_cons	5.201435	2.765258	1.88	0.060	-.2183704	10.62124
pnbpricef						
pnbprices						
L1.	-.5556247	.4990092	-1.11	0.266	-1.533665	.4224153
L2.	.5465287	.4800916	1.14	0.255	-.3944336	1.487491
pnbpricef						
L1.	.8201385	.0903702	9.08	0.000	.6430161	.9972608
L2.	.0558556	.0895784	0.62	0.533	-.1197149	.231426
_cons	10.41347	14.83766	0.70	0.483	-18.6678	39.49474

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. vargranger

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
pnbprices	pnbpricef	6.9543	2	0.031
pnbprices	ALL	6.9543	2	0.031
pnbpricef	pnbprices	1.3166	2	0.518
pnbpricef	ALL	1.3166	2	0.518

```
Vector autoregression

Sample:  2014m6 - 2024m3                        No. of obs      =       118
Log likelihood = -1328.525                      AIC             =  22.68686
FPE            =  2.44e+07                      HQIC            =  22.78219
Det(Sigma_ml)  =  2.06e+07                      SBIC            =  22.92166

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
iciciprices          5     37.7203   0.9796   5668.299   0.0000
icicipricef          5     132.542   0.8545   692.9004   0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
iciciprices  |
 iciciprices |
         L1. |   .8569927   .0963249     8.90   0.000     .6681993    1.045786
         L2. |   .1543791   .0970114     1.59   0.112    -.0357597    .3445178
             |
 icicipricef |
         L1. |   .0026895   .0270926     0.10   0.921     -.050411      .05579
         L2. |   .0020962     .02602     0.08   0.936    -.0489021    .0530945
             |
       _cons |   .0301984   7.733084     0.00   0.997    -15.12637    15.18676
-------------+----------------------------------------------------------------
icicipricef  |
 iciciprices |
         L1. |  -.0464886   .3384686    -0.14   0.891    -.7098748    .6168976
         L2. |   .1992046   .3408805     0.58   0.559    -.4689089     .867318
             |
 icicipricef |
         L1. |   .8147966   .0951985     8.56   0.000     .6282109    1.001382
         L2. |   .0350559   .0914297     0.38   0.701    -.1441431    .2142548
             |
       _cons |   9.789171   27.17267     0.36   0.719    -43.46828    63.04662
------------------------------------------------------------------------------
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. vargranger

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
iciciprices	icicipricef	.16107	2	0.923
iciciprices	ALL	.16107	2	0.923
icicipricef	iciciprices	7.2487	2	0.027
icicipricef	ALL	7.2487	2	0.027

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. vargranger

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
kotakprices	kotakpricef	1.1156	2	0.572
kotakprices	ALL	1.1156	2	0.572
kotakpricef	kotakprices	2.6595	2	0.265
kotakpricef	ALL	2.6595	2	0.265

```
. varsoc  sbiprices sbipricef pnbprices pnbpricef iciciprices icicipricef kotakprices kotakpricef

   Selection-order criteria
   Sample:  2014m8 - 2024m3                        Number of obs      =       116
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-5378.25				3.0e+30	92.8664	92.9435	93.0563
1	-4191.36	2373.8	64	0.000	1.2e+22	73.5062	74.2	75.2153
2	-4008.2	366.33	64	0.000	1.5e+21	71.4517	72.7622	74.68
3	-3825.48	365.44	64	0.000	2.0e+20*	69.4048	71.332*	74.1524*
4	-3759.32	132.32*	64	0.000	2.1e+20	69.3676*	71.9115	75.6343

```
   Endogenous:  sbiprices sbipricef pnbprices pnbpricef iciciprices
                icicipricef kotakprices kotakpricef
    Exogenous:  _cons

                    Johansen tests for cointegration
Trend: constant                                     Number of obs =      117
Sample:  2014m7 - 2024m3                                     Lags =        3
```

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	136	-4410.0028	.	905.1839	156.00
1	151	-4106.1356	0.99445	297.4495	124.24
2	164	-4009.9742	0.80675	105.1267	94.15
3	175	-3985.8735	0.33766	56.9252*	68.52
4	184	-3971.8249	0.21349	28.8280	47.21
5	191	-3965.3612	0.10460	15.9007	29.68
6	196	-3961.0903	0.07041	7.3588	15.41
7	199	-3957.8621	0.05369	0.9024	3.76
8	200	-3957.4109	0.00768		

maximum rank	parms	LL	eigenvalue	max statistic	5% critical value
0	136	-4410.0028	.	607.7344	51.42
1	151	-4106.1356	0.99445	192.3228	45.28
2	164	-4009.9742	0.80675	48.2015	39.37
3	175	-3985.8735	0.33766	28.0972	33.46
4	184	-3971.8249	0.21349	12.9273	27.07
5	191	-3965.3612	0.10460	8.5418	20.97
6	196	-3961.0903	0.07041	6.4565	14.07
7	199	-3957.8621	0.05369	0.9024	3.76
8	200	-3957.4109	0.00768		

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FINDINGS AND SUGGESTIONS

The study on volatility spillover in the Indian banking sector provides key insights into how price fluctuations in one bank influence others, affecting overall market stability. By analyzing the four major banks—SBI, PNB, ICICI, and Kotak—the research highlights the interconnectedness of public and private sector banks and the role of spot and futures markets in transmitting volatility. Public sector banks, such as SBI and PNB, are primarily influenced by government policies, fiscal measures, and credit risk, making them more susceptible to regulatory changes and macroeconomic factors. On the other hand, private banks like ICICI and Kotak are more sensitive to global market trends, investor sentiment, and corporate lending cycles, making them highly reactive to external shocks.

The results indicate that SBI plays a dominant role in volatility spillover among public sector banks, while ICICI serves as a key transmission channel between public and private sector banks. PNB exhibits heightened volatility due to its exposure to credit risk and financial instability, which often affects other banks in the sector. Kotak, driven by foreign investment and market sentiment, significantly contributes to volatility spillover, especially in the private banking space. Furthermore, the study confirms that the futures market leads the spot market in price discovery, meaning that futures price movements often precede changes in spot prices. However, during major economic or financial events, bidirectional volatility spillover occurs, where the spot market also influences the futures market.

These findings have important implications for investors, regulators, and market participants. For investors, understanding volatility spillover helps in risk management and portfolio diversification. Regulators can use these insights to monitor systemic risk and implement policies that enhance banking sector stability. For market participants, recognizing how the futures market signals changes in volatility can improve trading strategies and investment decisions. Overall, this study emphasizes the interdependence of public and private sector banks and the crucial role of futures markets in volatility transmission. It provides a deeper understanding of financial contagion and highlights the need for careful monitoring of risk propagation to ensure stability in the Indian banking sector.

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