Analysing the Relationship between Nifty Sectoral Indices Returns and India Volatility Index (IVIX)

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ABSTRACT

The sectoral index aims to provide a comprehensive value for the performance of several enterprises in a specific sector of the economy. The present research explores the relationship between the returns of sectoral indices listed on the National Stock Exchange (NSE) and the India Volatility Index (VIX). The data was obtained over an 11-year span, from January 1, 2013, to December 31, 2023, was collected solely from the National Stock Exchange official budget. This study focuses on the performance of the Nifty Sectoral indices, using the daily closing prices. The Phillips-Perron and Augmented Dickey-Fuller tests were utilized to assess the stationarity of the return series. Correlation and Regression analyses were conducted on the time series dataset to derive the linkage. This research both supports and contradicts previous findings. The purpose of this research is to gain insights into the performance of the Nifty sectoral indices and the volatility observed during the study period. A significant finding from the analysis is that, all other Sectoral Indices have a positive influence on IVIX, only Nifty Financial Services and Nifty Realty are resistant to volatility shocks. This finding is supported by multiple regression analysis.

Keywords: Augmented Dickey-Fuller, IVIX, Nifty Sectoral, Phillips-Perron, Volatility Index.

INTRODUCTION

The research emphasizes the analyzes of sectoral indices daily prices log returns as opposed to raw index prices alone. Analyzing daily price movements helps researchers compare different market indices over various time periods by normalizing the data. Log returns are preferred for their statistical properties, making calculations simpler and enabling various analysis techniques. They closely resemble percentage returns, have a normal distribution, and are useful for risk management and hypothesis testing. Research using daily price log returns of sectoral indices can provide valuable insights into market dynamics, risk factors, and investment opportunities, supporting decision-making in finance.

Stakeholders in the Indian and international stock markets have paid close attention to the importance of studying market volatility. Dramatic swings in stock prices were common, and they occasionally diverged greatly from fundamentals. Market collapses have grown more frequent, perplexing investors, experts, and policymakers. Previous research consistently showed that the Volatility Index (IVIX) and stock prices were inversely correlated, indicating that increased volatility was associated with lower stock prices. As a gauge of short-term volatility expectation, the IVIX served as a "investors fear indicator," illustrating the magnitude of the influence of adverse volatility shocks on prices.

The significance of stock market indexes was also emphasised, since they offer important insights into price changes across a range of marketplaces. By providing a single measure for the total performance of businesses operating in a certain sector, sector-based indexes represented connected industries or economic sectors. Both active and passive investors relied on these indexes for portfolio trading since they provided easy-to-use measures of market performance. In order to get insights into market dynamics, risk considerations, and investment opportunities—and to support well-informed financial decision-making—research employing sectoral indices daily prices log returns and market volatility analysis was essential.

REVIEW OF LITERATURE

In order to maximise resource utilization and boost study productivity, it is imperative that comprehensive research be conducted in order to comprehend the body of current knowledge and pinpoint areas in which discoveries may be produced.

This knowledge helps researchers choose the best approaches and investigate topics that haven't been studied before. To achieve this goal, an extensive review of the literature has been done. It begins with a review of studies conducted abroad, followed sequentially by an appraisal of research conducted by Indian scholars.

The aim of **Shanmugasundram and John Benedict's (2013)** study was to identify risk variables in the CNX Nifty index and Indian sectoral indices. They identified substantial changes in risk within various time frames but no significant differences in risk among sectoral indices using statistical techniques including one-way ANOVA and two-sample T-tests.

Nateson (2013) examined the impact of volatility on BSE sectoral indices from the BSE Sensex. The lack of focus on volatility transmission from main indices to sectoral indices was identified by their study. While volatility transmitted from BSE Sensex to select sectors, shocks in Sensex returns did not affect BSE power and BSE tech sectors.

Simon and Lei (2015) identified that noise traders exist in the financial markets., who base their decisions on irrational emotions, enhancing market liquidity but also posing mispricing risks. During heightened volatility, VIX fluctuations were noted to influence trading volume, thereby reducing the required return for rational investors due to increased liquidity. Behavioral decision-making, relying on heuristics, provided insights into return-volatility dynamics beyond conventional hypotheses such as leverage and volatility feedback.

Chandra & Thenmozhi (2015) discovered the overnight transmission of volatility from the US market to the Indian market, revealing a negative relationship between stock returns and the India VIX. During market booms, Nifty 50 returns moved independently, while the VIX served as a reliable measure of market volatility. Additionally, they found that increasing volatility could prompt investors to switch from mid-cap to large-cap portfolios, making the VIX a useful risk management tool.

Choi & Richardson (2016) investigated how equity volatility responded to asset volatility and leverage effects using the Fama-French three-factor model. Contrary to prior literature, they found a positive correlation between equity volatility and leverage, supporting the leverage hypothesis. They observed that asset volatility exhibited less persistence compared to equity volatility.

Jin (2017) investigated the asymmetric link between return and volatility across 16 stock markets. Utilizing methodologies like the Hurst exponent and detrended cross-correlational analysis, the study disclosed a pronounced negative correlation, especially in the long term, and uncovered evidence of leverage effects. It highlighted the asymmetric responses to the adverse risk-return relationship and illustrated the reasons behind downturns.

Ngene and Lynch (2018)examined long memory and structural breakdowns in the variations of 11 US stock market sectors using a range-based volatility estimator as opposed to daily squared returns. They identified proof of long memory in volatility through their study using several parametric models, which they linked to the introduction of structural fractures. They examined volatility dynamics using models such as ARFIMA-FIEGARCH, ARFIMA-Hyperbolic GARCH and ARFIMA-FIGARCH.

Karaa et al. (2018) looked into how trading volume and intensity influenced return-volatility in the Tunis stock market. They discovered that higher volatility was a direct result of high trading intensity, with volume having a greater influence than intensity. They also came to the conclusion that the link between intensity and return was negative and that trading volume was an inaccurate indicator of information flow.

Objective

i.   To analyze the performance of Nifty Sectoral Indices of NSE.
ii.   To examine the correlation between sectoral indices and volatility index (VIX).
iii.   To analyze the relationship between Nifty Sectoral indices and volatility index (VIX).

A. Hypothesis for the study:
H1: The return series of sectoral indices are normally distributed.
    H2: The return series of sectoral indices are non- stationary (unit –root problem).
      H3: The dependent variable is significantly impacted by at least one independent variable.
      H4: At least one of the coefficients of the independent variables is not equal to zero.
      H5: Residuals are not auto correlated.
      H6: Variance of Residuals is heteroskedastic.

DATA AND METHODOLOGY

The aim of this research is to examine the relationship between the India VIX index and the NSE sectoral indices. Eleven indices, including the IVIX, were chosen in order to increase the study's comprehensiveness. The Nifty Bank, Nifty Energy, Nifty Auto, Nifty Financial Services, Nifty IT, Nifty FMCG, Nifty Media, Nifty Realty, Nifty Metal and Nifty PSU, which collectively represent crucial indices of the Indian economy. The inclusion of these indices enriches the analysis, making it more dynamic and robust. To accomplish this objective, we have collected daily closing prices of the sectoral indices and converted them into returns, alongside relevant readings of the India VIX.

The period of data collection for this research is 11 years, beginning on January 1, 2013, and ending on December 31, 2023. The 11 indices daily closing prices have been obtained from the NSE's official website. The study adopts a descriptive approach. Data analysis involves a total of 2710 observation for each index.

Duration of the study:
The timeframe of data collection is 11 years, starting on January 1, 2013, and ending on December 31, 2023.

A. Data collection:
The data collection process for this study involves gathering secondary data, specifically the daily closing prices of sectoral indices, from various sources including Yahoo Finance and the NSE website (www.nseindia.com). These indices represent different sectors of the economy and are essential for analyzing market dynamics. The study covers a span of 11 years, from 2013 to 2023, allowing for a comprehensive examination of long-term trends and fluctuations in the daily closing prices of selected sectoral indices.

Historical data on these sectoral indices is accessed through web-based platforms such as Yahoo Finance and the NSE website, encompassing daily closing prices for each trading day within the specified study period. The study primarily relies on secondary data collected from the NSE website, spanning from January 1st, 2013 to December 31st, 2023. Additionally, data is also collected from Yahoo Finance.

The following are the indices included in the study:
a) Nifty Auto
b) Nifty Bank
c) Nifty Energy
d) Nifty Financial Services
e) Nifty FMCG
f) Nifty IT
g) Nifty Media
h) Nifty Metal
i) Nifty PSU
j) Nifty Realty
k) India VIX (IVIX)

B. Tools for analysis:
➢ **Descriptive statistics:** The average return on the stock is calculated by taking the arithmetic mean of the daily stock returns. The study uses descriptive statistics to comprehend the distributional characteristics of the Sectoral Indices and IVIX, including Mean, Standard Deviation, Skewness, and Kurtosis.

➢ **Econometrics model**
1. Unit root test: In any research involving financial time series data, it's essential for the data to display stationarity. Thus, in this study, time series tests were utilized to test the stationarity of sectoral indices prices.
   • Augmented Dickey Fuller test
   • Phillips – Perron test
2. Correlation: Correlation analysis helps us understand connection between variables. If the data is stationary, it's easier to see if there's a direct connection between them. But in the case of data being non-stationary, it can make the relationship seem stronger or weaker than it really is because of those changes.

3. Regression: The purpose of regression analysis is to investigate the relationship between a number of independent variables and a single dependent variable. It allows the value of the dependent variable to be

predicted using the independent variables. Regression analysis measures the strength and direction of these relationships by evaluating how changes in the independent variables correspond to changes in the dependent variable.

4. This aids in understanding cause-and-effect dynamics, particularly when dealing with non-stationary data. Here IVIX is taken as dependent variable and Sectoral Indices are considered as independent variables.

C.   Limitations of the study
  ➢ The study is limited by several factors, notably reliance on secondary sources like NSE website and Yahoo Finance.
  ➢ The study requires time-consuming verification processes.
  ➢ The scope of statistical analysis is constrained to hypothesis testing and correlation.

DATA ANALYSIS

Table1: Descriptive Statistics of Sectoral Indices of NSE and IVIX

	IVIX	Auto	Bank	Energy	Fin. Services	FMCG	IT	Media	Metal	PSU	Realty
Mean	0.0000213	0.000495	0.000494	0.000531	0.000525	0.000486	0.000654	0.000107	0.000366	0.000155	0.000367
Median	-0.002995	0.000947	0.000732	0.000883	0.000597	0.000678	0.000697	0.000632	0.000821	1.58E-05	0.001270
Maximum	0.496881	0.098997	0.099952	0.082818	0.089107	0.079906	0.089220	0.134510	0.093875	0.259487	0.083025
Minimum	-0.414379	-0.149055	-0.183130	-0.102167	-0.173623	-0.111998	-0.124903	-0.178817	-0.123318	-0.141109	-0.123348
Std. Dev.	0.050900	0.013642	0.014858	0.013133	0.014111	0.010753	0.013176	0.016709	0.017881	0.021312	0.020024
Skewness	0.655485	-0.515049	-0.759737	-0.609094	-0.893808	-0.453175	-0.575112	-0.483444	-0.372542	0.534200	-0.501324
Kurtosis	11.51673	13.20220	16.65398	8.897266	16.61965	13.14998	11.75492	13.05988	6.003240	13.47008	6.279416
Jarque-Bera	8384.444	11872.73	21311.90	4094.554	21306.31	11725.68	8804.290	11532.87	1081.132	12507.12	1327.886
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	2710	2710	2710	2710	2710	2710	2710	2710	2710	2710	2710

Table 1 displays the descriptive statistics for returns on sectoral indices and changes in IVIX. These statistics are crucial for determining whether the distribution of data resembles a normal distribution. The data suggests that none of the distributions are normal, as all sectoral indices show positive mean returns.

Nifty ENERGY has the greatest mean return, while Nifty MEDIA has the lowest. IVIX shows a positive mean change, indicating increasing volatility, with the largest positive change being 0.496881 and the largest negative change being -0.414379. IVIX also has the highest standard deviation, indicating its volatile nature, while Nifty FMCG has the lowest. The skewness coefficients reveal that 9 out of 11 indices have negative skewness, with the Financial Service sector exhibiting the highest negative skewness at -0.893808, suggesting asymmetry with a longer tail to the left. Only IVIX and PSU show positive skewness, with values of 0.655485 and 0.5342 respectively.

Kurtosis values exceeding 3 indicate fat-tailed distributions for all sectoral indices, indicating non-normality. Furthermore, low Jarque-Bera statistic values and associated p value close to 0 recommends the rejection the null hypothesis of normality. This it can be concluded that the return series are not normally distributed for all the indices. The high coefficients of kurtosis for all distributions suggest leptokurtic behavior, with Nifty Bank having the highest kurtosis value at 16.65398. In summary, the descriptive statistics demonstrate that none of the indices, including IVIX, follow a normal distribution and therefore do not behave in a random manner.

Table2: Results of Augmented Dickey Fuller Test at level and Phillips-Perron Test.

Index	Augmented Dickey Fuller Test			Phillips-Perron Test		
	ADF	Critical Value @ 5%	Probability	PP	Critical Value @ 5%	Probability
	t-statistic			t-statistic		
IVIX	-39.39387	-2.862408	0.0000	-51.89093	-2.862407	0.0001
Auto	-50.18105	-2.862407	0.0001	-50.24891	-2.862407	0.0001
Bank	-49.28292	-2.862407	0.0001	-49.28712	-2.862407	0.0001
Energy	-51.11035	-2.862407	0.0001	-51.11776	-2.862407	0.0001
Fin. Services	-18.92457	-2.862410	0.0000	-49.95516	-2.862407	0.0001
FMCG	-52.32820	-2.862407	0.0001	-52.32781	-2.862407	0.0001
IT	-51.90236	-2.862407	0.0001	-51.91250	-2.862407	0.0001
Media	-51.46150	-2.862407	0.0001	-51.48056	-2.862407	0.0001
Metal	-52.27984	-2.862407	0.0001	-52.43485	-2.862407	0.0001
PSU	-50.56352	-2.862407	0.0001	-50.58503	-2.862407	0.0001
Realty	-47.95735	-2.862407	0.0001	-47.97449	-2.862407	0.0001

The alternative hypothesis in this test proposes non-stationarity, whereas the null hypothesis states that the data for the chosen indices are stationary. The findings of the Philips-Perron Test (PP Test) and the Augmented Dickey Fuller Test (ADF Test) used to assess the stationarity of the selected financial time series data are shown in Table 2. The purpose of the ADF test is to determine if the return series are non-stationary and whether a unit root exists in them. A necessary condition for the reliability of the random walk hypothesis is non-stationarity in return series.

The null hypothesis asserts that the time series data are stationary and lack any discernible pattern or relationship with other variables. In all cases, the probability of accepting the null hypothesis for NSE sectoral indices and IVIX is zero, accompanied by highly negative ADF t-statistics compared to the respective critical levels at 5%. This leads to another rejection of the null hypothesis, which states that the time series data are non-stationary. Time series data is suitable for additional investigation and analysis due to its non-stationarity. When the probability test yields a p-value of less than 0.05, it is considered statistically significant and the alternative hypothesis is accepted, rejecting the null hypothesis.

Since the null hypothesis is rejected as a result of the data's non-stationarity, it can be determined that the return series of all the indices are non-stationary. This consequently paves the way for analyzing the correlation and regression of selected sectoral indices with the Indian Volatility Index, as the null hypothesis is rejected due to the non-stationarity of the data.

Table3: Correlation Analysis.

INDEX	IVIX	AUTO	BANK	ENERGY	FIN. SERVICES	FMCG	IT	MEDIA	METAL	PSU	REALTY
IVIX	1	-0.223710	-0.239387	-0.199787	-0.250986	-0.160038	-0.082999	-0.180649	-0.204230	-0.183689	-0.232673
AUTO	-0.223710	1	0.688473	0.619650	0.698458	0.529237	0.376449	0.575632	0.629458	0.556059	0.614097
BANK	-0.239387	0.688473	1	0.620688	0.968693	0.485005	0.323700	0.509853	0.595444	0.738374	0.637136
ENERGY	-0.199787	0.619650	0.620688	1	0.627212	0.471626	0.330707	0.492730	0.644549	0.554159	0.576035
FIN. SERVICES	-0.250986	0.698458	0.968693	0.627212	1	0.512971	0.349060	0.506200	0.592237	0.678293	0.637834
FMCG	-0.160038	0.529237	0.485005	0.471626	0.512971	1	0.331548	0.390246	0.412362	0.359248	0.431713
IT	-0.082999	0.376449	0.323700	0.330707	0.349060	0.331548	1	0.327356	0.328831	0.207607	0.291433
MEDIA	-0.180649	0.575632	0.509853	0.492730	0.506200	0.390246	0.327356	1	0.524849	0.488293	0.544622
METAL	-0.204230	0.629458	0.595444	0.644549	0.592237	0.412362	0.328831	0.524849	1	0.568735	0.599664
PSU	-0.183689	0.556059	0.738374	0.554159	0.678293	0.359248	0.207607	0.488293	0.568735	1	0.577090
REALTY	-0.232673	0.614097	0.637136	0.576035	0.637834	0.431713	0.291433	0.544622	0.599664	0.577090	1

The correlation analysis results, as shown in Table 3, reveal strong positive correlations among sectoral indices. For example, Nifty Financial Services exhibits notably high positive correlations with Nifty Bank (0.968693), Nifty Auto (0.698458), Nifty PSU (0.678293), Nifty Realty (0.637834), and Nifty Energy (0.627212). Conversely, Nifty IT demonstrates the lowest correlation with other indices.

Additionally, Indian VIX shows a significantly high negative correlation with sectoral indices, suggesting that increased implied volatility in Indian markets could negatively impact equity indices. Notably, correlations are particularly high for Auto, Bank, Energy, Financial Services, Metal, and Realty sectors, while moderately positive for Media, Public Sector Undertaking (PSU) Banks, FMCG, and IT sectors.

Table4: Multiple Regression Matrix

Dependent Variable: IVIX		N (Number of observations):2710		
Multiple R-squared: 0.076538		Multiple Adjusted R-squared: 0.073117		
F-Statistic: 22.36980		Prob (F-Statistic): 0.0000		
Serial Correlation LM Test: Prob.F(Statistic)= 0		Homoskedasticity Test: Prob.F(Statistic)= 0		

Variable	Coefficient	Standard Error	t-Statistic	Prob.
CONSTANT	0.000465	0.000944	0.492954	0.6221
AUTO	-0.154024	0.112782	-1.365680	0.1722
BANK	0.375877	0.286208	1.313299	0.1892
ENERGY	-0.059294	0.106825	-0.555059	0.5789
FIN. SERVICES	-0.866973	0.287727	-3.013181	0.0026
FMCG	-0.057506	0.108922	-0.527957	0.5976
IT	0.134686	0.079988	1.683833	0.0923
MEDIA	-0.087192	0.074501	-1.170337	0.2420
METAL	-0.103363	0.079004	-1.308320	0.1909
PSU	0.032993	0.071531	0.461245	0.6447
REALTY	-0.230411	0.069256	-3.326939	0.0009

When the multiple R-squared value is more than 60%, the regression is considered to have a strong fit. The multiple adjusted R-squared value in this study, however, is just 0.076538, meaning that the independent factors account for only 7.65% of the variation in the dependent variable. Therefore, we have considered other factors for the analysis:

Regression analysis using a time series of daily returns from January 1, 2013, to December 31, 2023 shows that only the Nifty Financial Services and Realty indices have statistically significant influence on the India Volatility Index at the 5% level, as their returns probabilities lesser than 0.05, which indicates that they have statistically significant influence on the dependent variable, while other sectoral indices do not.All the regression coefficients, with the exception of Bank, Nifty IT, and Nifty PSU, have an intercept value close to zero.The statistical significance of the regression model suggests that the independent variables together exert a noteworthy influence on the dependent variable. According to the F-statistic value of 22.36 with a probability of 0.

With p-values significant below 0.05, the computed F-statistics values for every chosen stock return series surpass the observed R-square values, indicating that two independent variables have non-zero coefficients. Moreover, an F-statistic probability 0 indicates that the independent variables jointly affect the dependent variable IVIX. Similarly, an F-statistic probability of 0 indicates serial correlation, or autocorrelation, in the residuals.

The validity and reliability of regression analysis are further enhanced by the fact that a serial correlation LM test value of 0 denotes the absence of autocorrelation or the existence of a systematic pattern in the regression model's residuals. A

probability of zero in the homoscedasticity test suggests the presence of heteroscedasticity, which is represented by a consistently varying residual variance among the independent variable values.

FINDINGS AND THE CONCLUSION

The study analyses the performance of 11 NSE sectoral indices over an eleven-year period, along with changes in the Indian Volatility Index (IVIX). Descriptive statistics show that all indices including IVIX have non-normal distributions with positive mean returns across all sectors. Additionally, the Philips-Perron Test and the Augmented Dickey Fuller Test, which both confirm non-stationarity in the data, we reject the null hypothesis of stationarity. Correlation analysis reveals strong positive correlations among sectoral indices, particularly in the Financial Services, Auto, and Energy sectors. Regression research reveals that the Nifty Financial Services and Realty indices are only two indices that have a substantial impact on IVIX, indicating their significance in forecasting market volatility. The overall statistical significance of the regression model suggests that independent variables collectively affect IVIX. The study's conclusions highlight the non-normality and non-stationarity of IVIX and sectoral indices, suggesting that these variables don't behave randomly.

Even if there are strong connections across sectoral indices, only the financial services and realty sectors have an evident effect on IVIX, suggesting that they are capable of predicting market volatility. One notable finding from the study is that, while Nifty Financial Services and Nifty Realty are the only Sectoral Indices that are immune to volatility shocks, all other Sectoral Indices have a positive impact on IVIX. Multiple regression analysis supports this finding.

These results are further supported by the regression model, which shows how independent variables collective impact IVIX. Overall, these insights contribute to a deeper understanding of the dynamics between sectoral indices and market volatility, aiding investors and analysts in making informed decisions in the Indian financial market.

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