

# Wavelet Analysis of NIFTY 50: Unveiling Multiresolution Structures

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# Introduction

## About the study

- We have taken the Indian equity market, known for its dynamism, as the focus of our study due to its critical role in India's economic development.
- We have used the NIFTY 50 index as a benchmark, representing the performance of 50 major companies across sectors like financial services, IT, energy, and consumer goods.



## Objective

- To conduct a detailed wavelet-based analysis of the NIFTY 50 index, uncovering multi-resolution structures and identifying both short-term and long-term trends within the Indian equity market.
- To validate the stationarity of the NIFTY 50 index and ensure the reliability of wavelet analysis by employing the Augmented Dickey-Fuller (ADF) test.



# Literature Review

## **Stock Market Forecasting Using Hybrid Models (*Naliniprava Tripathy and Sanjita Jaipuria, 2020*)**

- Investigated stock forecasting using a hybrid model of DWT and ANN, applied to BSE data.
- Achieved 92.58% prediction accuracy, showcasing its effectiveness for investors.

## **Noise Removal and Trend Analysis (*S. Saravanan and S. Mala, 2018*)**

- Analyzed Indian stock prices using CWT and DWT for noise removal and trend identification.
- Found 49.38% prediction accuracy and highlighted the importance of trading intervals.

## **Enhancing Stock Market Trends (*Kin Keung Lai and Jing Huang, 2007*)**

- Used CWT and DWT to decompose stock prices into frequency components for trend analysis.
- Demonstrated improved predictive power compared to traditional methods.

## **Intraday Stock Index Forecasting (*Albin Henriksson, 2023*)**

- Examined DWT integrated with Transformer neural network on OMXS30 index.
- Found slight outperformance over simple strategies, with limited profitability.

## **Cryptocurrencies and Indian Equity Markets (*Susovon Jana and Tarak Nath Sahu, 2024*)**

- Used wavelet analysis to explore relationships between cryptocurrencies and Indian equities.
- Found cryptocurrencies effective for diversification but not as safe havens during crises.

# Methodology

## Research Gap

Wavelet analysis has mainly focused on developed markets, with limited research on emerging ones like India's NIFTY 50. The application of hybrid models, such as wavelets with ANN and Transformers, in real-world trading remains underexplored. Additionally, examining the traditional techniques with advance transformation offers valuable insights for investors during crises.

## Research Design

The study utilizes daily closing prices of the NIFTY 50 index, covering the period from April 2, 2019, to July 31, 2024.and analysed using EViews software.

## Research Method

### Wavelet Transform Analysis:

- Used **MODWT** for decomposition, retaining data length and enabling detailed time-frequency analysis.
- Decomposition employed **Daubechies wavelet (db4)** to capture short-term fluctuations and long-term trends.

### Multi-Resolution Analysis (MRA):

- Applied **MODWT-based MRA** up to scale level 2 for separating short- and medium-term components.
- Ensured no decomposition for accurate financial time series analysis.

### Unit Root Test:

- Conducted **Augmented Dickey-Fuller (ADF) test** to confirm stationarity of the NIFTY 50 index, a prerequisite for reliable wavelet analysis.

### Variance Decomposition:

- Analyzed the distribution of variance across different frequency components using **MODWT with Band-Limited Confidence Intervals**.

### Wavelet Thresholding:

- Used **Least Asymmetric wavelet (LA12)** for denoising high-frequency noise while preserving the data's core signal.

### Outlier Detection:

- Detected anomalies in high-frequency components with **Mean Median Absolute Deviation (MAD)**, identifying significant market events.

# Findings & Discussion

## Wavelet Transform Analysis:

- MODWT decomposition identified significant short-term volatility at **W1 and W2 scales** during market shocks, such as the COVID-19 pandemic in early 2020.
- Long-term trends at higher scales (W3 to W10) indicated sustained market growth, particularly during the recovery phase post-2021.

## Quarterly Seasonality:

- We observed recurring seasonal trends, with peaks aligning with **fiscal year-end and policy announcements** like the Union Budget.
- High-frequency components (W1) captured sharp quarterly market reactions, while intermediate components (W2) extended volatility over weeks.

## Variance Decomposition:

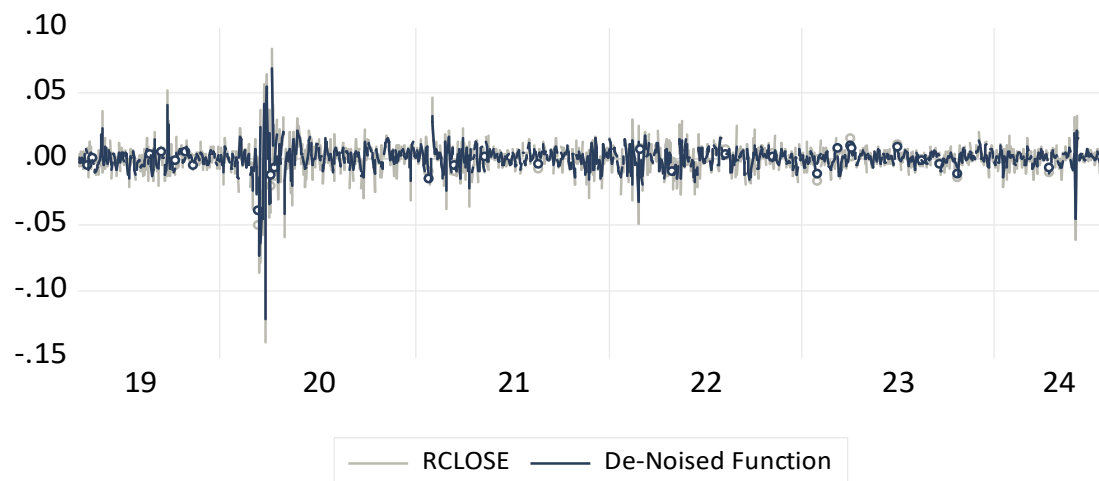
- Short-term fluctuations (W1) accounted for **53.6% of total variance**, indicating the dominance of daily volatility.
- Long-term components (W4–W8) contributed progressively less to variance, highlighting market stability over extended periods.

## Unit Root Test:

- The ADF test confirmed the **stationarity of the NIFTY 50 index**, validating the reliability of our wavelet-based results.

# Findings & Discussion

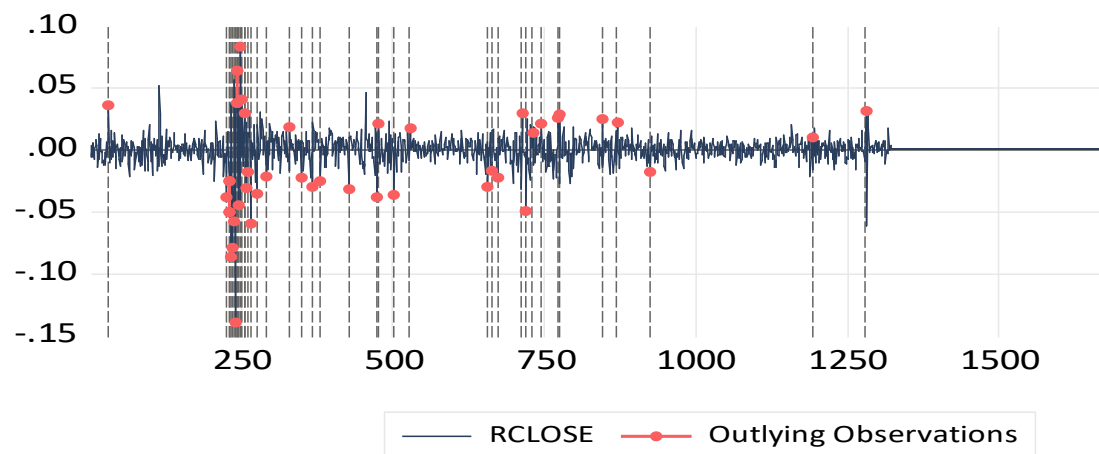
Wavelet Shrinkage Estimator



## Wavelet Thresholding:

- High-frequency noise was successfully denoised, revealing clearer long-term trends and enhancing the accuracy of market analysis.

Outlier Detection: Scale 1



## Outlier Detection:

- Significant outliers were identified, especially during March 2020, correlating with extreme market events driven by the COVID-19 pandemic.

# Conclusion

Our analysis of the NIFTY 50 index using advanced wavelet techniques provides a clear understanding of its behavior across multiple time scales:

- **Short-term Volatility:** We observed significant short-term fluctuations during market shocks, particularly in W1 and W2 scales, highlighting the index's sensitivity to external events.
- **Long-term Stability:** Higher scales (W3–W10) revealed stable trends, showcasing sustained market growth and resilience during the post-pandemic recovery.
- **Seasonal Patterns:** Recurring peaks were identified during fiscal year-ends and major policy events, emphasizing the importance of quarterly seasonality.
- **Noise Reduction:** Wavelet thresholding effectively reduced high-frequency noise, allowing for clearer identification of meaningful market trends.
- **Market Sensitivity:** Outlier detection pinpointed critical deviations during turbulent periods, such as March 2020, correlating with significant external shocks.

Q&A