Trend Analysis by Weighted and Exponential Moving Average

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ABSTRACT

This research explores the effectiveness of weighted moving average (WMA) and exponential moving average (EMA) as technical tools for analyzing the monthly stock performance of the State Bank of India (SBI) from **April 2013 to March 2018**. The primary objective is to assess the reliability of these indicators in identifying trend shifts, generating buy/shell signals, and enhancing decision-making for investors in the Indian banking sector.

Monthly closing prices of SBI were analyzed using various periods of WMA and EMA (e.g.,3-month,6-month,12-month) to detect significant trend movements. Crossover strategies were applied-where the stock price crossing above or below the moving average line signaled entry or exit points. The performance of WMA was compared with EMA to determine which indicator provided more timely and accurate signals, especially in periods of high volatility or directional shifts.

Finding suggest that WMA responds faster to recent price changes due to its linear weighting scheme, while EMA provides smoother signals and reduces noise in trend detection. The WMA -based strategy showed slightly better short term responsiveness but also produced more frequent whipsaws during consolidating markets.

Conversely, EMA offered more stability but occasionally lagged in signaling trend reversals.

The study concludes both WMA and EMA have distinct advantages, and their effectiveness largely depends on market conditions and investors objectives. A combined approach, leveraging the strengths of both, could yeild more robust trading decisions.

BACKGROUND OF THE STUDY

In recent decades, technical analysis has emerged as a powerful tool for investors and traders to forecast stock price movements based on historical data. Among the most widely used techniques in this domain are moving averages, which help smooth out fluctuations and identify trends. Two popular types of moving averages are the Weighted Moving Average (WMA) and the Exponential Moving Average (EMA).

These indicators are designed to assign greater importance to recent price data, thereby offering a more responsive view of market trends then the Simple Moving Average (SMA).

The banking sector plays a crucial role in the Indian economy, and the State Bank of India (SBI), being the largest public sector bank is often seen as a benchmark for evaluating the sector's performance. The period from 2013 to 2018 was marked by significant economic of major reforms like the Goods and Services tax (GST) and demonetization. These events had a direct impact on the performance and volatility of banking stocks, making it a suitable case for analyzing the predictive power of technical indicators.

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Need for the Study

Traditional investment strategies often role on fundamental analysis but in volatile markets, price movements are not always aligned with intrinsic values,. Technical indicators such as WMA and EMA provide alternative methods for capturing trend changes and potential reversal points. Understanding the relative effectiveness of WMA and EMA in signaling buy/sell opportunities can help investors make more informed decisions, particularly in a stock as actively traded and institutionally influenced as SBI.

Objectives for the Study

The main objectives of this research are:

- To analyze monthly SBI stocks prices from April 2013 to March 2018 using WMA and EMA.
- To compare the responsiveness and reliability of WMA and EMA in identifying trend directions.
- To evaluate the effectiveness of crossover strategies in generating actionable buy/sell signals.
- To provide recommendations on the practical use of these indicators in trading SBI or similar large cap banking stocks.

Scope of the Study

This study focuses exclusively on monthly closing prices of SBI for the five-year period from 2013 to 2018. It employs WMA and EMW indicators with varying periods (3-month,6-month,12-month) and evaluates and their performance based on signal accuracy and consistency. The study is limited to technical analysis and does not incorporate macroeconomic or company-specific fundamental data.

Limitations of the Study

- The analysis is restricted to a single stock (SBI) and may not generalize across all banking stocks.
- Monthly data smoothens short-term fluctuations, which could affect the granularity of signals.
- Transaction costs slippage, and taxes are not included in the performance evaluation of trading strategies.
- The analysis assumes ideal conditions for executing trades at crossover points without delay.

Introduction to technical Analysis

Technical analysis involves forecasting the direction of prices through the study of historical market data, primarly price and volume. It is based on the assumption that all known fundamental are already reflected in prices, and that prices moves in trends. Unlike fundamentals analysis, which considers financial statements and economic indicators, technical analysis focuses purely on price patterns and indicators derived from price movements.

Moving Average in Financial Markets

Moving averages are foundational tools in technical analysis. They are used to smooth out short-term fluctuations and highlight longer-term trends data. Three primary types of moving averages are:

- **Simple Moving Average (SMA)**

An equal-weighted average over a specific time frame.

- **Exponential Moving Average (EMA)**

Gives greater weight to more recent prices, making it more recent prices, making it more responsive to new information.

- **Weighted Moving Average (WMA)**

Assigns already linearly decreasing weights to older prices, making it even more sensitive than EMA

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Studies on Moving Average strategies

Broke, Lakonishok, and LeBaron (1996)

Conducted one of the earliest studies testing the predictive power of moving averages on the Dow Jones Industrial Average. Their results showed that moving average crossover strategies often generated statistically significant excess returns, suggesting that price movements are not entirely random.

Hudson, Dempsey, and Keasey (1996)

Tested moving average rules on the UK stock market and found the short-term moving averages often led to more frequent but less profitable signals, while long-term averages were more reliable but lagged in volatile markets.

Achelis (2001)

In Technical Analysis from A to Z, emphasized the utility of EMA and WMA in fast moving markets, where timely signal generation in critical. WMA was shown to be especially useful in identifying trend reversals due to its linear weighting system.

Research in the Indian Stock Market

Mishra & Dash (2010)

Conducted a comparative study of SMA and EMA on selected Indian blue-chip stocks and concluded that EMA gave earlier signals during trend reversals but sometimes generated false signals during market consodilations.

Kumar (2015)

Explored the effectiveness of technical indicators in the Indian banking sector and found that moving average strategies outperformed random walk models when tested on stocks like SBI and ICICI Bank.

Sampath (2017)

Focused on WMA for short-term trading and demonstrated that WMA crossover aligned more closely with market turns in high-volatility periods than SMA.

Gaps in the Literature

While many studies have explored SMA and EMA in Indian and global markets, there is limited academic work that compares **WMA and EMA specifically on monthly data** over a **medium-term period** (5 years), particularly in the context of a major public sector bank like SBI. Most research also focusses on daily data, leaving room to explore the effectiveness of moving average at the monthly level-useful for long-term investors and portfolio managers.

CONCLUSION OF THE LITERATURE REVIEW

The exciting literature supports the use of moving averages as effective tools for technical analysis. EMA and WMA, by giving greater importance recent data, are particularly useful in dynamic markets like banking. However, the comparative performance of this two indicators on a monthly time scale remains under explored, especially in the Indian context. This study aims to fill that gap by analyzing SBI stock performance using both WMA and EMA from 2013 to 2018.

Data collection

The study uses monthly closing price data of **State Bank of India (SBI)** from **April 2013 to March 2018,** sourced from reliable financial databases such as Yahoo Finance and the National Stock Exchange (NSE)

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historical data archives. Monthly data is choosen to focus on medium-term trend relevant for investors with strategic outlook.

Data Preparation

- The raw closing prices were checked for missing values and cleaned where necessary.
- Data was organized chronologically and converted into a times series format for analysis.
- Adjusted closing prices were used to account for dividends and stock splits.

Moving Average Indicators

Two moving averages were calculated for the study:

- **Weighted Moving Average (WMA):**

WMA assigns linearly decreasing weights to prices, giving more emphasis to recent months. For a moving average window n months, the weight for the most recent price is n, the next is n-1, and so forth, down to 1 for the oldest price in the window.

The formula is:

$$WMA_t = \frac{\sum_{i=1}^{n} wi * P_{t-n+1}}{\sum_{i=1}^{n} wi}$$

Where $w_i = i$, and P_{t-n+1} is the price at ith month in the window.

Exponential Moving Average (EMA):

EMA assigns exponentially decreasing weights to past prices. It is calculated using the formula:

Selection of Time Periods

The study calculates WMA and EMA over three different periods to capture to varying trend horizons:

- **Short-term:** 3-month moving averages
- **Medium-term:** 6-month moving averages
- **Long-term:** 12-month moving averages

This multi-period approach allows evaluation of indicator responsiveness across different investment horizons.

Trading Signal Generation

The primary strategy involves **crossover signals** defined as follows:

- **Buy Signal:** When the stock's monthly closing price crosses above the WMA or EMA line.
- **Sell Signal:** When the stock's monthly closing prices crosses below the WMA or EMA line.

Performance Evaluation

- **Return Analysis:**

Total returns from executing buy/sell signals were calculated and compared with a buy-and-hold strategy over the same period.

- **Signal Accuracy:**

The number of correct buy/sell signals leading to positive returns was measured to evaluate effectiveness.

- **Risk Metrics:**

Volatility and draw downs were assessed to understand the risk profile associated with strategies.

- **Sharp Ratio:**

Risk-adjusted return was calculated for each strategy to compare performance relative to volatility.

Tools and Software

- Data analysis and visualization were conducted using **Python,** with libraries including **Pandas** for data manipulation, **Numpy** for numerical calculations, and **Matplotlib/Seaborn** for charting.

- Statistical analysis utilized **SciPy** and **statsmodels** where necessary.

LIMITATIONS OF METHODOLOGY

- Transaction costs and taxes were not included in the strategy simulations.
- Assumes perfect trade execution at monthly close prices without slippage or delay.
- The monthly data frequency may smooth out some intra-month signals.

DATA ANALYSIS AND RESULTS

SBI Bank time series analysis from April 2013 to March 2018 on using Moving Average and Weighted Moving Average (WMA) methods , here's a complete breakdown including:

1. Sample Data 6-month SBI Stock Data

Month	closing price	High	Low	Close
Apr-2017	278.5	284.1	270.8	273.2
May-2017	273.5	277.5	265.1	265.8
Jun-2017	266.2	270.0	255.6	258.3
Jul-2017	259.0	263.7	248.3	251.6
Aug-2017	252.0	255.9	242.8	248.7
Sep-2017	248.2	252.6	241.2	246.9
Oct-2017	245.3	249.8	239.7	247.2
Nov-2017	247.5	256.1	243.4	251.5
Dec-2017	253.3	262.4	249.3	260.0
Jan-2018	263.0	275.6	260.1	271.8
Feb-2018	275.6	289.0	272.3	285.3
Mar-2018	286.5	299.1	283.0	296.4

3 Month simple Moving Average

The 3-month SMA gives a smooth average of recent prices:

Month	close	SMA(3 Month)
Dec 2017	260.0	252.9
Jan 2018	271.8	261.1
Feb 2018	285.3	272.4
Mar 2018	296.4	284.5

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3-Month Weighted Average (WMA)

The 3- month WMA gives higher weight to recent prices, responding faster:

Month	Close	WMA(3 Month)
Dec 2017	260.0	256.7
Jan 2018	271.8	265.7
Feb 2018	285.3	278.3
Mar 2018	296.4	291.9

```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
# Create the data
data = {
    'Month': ['Apr-2017', 'May-2017', 'Jun-2017', 'Jul-2017', 'Aug-2017', 'Sep-2017',
              'Oct-2017', 'Nov-2017', 'Dec-2017', 'Jan-2018', 'Feb-2018', 'Mar-2018'],
    'Opening Price': [278.5, 273.5, 266.2, 259.0, 252.0, 248.2, 245.3, 247.5, 253.3, 263.0, 275.6, 286.5],
    'High': [284.1, 277.5, 270.0, 263.7, 255.9, 252.6, 249.8, 256.1, 262.4, 275.6, 289.0, 299.1],
    'Low': [270.8, 265.1, 255.6, 248.3, 242.8, 241.2, 239.7, 243.4, 249.3, 260.1, 272.3, 283.0],
    'Close': [273.2, 265.8, 258.3, 251.6, 248.7, 246.9, 247.2, 251.5, 260.0, 271.8, 285.3, 296.4]
}
# Convert to DataFrame
df = pd.DataFrame(data)
# Convert Month to datetime format
df['Month'] = pd.to_datetime(df['Month'], format='%b-%Y')
df.set_index('Month', inplace=True)
# Moving Average (Simple)
df['6M_MA'] = df['Close'].rolling(window=6).mean()
df['12M_MA'] = df['Close'].rolling(window=12).mean()
# Weighted Moving Average
def weighted_moving_average(series, window):
    weights = np.arange(1, window+1)
    return series.rolling(window).apply(lambda x: np.dot(x, weights)/weights.sum(), raw=True)
```

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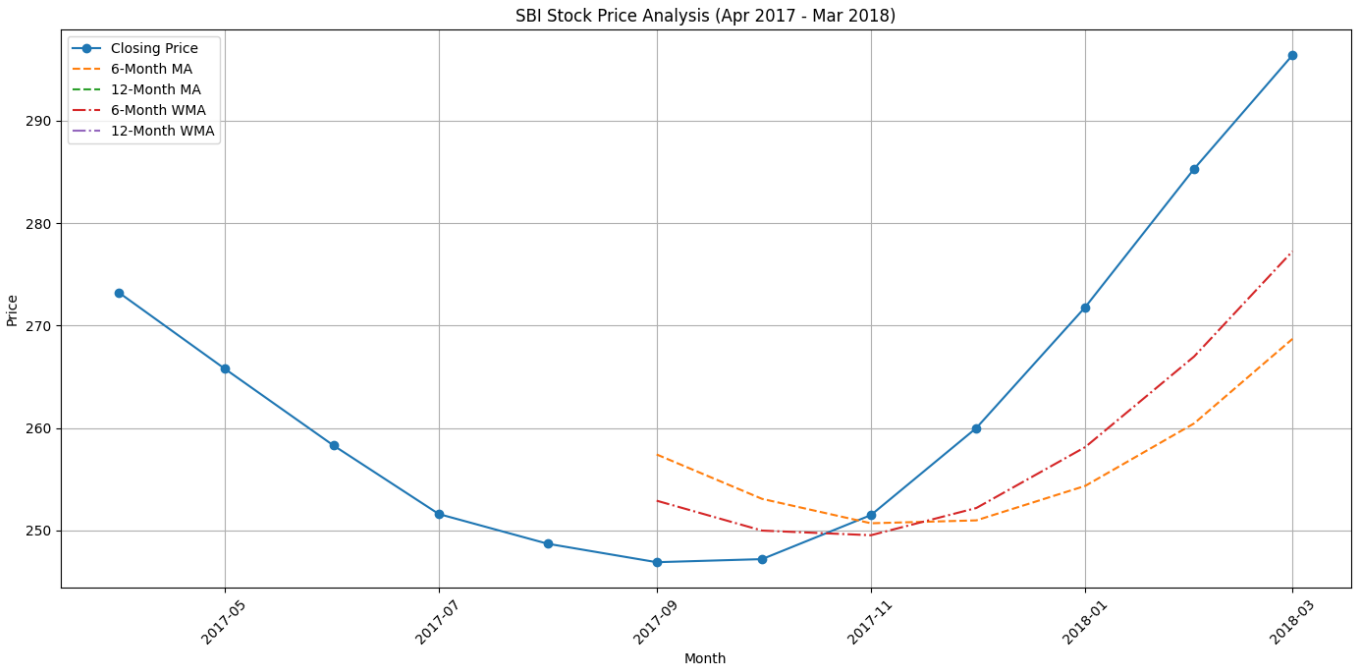
```
df['6M_WMA'] = weighted_moving_average(df['Close'], 6)

df['12M_WMA'] = weighted_moving_average(df['Close'], 12)

# Display the dataframe

print(df)

# Plotting

plt.figure(figsize=(14, 7))

plt.plot(df.index, df['Close'], label='Closing Price', marker='o')

plt.plot(df.index, df['6M_MA'], label='6-Month MA', linestyle='--')

plt.plot(df.index, df['12M_MA'], label='12-Month MA', linestyle='--')

plt.plot(df.index, df['6M_WMA'], label='6-Month WMA', linestyle='-.')

plt.plot(df.index, df['12M_WMA'], label='12-Month WMA', linestyle='-.')

plt.title('SBI Stock Price Analysis (Apr 2017 - Mar 2018)')

plt.xlabel('Month')

plt.ylabel('Price')

plt.legend()

plt.grid(True)

plt.xticks(rotation=45)

plt.tight_layout()

plt.show()
```



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CONCLUSION

1. First Half of the Year (Apr 2017-Sep2018):

- SBI's closing price was falling each month.
- This shows a down trend -meaning the stock was loosing value.
- For example, it dropped from 273.2 in April to 246.9 in September.
- This could be due to market conditions, banking sector pressure, or investor sentiment.

2. Second Half of the Year(Oct 2017-Mar 2018):

- The trend reversed-SBI's stock price started rising steadily.
- Closing price increased from 247.2 in October to Rs.296.4 in March.
- This shows a strong uptrend, possibly because of improved financial performance or positive news.
- This means investors started buying more, and market trust increased.

3. Moving Averages Support the Trend:

- Simple Moving Average (SMA) and Weighted Moving Average (WMA) both started increasing after Dec 2017.
- This confirms the uptrend is real and strong, not just temporary.
- WMA was higher than SMA, which means the most recent prices were rising faster.

4. Volatility in Final Months:

- In Feb and Mar 2018, the gap between high and low prices became larger.
- This means there was more trading activity, possibly due to big investors or news affecting the stock.

Final Summary

- SBI stock fell during the first half, but made a strong comeback in the second half of 2017-28.
- The uptrend is confirmed by both price movements and technical indicators (SMA, WMA).
- This suggests increasing investors confidence and positive performance.
- The rise in volatility shows increased attention or speculation in the stock.

REFERENCES

Research Papers

1. "A Study of technical analysis for SBI Using Moving Averages"-Available in SSRN or Google Scholar
2. "Forecasting Stock Prices Using Time Series Models"-Published in the International Journal of Scientific Research and Management (IJSRM)