The Profitability of Five Popular Variations of Moving Averages on Indian Market Index S & P CNX Nifty 50 During January 2004–December 2014

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Abstract—*This research paper aims to investigate the profitability of five popular variations of moving averages: simple (also referred to as arithmetic), exponential, triangular, variable, and weighted as the main tool of technical analysis on the end of the day data on Indian market index S&P CNX Nifty 50 from January 2004 to December 2014. Moving average performance is checked with three basic rules of trading using a moving average, first with direction of the moving average, second with price & moving average crossover and third rule is a crossover of two moving averages with different periods. An optimization technique is used to find the most profitable trading system among all the moving averages. The results show that trading rules based short term simple moving average generate more profit with less drawdown and outperform buy-and-hold strategy for almost all type of moving averages.*

1. INTRODUCTION

Technical analysis is a prediction or forecasting of future prices of a stock based on its historical prices and volume data. Technical analysis involves the sole use of price and related summary statistics, such as volume, to inform trading decisions It can be said as the study of history to predict the future. A very early form of technical analysis was developed in rice data in Japan in 1700s. In late 1800s traders used to plot candlestick charts and used them for trading decisions.

According to Edwards et al. (2001), modern Technical analysis started with the development of Dow Theory by Charles Dow, who initially used an average of daily closing prices of 11 important stocks. Richard W Schabacker further updated the investigation of Dows work during the 1920s and 1930s. Wilders (1978) contributions to technical analysis is regarded as more valuable during his time. Many of the modern technical indicators used today are a variety of original Wilder's work. Nison (1994) provided a framework and analysis of candelisitic chart, which provide a visual representation of the opening, closing, high and low prices for a discrete period. Over the period of the last few decades, technical analysis has become a focus for academia and research. Most of the research done is for Dow Jones Industrial Average (DJIA) or on global indices of most developed countries only, while very less research is done in markets of emerging countries like India. This research paper will be providing analysis for an untouched part, i.e., S&P CNX Nifty50 on most recent data 2004-2014.

2. SURVEY STUDIES ON USE OF TECHNICAL ANALYSIS

There are various survey studies supporting the increasing use of technical analysis in decision making by traders. For instance Taylor and Allen (1992) found that at least 90% of chief foreign exchange dealers in London give some weight to technical analysis in their decision making. Technical analysis and fundamental analysis were seen as complementary with more than 60% of the respondents giving technical analysis at least as important as they give to fundamental analysis.

In Germany, another survey study by Menhkhoff (1997) for dealers and fund managers in 1992 revealed the extensive use of technical analysis by the respondents, the survey concluded that 87% respondents give at least 10% weight to technical analysis in their trading decisions. Same study suggested mean weights of technical analysis more than that of flow analysis while it was less than fundamental analysis.

Lui and Mole (1998) survey of foreign exchange dealers in Hong Kong in 1995 confirmed the use of technical analysis by a majority of the respondents. Oberlechner (2001) study on traders and journalists in Frankfurt, London, Vienna and Zurich in 1996 confirmed the use of technical analysis with more importance for short term trading than for long term trading.

Cheung and Chinn (2001) survey study clearly concluded that the use of technical analysis as best trading practice. In the

study, 30% of respondents voted for technical analysis as best trading practice, while 25% for fundamental analysis, 22% for customer order driven and remaining 23% for jobbing.

The best know survey study on equity market is Menkhoff (2010), it was a survey of mutual fund, pension, bond and equity fund managers in the United States, Germany, Switzerland, Italy and Thailand in 2003/2004. At least 10% weight was given to technical analysis by 55%-87% respondents.

3. RESEARCH ON USE OF MOVING AVERAGE FOR PRICE PREDICTIONS.

Brock, Lakonishok and LeBaron (1992) analyzed moving average trading rules for 1897-1986 dataset on Dow Jones Industrial average and concluded that on average, the strategies were profitable. Long (short) positions mean returns were higher (lower) than unconditional returns. Commonly used return generating models cannot explain the rules profitability.

Isakov and Holliston (1999) research was based on a Swiss index (SBC) and 5 individual stocks for 1969-1997, he used moving average, RSI and stochastic oscillator for the conclusion. They found that an MA rule produced a yearly excess return of 18%, which might not be matched by common returns generating models. However, only institutional investors with low transaction costs (≤0. 3%) could benefit from this trading strategy.

Fang and Xu (2003) finding were that technical and time series models have predictive power. The profitability of strategies combining the two forecasting methods is significantly higher (between 92% and 142%) than those of the individual strategies. Break-even transaction costs are between 1% and 2%.

Wong, Mansur and Chew (2003) research was for Singapore Index for dataset ranging from 1974 to 1994. They used MA rules with RSI for generating trading signals and concluded that On average, the strategies are profitable or when they are not, they have some predictive power. Nevertheless, they show that the confidence levels of excess returns decrease from between 1% and 5% during the first half of the sample to a level of 10% during the most recent period.

4. MOVING AVERAGE

A Moving Average is a technical analysis indicator that shows the average value of a security's price over a chosen period of time. It is a commonly used indicator in technical analysis that helps smooth out price action by filtering out the "noise" from random price fluctuations. When calculating a moving average, a mathematical analysis of the security's average value over a predetermined time period is made. As the security's price changes, its average price moves up or down.

There are five popular variations of moving averages: simple (also referred to as arithmetic), exponential, triangular, variable, and weighted. Moving averages can be calculated on any data set including a security's open, high, low, close, volume, or any other data.

5. TYPES OF MOVING AVERAGE

The only significant difference between the various types of moving averages is the weight assigned to the most recent data. Simple moving averages apply equal weight to the prices. Exponential and weighted averages apply more weight to recent prices. Triangular averages apply more weight to prices in the middle of the time period. And variable moving averages change the weighting based on the volatility of prices.

6. SIMPLE

A simple moving average (or arithmetic moving average) is calculated by adding the closing prices of the security for selected number of periods (e.g., 14 days) and then dividing this total by the number of time periods. The result is the average price of the security over the time period. Simple moving averages give equal weight to each daily price.

For example, to calculate a 14-day moving average of a security: First, we would add the closing prices for the most recent 14 days of the security. Next, we have to divide that sum by 14; this would give us the average price of security over the preceding 14 days. We can plot this average price on the chart for better visualization. We would perform the same calculation next day: add up the previous 14 days' closing prices, divide by 14, and plot the resulting figure on the chart.

$$Moving\ Average = Sum\ of\ n\ Closing\ Prices\ /\ n$$

Where:

n = The Number of time periods in moving average

7. EXPONENTIAL

An exponential moving average or or exponentially weighted moving average is calculated by applying a percentage of today's closing price to yesterday's moving average value. Exponential moving averages place more weightage on the latest prices.

For example, to calculate a 9% exponential moving average of security, we would first take today's closing price and multiply it by 9%. Next, we would add this product to the value of

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yesterday's moving average multiplied by 91% (100% - 9% = 91%).

(Today's Close*0.09)+(Yesterday's MA*0.91)

Because most traders feel more comfortable working with time periods than working with percentages, thus the exponential percentage can be converted into an approximate number of days. For example, a 9% moving average is equal to a 21.2 time period (rounded to 21) exponential moving average.

The formula for converting exponential percentages to time periods is:

Time Periods = (2/Percentage) - l

We can use the above formula to determine that a 9% moving average is equivalent to a 21-day exponential moving average:

21.2 days = (2/0.09) - l

The formula for converting time periods to exponential percentages is:

Exponential Percentage = 2 / (Time Periods + l)

We can use the above formula to determine that a 21-day exponential moving average is actually a 9% moving average:

0.09 = 2 /(21 + l)

8. TRIANGULAR

This type of moving averages place most of the weight on the middle portion of the price series. They are actually double-smoothed simple moving averages. The periods used in the simple moving averages vary depending on if we specify an odd or even number of time periods.

The following steps explain how we calculate a 12-period triangular moving average.
1. Add 1 to the number of periods in the moving average (e.g., 12 plus 1 is 13).
2. Divide the sum from Step #1 by 2 (e.g., 13 divided by 2 is 6.5).
3. If the result of Step #2 contains a fractional portion, round the result up to the nearest integer (e.g., round 6.5 up to 7).
4. Using the value from Step #3 (i.e., 7), calculate a simple moving average of the closing prices (i.e., a 7-period simple moving average).
5. Again, using the value from Step #3 (i.e., 7) calculate a simple moving average of the moving average calculated in Step #4 (i.e., a moving average of a moving average).

9. VARIABLE

A variable moving average is an exponential moving average that automatically adjusts the smoothing percentage based on the volatility of the data series. The more volatile the data, the more sensitive the smoothing constant used in the moving average calculation. Sensitivity is increased by giving more weight given to the current data.

Most moving average calculation methods are unable to compensate for trading range versus trending markets. During trading ranges (when prices move sideways in a narrow range) shorter term moving averages tend to produce numerous false signals. In trending markets (when prices move up or down over an extended period) longer term moving averages are slow to react to reversals in trend. By automatically adjusting the smoothing constant, a variable moving average is able to adjust its sensitivity, allowing it to perform better in both types of markets.

A variable moving average is calculated as follows:

(0.078(VR)*Close) + (l – 0.078(VR)*Yesterday's MA

Where:

VR = The Volatility Ratio

10. WEIGHTED

A weighted moving average is designed to put more weight on recent data and less weight on past data. A weighted moving average is calculated by multiplying each of the previous day's data by a weight. The following table shows the calculation of a 5-day weighted moving average.

Day	Weight	Price Weighted	Average
1	1	*25 = 25	
2	2	*26 = 52	
3	3	*28 = 84	
4	4	*25 = 100	
5	5	*29 = 145	
Totals		*133=406/15	27.067

The weight is based on the number of days in the moving average. In the above example, the weight on the first day is 1.0 while the value on the most recent day is 5.0. This gave five times more weight to today's price than the price five days ago.

11. TRADING RULES

We will analyze the profitability on the basis of three most commonly used rules of moving averages

12. FIRST RULE

The direction of the moving average conveys important information about prices. A rising moving average shows that prices are generally increasing. A falling moving average indicates that prices, on average, are falling. A rising long-term moving average reflects a long-term uptrend. A falling long-term moving average reflects a long-term downtrend.

Buy	When the direction of the moving average is upward.
Sell	When the direction of the moving average is downward.
Short Sell	When the direction of the moving average is downward.
Buy to Cover	When the direction of the moving average is upward.

13. SECOND RULE

The most popular method of interpreting a moving average is to compare the relationship between a moving average of the security's price with the security's price itself. A buy signal is generated when the security's price rises above its moving average and a sell signal is generated when the security's price falls below its moving average.

Buy	When the price is above its moving average
Sell	When the price is below its moving average
Short Sell	When the price is below its moving average.
Buy to Cover	When the price is above its moving average

14. THIRD RULE (MA CROSSOVER)

Two moving averages can be used together to generate crossover signals. In the book Technical Analysis of the Financial Markets, John Murphy calls this the "double crossover method". Double crossovers involve one relatively short moving average and one relatively long moving average. Moving average crossovers produce relatively late signals. After all, the system employs two lagging indicators. The longer the moving average periods, the greater the lag in the signals. These signals work great when a good trend takes hold. However, a moving average crossover system will produce lots of whipsaws in the absence of a strong trend.

Buy	When the short term moving average is greater than long term moving average.
Sell	When the short term moving average is less than long term moving average.
Short Sell	When the short term moving average is less than long term moving average.
Buy to Cover	When the short term moving average is greater than long term moving average.

15. DATA AND METHODOLOGY

It is highly desirable to use a large dataset because a small number of datasets gives less concrete grounds for inference on the profitability. The review of the literature revealed that the comparatively few detailed studies about technical analysis have often used small data sets. To reiterate, Brock et al. (1992) look at 90 years of data, but only for the Dow Jones Industrial average. Only more recently, with less cost and more powerful computing capabilities, have larger data sets being used. For example, Lo et al. (2000) look at just over thirty years of individual US stock data from NYSE/AMEX and the Nasdaq.

Trading in Nifty future started on 12th June 2000. In contrast to Dow Jones and other global indices, very less data set is available for trading and analysis purpose. The E-signal historical database service was used for the collection of price and volume data. The sample period is 1st January 2004 to 31st December 2014, representing 11 years of daily data for S&P CNX Nifty50.

The program works only on the closing of the day, irrespective of the movement taken place during the day. All the trading rules have been tested on closing prices only.

16. TRANSACTION COST

As mentioned in the literature review, most of the previous studies do not adopt a consistent approach for the adjustment of transaction costs. For instance, as Lo et al. (2000) specifically do not set out to examine profitability, but rather compare the unconditional and conditional one-day returns, they do not consider trading costs. Savin et al. (2007) do, however, consider one-way break-even costs in relation to raw excess returns, noting figures of 0.18% (Jones, 2002) and 0.23% (Berkowitz et al., 1988) for an institutional trader. Thus, we have analyzed all the trading rules without taking into account any type of transaction cost or any form of taxes.

All our tests are point only test, so performance is tested without initial equity consideration, merely the profit of a single trade is important, measured in points. All test started with zero and are without any compounding. All the result reports are generated in points.

17. TEST RESULTS

This section presents the empirical results of the study. Results are shown for the sample period, from 1st January 2004 to 31st December 2014.

18. PERFORMANCE WITH TRADING RULE 1.

Simple Moving Average (SMA)	
MA Period	17
Total No. of Trades	219
Trade Profit/ Loss	95/124
Avg. Profit/ Avg. Loss	2.67
Buy and Hold Profit	6402
Strategy Profit	10367

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Buy and Hold %	61.93%
Exponential Moving Average (EMA)	
MA Period	9
Total No. of Trades	453
Trade Profit/ Loss	163/290
Avg. Profit/ Avg. Loss	2.65
Buy and Hold Profit	6402
Strategy Profit	8682
Buy and Hold %	35.61%
Triangular Moving Average (TMA)	
MA Period	16
Total No. of Trades	155
Trade Profit/ Loss	65/90
Avg. Profit/ Avg. Loss	1.96
Buy and Hold Profit	6402
Strategy Profit	5207
Buy and Hold %	-18.65%
Variable Moving Average (VMA)	
MA Period	20
Total No. of Trades	167
Trade Profit/ Loss	54/113
Avg. Profit/ Avg. Loss	4.58
Buy and Hold Profit	6402
Strategy Profit	8609
Buy and Hold %	34.47%
Weighted Moving Average (WMA)	
MA Period	9
Total No. of Trades	403
Trade Profit/ Loss	153/250
Avg. Profit/ Avg. Loss	2.47
Buy and Hold Profit	6402
Strategy Profit	8747
Buy and Hold %	36.63%

Total No. of Trades	453
Trade Profit/ Loss	163/290
Avg. Profit/ Avg. Loss	2.65
Buy and Hold Profit	6402
Strategy Profit	8677
Buy and Hold %	35.54%
Triangular Moving Average (TMA)	
MA Period	10
Total No. of Trades	415
Trade Profit/ Loss	163/252
Avg. Profit/ Avg. Loss	2.24
Buy and Hold Profit	6402
Strategy Profit	8054
Buy and Hold %	25.81%
Variable Moving Average (VMA)	
MA Period	20
Total No. of Trades	167
Trade Profit/ Loss	54/113
Avg. Profit/ Avg. Loss	4.58
Buy and Hold Profit	6402
Strategy Profit	8609
Buy and Hold %	34.47%
Weighted Moving Average (WMA)	
MA Period	13
Total No. of Trades	438
Trade Profit/ Loss	163/275
Avg. Profit/ Avg. Loss	2.48
Buy and Hold Profit	6402
Strategy Profit	8336
Buy and Hold %	30.22%

It is evidently clear from the results that 17 period simple moving average outperform the buy and hold profit by a huge margin. Among all five types of moving averages, simple moving average outperform the remaining four moving averages in profitability.

In terms of Average Profit / Average Loss ratio, with a value of 4.58 variable moving average is best in all types of moving averages. Although it does not generate frequent signals and thus giving only 167 trades in 11 years of duration.

19. PERFORMANCE WITH TRADING RULE 2

Simple Moving Average (SMA)	
MA Period	10
Total No. of Trades	403
Trade Profit/ Loss	153/250
Avg. Profit/ Avg. Loss	2.47
Buy and Hold Profit	6402
Strategy Profit	8747
Buy and Hold %	36.63%
Exponential Moving Average (EMA)	
MA Period	9

For second trading rule, simple moving average (SMA) marginally outperforms EMA and VMA. There is a close competition in terms of profitability among these three types of moving averages. The most profitable period for the Simple Moving Average is 10, generating a profit of 8747 points.

Variable Moving Average is best in performance in terms of Average Profit / Average Loss ratio, with a value of 4.58, VMA generate the least number of trades among all five types of averages.

20. PERFORMANCE WITH TRADING RULE 3.

Simple Moving Average (SMA)	
MA Period	10, 25
Total No. of Trades	305
Trade Profit/ Loss	123/182
Avg. Profit/ Avg. Loss	2.51
Buy and Hold Profit	6402
Strategy Profit	8709
Buy and Hold %	36.03%
Exponential Moving Average (EMA)	
MA Period	9, 33
Total No. of Trades	336
Trade Profit/ Loss	123/213

Avg. Profit/ Avg. Loss	2.86
Buy and Hold Profit	6402
Strategy Profit	8479
Buy and Hold %	32.44%
Triangular Moving Average (TMA)	
MA Period	10 , 31
Total No. of Trades	292
Trade Profit/ Loss	128/164
Avg. Profit/ Avg. Loss	2.16
Buy and Hold Profit	6402
Strategy Profit	8343
Buy and Hold %	30.31%
Variable Moving Average (VMA)	
MA Period	22, 27
Total No. of Trades	156
Trade Profit/ Loss	49/107
Avg. Profit/ Avg. Loss	4.95
Buy and Hold Profit	6402
Strategy Profit	8336
Buy and Hold %	30.21%
Weighted Moving Average (WMA)	
MA Period	13, 22
Total No. of Trades	377
Trade Profit/ Loss	139 /238
Avg. Profit/ Avg. Loss	2.57
Buy and Hold Profit	6402
Strategy Profit	7940
Buy and Hold %	24.03%

Two moving average crossover rule, i.e., third rule, it generates less number of trades for all five of averages than the other two rules. This rule produces almost similar results for all types of moving averages, giving a profit ranging from 7940 points to 8709 points.

21. CONCLUSION

Technical analysis is profitable using moving average in all the three rules, but profitability depends on the period of the moving average used, it may vary in a wide range. In terms of profitability, simple moving average (SMA) outperforms all other types of moving averages in all the three rules tested generating profits of 10367, 8747 and 8709 points respectively for trading rule 1, 2 and 3 respectively.

For considering the average profit to Average loss ratio, variable moving average generates better results for all three trading rules with values of 4.58, 4.58 and 4.95 for trading rule 1, 2 and 3 respectively.

22. ACKNOWLEDGEMENTS

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