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## EXPONENTIAL MOVING AVERAGE – AN ALGORITHMIC TRADING STRATEGY

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### ABSTRACT

*This research paper deals with one of the most widely used tools in the technician's toolbox, i.e. the moving average. There are various types of moving averages which are used to smooth price fluctuations and get a clear picture of a trend in security. This paper deals with appropriate moving averages useful for trading in a security.*

**Keywords:** *Average, Simple moving Average, Weighted moving average, Exponential moving averages.*

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## OBJECTIVE

The objective of the research is discussed below:

1. To show the disadvantages of simple and weighted moving average.
2. To show the sensitivity of EMA to the security price.
3. To prove the importance of Exponential Moving Average.

## METHODOLOGY

The disadvantages of the simple and weighted moving averages are illustrated using a simple example and compared with the Exponential moving average. The appropriate average to be used, i.e., exponential moving average has been back tested using 144 scrips pre-existing in the F & O segment of the Indian stock market for the calendar year 2014.

### Data for Study

The data used for study is primary data of all the 144 scrips present in the Indian F & O segment. Everyday information of all the stocks were gathered for a period of a year ranging from 01/01/2014 to 01/01/2015. The gathered information was combined according to study requirements.

## INTRODUCTION

The disadvantage of using simple and weighted moving average is the inclusion of data that only the moving average covers. For example, a five-day simple or weighted moving average only uses five days of data and the data prior to the five days are completely ignored in calculation of moving average.

In simple words, technical analysis can be defined as a study of historical data and the prediction of the future movement of the security. Going by the definition, the simple and weighted moving averages do not cover the historical data of the security. Therefore, exponential moving average can be used instead of simple and weighted moving averages.

## RESEARCH STUDY

An exponential moving average gives more weight to recent prices and ever decreasing weight to older data. Unlike the Simple and weighted moving average, the older data can never be ignored in calculation of exponential moving average.

Let us analyze the three moving averages discussed with an example.

*Let us analyze the simple and weighted moving average:*

| Date  | Closing Price | Closing price Four days ago | Closing price 3 days ago | Closing price two days ago | Closing price one day ago | Today's closing price Times average | Five day total | Five day total of closing price times weight | Five day simple moving average | Five day weighted moving average |
|-------|---------------|-----------------------------|--------------------------|----------------------------|---------------------------|-------------------------------------|----------------|--|--------------------------------|----------------------------------|
| 22/03 | 45.375        |                             |                          |                            |                           |                                     |                |  |                                |                                  |
| 23/03 | 45.5          |                             |                          |                            |                           |                                     |                |  |                                |                                  |
| 24/03 | 45            |                             |                          |                            |                           |                                     |                |  |                                |                                  |
| 25/03 | 43.625        |                             |                          |                            |                           |                                     |                |  |                                |                                  |
| 28/03 | 43.375        | 45.375                      | 91                       | 135                        | 174.5                     | 216.875                             | 222.875        | 662.75                                       | 44.575                         | 44.183                           |
| 29/03 | 43.125        | 45.5                        | 90                       | 130.875                    | 173                       | 215.625                             | 220.625        | 655.5  | 44.125                         | 43.7                             |
| 30/03 | 43.125        | 45                          | 87.25                    | 130.125                    | 172.5                     | 215.625                             | 218.25         | 650.5  | 43.65                          | 43.567                           |
| 31/03 | 44.25         | 43.625                      | 86.75                    | 129.375                    | 172.5                     | 221.25                              | 217.5          | 653.5  | 43.5                           | 43.567                           |
| 04/04 | 43.5          | 43.375                      | 86.25                    | 129.375                    | 177                       | 217.5                               | 217.375        | 653.5  | 43.475                         | 43.567                           |
| 05/04 | 44.375        | 43.125                      | 86.25                    | 132.75                     | 174                       | 221.875                             | 218.375        | 658  | 43.675                         | 43.867                           |
| 06/04 | 45.875        | 43.125                      | 88.5                     | 130.5                      | 177.5                     | 229.375                             | 221.125        | 669  | 44.225                         | 44.6                             |
| 07/04 | 46.75         | 44.25                       | 87                       | 133.125                    | 183.5                     | 233.75                              | 224.75         | 681.625                                      | 44.95                          | 45.442                           |

*Let us analyze the exponential moving average with an example:*

| Date   | Closing Price (A) | Previous Day's EMA (B) | Closing Price minus Previous Day's EMA (A)-(B)= [C] | Difference times Smoothing Constant [C]*0.4=(D) | Five-Day EMA Previous Day's EMA /(D) |
|--------|-------------------|------------------------|---|---|--------------------------------------|
| Mar-22 | 45.375            |                        |   |   |                                      |
| Mar-23 | 45.500            |                        |   |   |                                      |
| Mar-24 | 45.000            |                        |   |   |                                      |
| Mar-25 | 45.625            |                        |   |   |                                      |
| Mar-28 | 43.375            | 44.575                 | -1.200  | -0.480  | 44.095                               |
| Mar-29 | 43.125            | 44.095                 | -0.970  | -0.388  | 43.707                               |
| Mar-30 | 43.125            | 43.707                 | -0.582  | -0.233  | 43.474                               |
| Mar-31 | 44.250            | 43.474                 | 0.776   | 0.310   | 43.785                               |
| Apr-04 | 43.500            | 43.785                 | -0.285  | -0.114  | 43.671                               |
| Apr-05 | 44.375            | 43.671                 | 0.704   | 0.282   | 43.952                               |
| Apr-06 | 45.875            | 43.952                 | 1.923   | 0.769   | 44.721                               |
| Apr-07 | 46.750            | 44.721                 | 2.029   | 0.811   | 45.533                               |

By analyzing the example above we can see that the simple moving average is calculated by adding the prices for number of periods whereas the weighted moving average is calculated by giving weights to the price and by multiplying it with the price.

The formula for calculating the exponential moving average is somewhat complex but it supports the definition of technical analysis. By looking at the example we can see that EMA gives weight to recent prices and ever decreasing data.

Now the question arises as to which type of moving average – simple, weighted, or exponential – is best? There cannot be a correct answer as technical analysis is just estimation of prices of securities. Research shows that none of the technical tools can give exact prices of securities but can only give an estimate of the price.

Simple and weighted moving averages can work well on their own but when compared to EMA, the latter is more sensitive to changes in price than the simple and weighted moving averages. Considering the latter as a good technical indicator, a strategy is executed with the 144 scrips present in the Indian F & O segment.

Now a question may arise as to what will be the appropriate time period to be selected to plot the average on the securities chart. There is no definite answer since it depends on the psychology of a person. This is also because the number of periods to use varies significantly from security to security as well as the time horizon. It is appropriate to test a number of different periods for each security you are examining. As a rule of thumb, it is appropriate to use 3 averages with a ratio of 1:3 with the third average having a greater value, since it will be appropriate for trend determination.

When two or more moving averages are used, a buy signal is given when the short term moving average crosses above the long term moving average. A sell signal occurs when the opposite happens.

Considering the above the following strategy is back tested:

- Entry is a Bullish Rule.
- Rule is: ( Last Close Price  $\geq$  50 EMA AND ( 12 EMA  $\geq$  50 EMA ) )
- Exit Rule is: 12 EMA  $<$  50 EMA

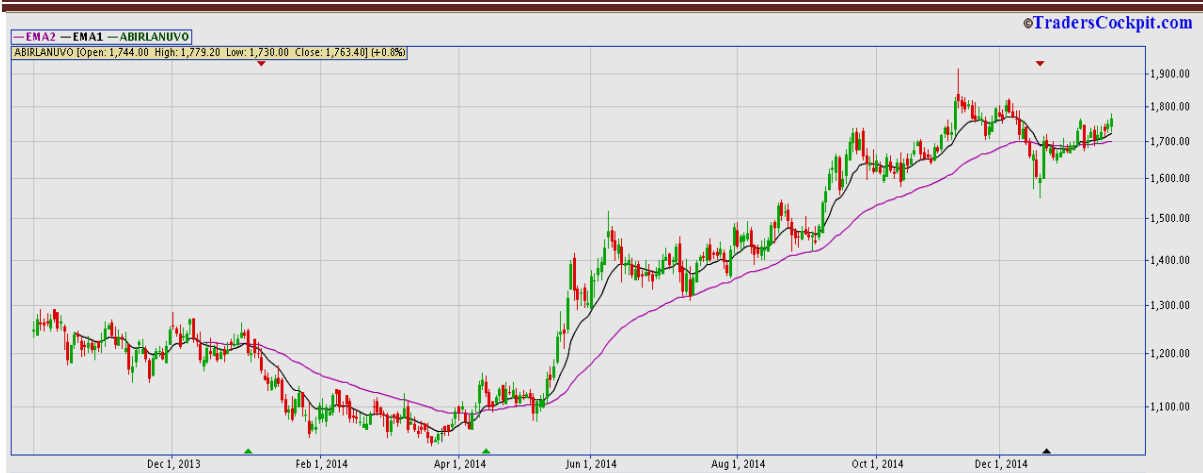
*(Note: To test the success of EMA, no stop loss or targets are defined in the above strategy.)*

***After the strategy is back tested the following results are arrived at:***

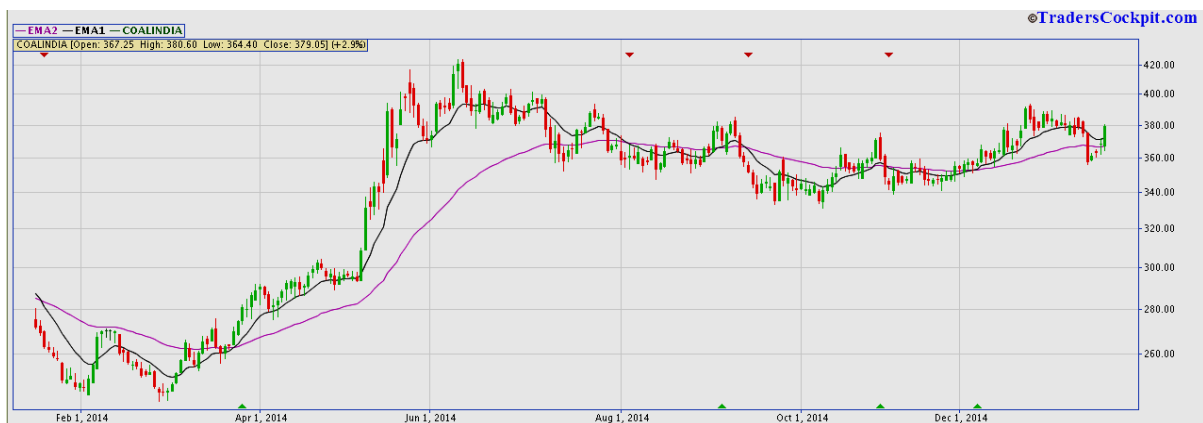
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|--|----------------|
| Expectancy (Avg. Net Profit per trade) | 8.32           |
| <b>Cumulative % Gain/Loss</b>          | <b>3720.51</b> |
| PayOff Ratio                           | 5.86           |
| Profit Factor                          | 2.7            |

Out of the 144 scrips present in the F & O segment, 5 scrips have been randomly selected for the purpose of validating the study.

The table signifies the entry and exit points of the traded stock as well as the profit and loss derived from the strategy.



| Entry Date          | Entry Price | Closing Date | Closing Price | Max Gain(%) (Max Price) | Min Gain(%) (Min Price) | Net P/L      |
|---------------------|-------------|--------------|---------------|-------------------------|-------------------------|--------------|
| 19/12/2014          | 1704.0      | 19/12/2014   | 1684.9        | 0.91                    | -1.77                   | -1.12        |
| 15/04/2014          | 1146.0      | 17/12/2014   | 1600.5        | 67.2                    | -6.15                   | 39.66        |
| 02/01/2014          | 1245.95     | 08/01/2014   | 1169.1        | 0.32                    | -6.7                    | -6.17        |
| <b>Total profit</b> |             |              |               |                         |                         | <b>32.37</b> |



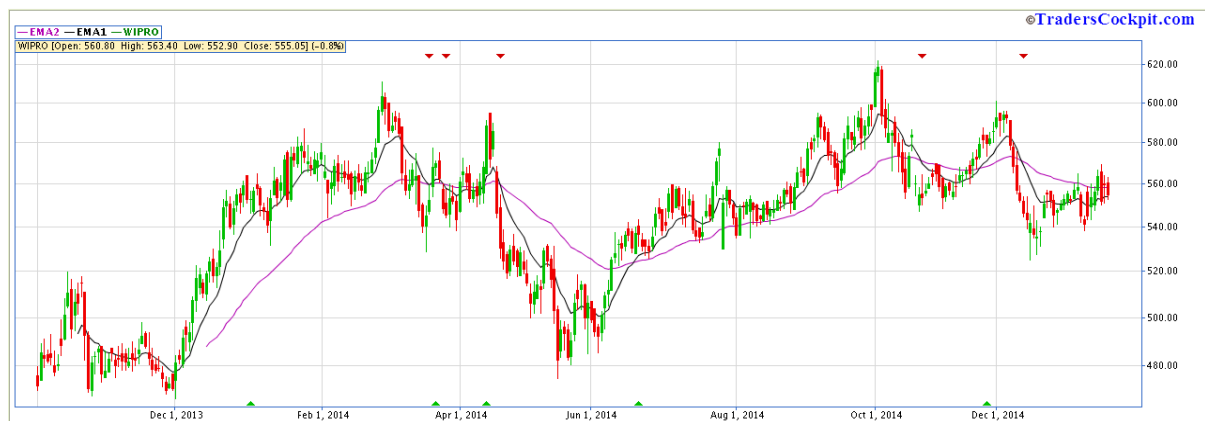
| Entry Date        | Entry Price | Closing Date | Closing Price | Max Gain(%) (Max Price) | Min Gain(%) (Min Price) | Net P/L      |
|-------------------|-------------|--------------|---------------|-------------------------|-------------------------|--------------|
| 05/12/2014        | 355.4       | 01/01/2015   | 380.05        | 10.68                   | -0.11                   | 6.94         |
| 03/11/2014        | 372.0       | 07/11/2014   | 344.55        | 0.81                    | -8.16                   | -7.38        |
| 05/09/2014        | 378.0       | 15/09/2014   | 351.85        | 1.83                    | -7.14                   | -6.92        |
| 26/03/2014        | 274.95      | 05/08/2014   | 361.1         | 54.1                    | -0.71                   | 31.33        |
| 09/01/2014        | 292.0       | 21/01/2014   | 263.0         | 5.43                    | -10.15                  | -9.93        |
| <b>Net Profit</b> |             |              |               |                         |                         | <b>14.04</b> |



| Entry Date        | Entry Price | Closing Date | Closing Price | Max Gain(%) (Max Price) | Min Gain(%) (Min Price) | Net P/L     |
|-------------------|-------------|--------------|---------------|-------------------------|-------------------------|-------------|
| 30/10/2014        | 1572.0      | 12/12/2014   | 1510.95       | 7.69                    | -4.4                    | -3.88       |
| 19/09/2014        | 1578.2      | 19/09/2014   | 1532.45       | 0.71                    | -3.18                   | -2.9        |
| 08/09/2014        | 1622.2      | 17/09/2014   | 1519.15       | 0.65                    | -7.52                   | -6.35       |
| 20/02/2014        | 1022.8      | 01/08/2014   | 1468.7        | 73.7                    | -0.62                   | 43.6        |
| 24/01/2014        | 1029.0      | 27/01/2014   | 980.15        | 0.04                    | -5.44                   | -4.75       |
| 02/01/2014        | 1067.25     | 14/01/2014   | 972.0         | 1.19                    | -10.85                  | -8.92       |
| <b>Net Profit</b> |             |              |               |                         |                         | <b>16.8</b> |



| Entry Date      | Entry Price | Closing Date | Closing Price | Max Gain(%) (Max Price) | Min Gain(%) (Min Price) | Net P/L        |
|-----------------|-------------|--------------|---------------|-------------------------|-------------------------|----------------|
| 03/11/2014      | 93.5        | 09/12/2014   | 85.4          | 1.5                     | -9.79                   | -8.66          |
| 15/05/2014      | 85.6        | 01/08/2014   | 95.0          | 35.05                   | -0.29                   | 10.98          |
| 11/03/2014      | 80.3        | 05/05/2014   | 78.75         | 9.46                    | -3.67                   | -1.93          |
| 02/01/2014      | 90.45       | 10/01/2014   | 80.35         | 0.94                    | -12.22                  | -11.17         |
| <b>Net Loss</b> |             |              |               |                         |                         | <b>(10.78)</b> |



| Entry Date | Entry Price | Closing Date | Closing Price | Max Gain(%) (Max Price) | Min Gain(%) (Min Price) | Net P/L |
|------------|-------------|--------------|---------------|-------------------------|-------------------------|---------|
| 26/11/2014 | 584.0       | 11/12/2014   | 546.3         | 2.89                    | -6.73                   | -6.46   |
| 20/06/2014 | 540.5       | 28/10/2014   | 553.7         | 15.06                   | -2.68                   | 2.44    |



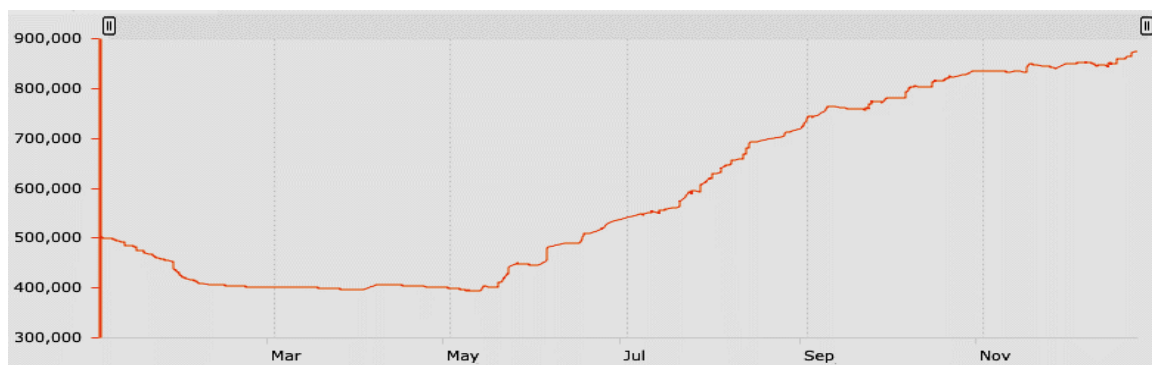
|                   |        |            |        |       |       |                |
|-------------------|--------|------------|--------|-------|-------|----------------|
| 15/04/2014        | 565.05 | 22/04/2014 | 530.55 | 5.25  | -6.91 | -6.11          |
| 22/03/2014        | 567.9  | 26/03/2014 | 545.55 | 1.25  | -4.21 | -3.94          |
| 02/01/2014        | 552.7  | 20/03/2014 | 552.35 | 10.55 | -4.34 | -0.06          |
| <b>Total Loss</b> |        |            |        |       |       | <b>(14.13)</b> |

## Findings

When the 12 day EMA is compared with the 50 day EMA and the position is taken at the cross over of the averages, it is found that there is an uptrend in the stock as long as the cross overs happens again. This can be used as an algorithmic strategy by maintaining a risk management strategy. In this research report, a risk management strategy is not maintained because the objective here is to prove the sensitivity of EMA to the security price. Even when the risk management strategy is not followed, the success rate on a random pick of the stocks is 60%

## CONCLUSION

EMA can be used as an algorithmic strategy. By using the strategy mentioned in this report, a risk management strategy can be used by observing the reaction of the moving averages to the stock price. The position can be exited when the trend of the stock reverses and the EMA's start getting closer to each other since that will be an indication of the crossover. When the above strategy is tested with the 144 scrips present in the F & O segment with the strategy labs with an amount of Rs.10,000 used for a trade in each stock and a corpus of Rs.500,000 is employed, a profit of Rs.375,000 is generated, a return of 75% and a cumulative return of 3720%. The equity curve for the strategy is plotted below:



## Sources

1. "Technical Analysis Course" by Thomas A Meyers
2. Strategy Labs© [www.traderscockpit.com](http://www.traderscockpit.com)