The profitability of moving averages in the South African market

14th September 2017

(GNGASH001)Ashley Gengiah

GNGASH001@myuct.ac.za

Abstract

Moving Averages in the South African market are profitable. The Research Paper aims to prove this statement by using simple and exponential Moving Averages on 3 different Johannesburg Stock Exchange Indices. The best strategies from simple and exponential moving averages were tested in-sample and out-of-sample. The results disagreed with the initial hypothesis and Moving averages were not profitable. The results could change if equal lengths of in and out of sample periods were used.

Keywords: JSE Top40, JSE IND, JSE FIN, Moving Average, chartseries.

1 Introduction

The Research Paper aims to prove the profitability of moving averages in the South African Market. Given South Africa's growing global presence, research on the profitability of moving averages in the South African Market could be utilized for future profits. The Research Project will focus on the JSE top40, The JSE IND and the JSE FINI. The Research project will focus on using Simple and Exponential moving averages to determine profitability of these 3 sectors and transaction costs will be included.

The JSE top40 is South Africa's best known index. It includes the 40 largest companies listed on the JSE. This is the index that most people monitor as an overall benchmark for the South African exchange. These 40 companies are the largest in terms of market capitalization which provides a representation of the South African market as a whole. Performing moving average trend line analysis on the Top40 index will generate results representing the profitability of moving average in the whole South African market. The JSE IND is the top 25 industrial companies index in terms of market capitalization and the JSE FINI is the top 15 financial companies index in the JSE in terms of market capitalization. The industrial and financial sector are the 2 biggest sectors in South Africa, thus testing profitability for these 2 sectors individually could be profitable. Moving Average trend lines are a form of technical analysis.

Technical analysis involves using the volume and latest stock prices to determine models and technical trading indicators for a given set of data. Moving averages are the most widely known and used by practitioners and financial traders in the markets. (Sobreiro et al. 2016) A paper was done on the 5 emerging national economies of Brazil, Russia, India, China and South Africa, (BRICS).(Sobreiro et al. 2016) The paper analyzed South Africa but

did not cover the South African market extensively. The South African stock market is described in a paper done in 2003 as not weak form market efficient suggesting profitable opportunities. (Appiah-Kusi and Menyah 2003) The lack of information involving moving average trend lines in the South African market and the potential for profits emphasizes the importance of the research question.

2 Background

2.1 The beginning of technical analysis

Technical analysis was first introduced by Charles H. Dow. Charles H. Dow believed stock market prices could provide information on the overall market. This lead to Dow theory which was introduced in the late 1800's starting what is known as technical analysis.(Bessembinder and Chan 1998) Technical analysis is used in the financial industry amongst different market participants. The introduction of the Efficient Market Hypothesis proposed by Fama (1970) lead to a decline in the use of technical analysis and the disbelief that profits could be generated from technical analysis. (Sobreiro et al. 2016) It was only in 1992 when a paper done by William Brock, Josef Lakonishok and Blake LeBaron provided significant evidence in justifying the use of technical analysis. (Fong and Yong 2005). The paper lead to the resurgence in testing technical analysis in different markets and determining whether it is actually profitable.

2.2 The Efficient Market Hypothesis

The paper rewritten by (Fama 1991) refers to the Efficient Market Hypothesis as the asset prices fully reflecting all available information. The Efficient Market Hypothesis can be split into 3 forms based on the definition of the information:

1. Weak Form EMH: Prices reflect all information in the past price history
2. Semi-Strong Form EMH: Prices reflect all publicly available information
3. Strong Form EMH: Prices reflect all information, public and private. (Park and Irwin 2007)

If all information is available in the prices, then additional information such as moving averages shouldn't provide any financial profitability. The Weak form efficient market hypothesis states that there is no justification for technical analysis. This implies that markets are efficient and arbitrage should not be attainable through technical analysis. (Fama 1991). The weak form of the efficient market hypothesis has been the paradigm in describing the behaviour of prices in speculative market. A paper done in 1988 proved the non-existence of random walks in the stock market using the NYSE-AMEX index. (Lo and MacKinlay 1988) The Efficient Market Hypothesis is one of the main reasons why individuals do not regard technical analysis as useful and has lead market participants to avoid technical analysis. Technical analysis is still used by market participants. Moving averages might not provide exact profits but they do provide other information about the data.

2.3 Moving Averages

"Moving Average are a type of smoothing method for reducing, or cancelling random variation inherent in data taken over time. When applied properly, this technique reveals more clearly the underlying trend, seasonal and cyclic approach components in the data." (Okkels, n.d.) This definition implies that moving average can still be used in understanding the direction of the market even if it cannot be used directly in beating the buy-and-hold strategy. The simple and exponential moving averages are the most frequently used moving averages and are used in different ways to predict the buy and sell signals in the price history. Exponential moving average gives more weight to recent stock prices while simple provides equal weighting for all stock prices in a given time period. (Okkels, n.d.). One method is the comparison of short and long run simple moving averages. Short and long run moving averages refers to the specific time frame in which the moving average is calculated. In a paper done on South Asian markets, short is referred to as 10, 20 or 50 day moving averages, while long run is referred to as 50,100 or 200 day moving averages. (Ming-Ming and Siok-Hwa 2006) Moving average techniques require buy and sell signals after comparing short and long run simple or exponential moving averages. (Gunasekarage and Power 2001). The paper discusses 2 moving average techniques which are: Variable length moving average and fixed length moving average. The variable length moving average rule generates a buy-and-sell signal every day. Variable length moving average signals to buy when short moving average is above the long moving average. The crossing over of Moving averages is referred to as the dual moving average crossover. (Ming-Ming and Siok-Hwa 2006). The fixed length moving average holds a moving average for a fixed period of time. This is a 10-day holding period in Brock (1992) and Ming-Ming, L & Siok-

Hwa, L (2006). During this 10-day period signals do not change the fixed length moving average till the end of the holding period, where cumulative profits are calculated. Fixed length moving average focuses on crossing over of long and short moving averages. A sell (buy) signal occurs when the short (long) moving average crosses the long (short) moving average from above.

2.4 Empirical results

Brock (1992) analysed fixed and variable moving averages in the Dow Jones industrial Average Index using 90 years of data. (1897-1986). Both the fixed and variable moving averages provided excess returns compared to the buy-and-hold strategy. These returns did not include transaction costs.

The study done on 6 equity indices in Asia provided results indicating strong predictive power of moving averages in Malaysian, Thailand and Taiwan stock markets. The paper's results confirm the profitability of moving average trend lines.(Bessembinder and Chan 1998) The study obtained stock price index data from (1975-1989). The returns are computed as changes in log price indices thus preventing autocorrelation. The transaction costs were reported as break even costs in order to calculate the highest percentage of profits available for transaction costs. The average transaction cost is 1.57% for the whole sample. If the transaction cost were 1% then moving averages would have been profitable.

The study done by Ming-Ming & Siok-Hwa used the daily closing price index is used as the short term moving average. (2006) The long term moving average varies between the time period of 20, 60,120,180,240 days. Multiple long moving averages are compared to the 1-day short moving average. The results concluded that the best strategy was using a 60-day long moving average and the 1-day short moving average. The results indicated variable

moving averages were more profitable than fixed moving average and both provided significant returns.

3 Data

The data chosen for the study involves using 2 sets of closing prices which range from the 2006 to 2017. The 1st set of closing prices are over an 8-year period from 1st of May, 2006 to 31st of April 2014 The out-of-sample test will occur between the 1st of May 2014 to 31st of April 2017. All data is taken from Google Finance and focuses on the JSE TOP40, JSE Top25 industrial companies and the JSE top15 financial companies

The Transaction cost used consists of 4 aspects: Brockerage fee= 0.6%

Investor protection levy = 0.0002%

STRATE fee= 0.005459%

Security Transfer Tax=0.25%

The total transaction costs = 0.855659%.("FNB: FAQs - Buying and Selling" 2017)

4 Methodology

The 2 main Moving Averages used in this reasearch paper are simple moving average and exponential moving average. Simple moving averages is the sum of latest stock prices divided by the number of stock prices: Simple moving average calculation

$$SMA_n = \frac{1}{k} \times \sum_{t=n-k+1}^{n} P_t$$

Where: P_t is the closing price of the stock in t period.

n is the relative position of the current period observed; and k is the number of periods included un the SMA calculation;

Simple averages are the easiest to interpret while exponential moving averages provide stronger predictive ability in market prices. Exponential moving averages focus on the most recent values and thus are similar to weighted moving averages.

Exponential moving average calculation

$$EMA_n = \left(\frac{2}{k+1}\right) \times P_{t-1} + \left(1 - \left(\frac{2}{k+1}\right)\right) \times EMA_{n-1}$$

where: P_{t-1} is the closing price of the stock in the previous period.
EMA_{n-1} is the EMA in the previous period.
n is the relative position of the current period observed; and

k is the number of periods included in the EMA calculation;

The Research project will only focus on simple and exponential moving average trend lines. Moving Average Convergence Divergence is the formal name for comparing a short and long run exponential moving average. The simple and exponential moving averages were calculated using the TTR package in R.

The Methodology that will be incorporated in answering the research question is the application of dual moving average crossover and moving average convergence divergence. This allows for short and long term moving averages while comparing simple and exponential moving averages. The literature reviewed suggests using a short moving average of either 5,10,30 or 50 days and long moving average of either 50,100 or 200 days. The time frame that will be used is 2006-2017.

The exact method for comparing the different moving averages to the buy-and-hold strategy involves 5 steps: Step: 1. Generate trade signals over

the period. This done by comparing short and long run moving averages.
Step: 2. Use the signals generated to calculate the holding period.
Step: 3. Compare the returns of the moving average to the buy-and-hold strategy
Step 4: Run a number of different long and short period combinations
Step 5: Choose the best combination of short and long simple and exponential moving average for the JSE Top40, JSE IND and the JSE FIN that provide the greatest return and compare them to the buy-and-hold strategy.

The package quantmod is used to collect the data from google finance and convert prices to log returns. To avoid autocorrelation daily log returns were used to calculate profits rather than the actual closing prices. A sequence was run to generate different values for the short and long periods. The short periods ranged from 5 to 55 in steps of 25 while the long periods ranged from 55 to 405 in steps of 50. Back testing was used in the training period to calculate the optimal strategy for each JSE index using simple and exponential moving averages. The Best strategy for each moving average will be tested out-of-sample to ensure the results were not over optimized to match the specific training period.This prevents inaccurate results.

5 Empirical results

The empirical results for the best strategies in the in-sample period are plotted in the table below.

Specific Index Strategy (Short days/Long Days)	Annual Return	Annual Standard Deviation	Annual Sharpe Ratio	Annual Buy and hold Return	Annual Buy and hold Standard deviation	Annual Buy and Hold Sharpe Ratio	Trades Buy	Trades Sell
SMA(TOP40)(30/355)	0.0497	0.1666	0.2986	0.0516	0.2189	0.2354	8	8
EMA(TOP40)(55/355)	0.0555	0.1724	0.3219	0.0516	0.2189	0.2354	3	3
SMA(INDI)(5/355)	0.1360	0.1529	0.8890	0.1306	0.1889	0.6911	3	3
EMA(INDI)(5/305)	0.1451	0.1545	0.9390	0.1306	0.1889	0.6911	4	3
SMA(FIN)(30/205)	0.0701	0.1627	0.4306	0.0239	0.2383	0.1002	6	5
EMA(FIN)(55/155)	0.0532	0.1609	0.3305	0.0239	0.2383	0.1002	8	7

Figure 5.1: Table to show the top strategy returns and standard deviations compared to the buy and hold returns and standard deviation and the number of buy and sell trades.

The Best Simple Moving Average strategy for the JSE Top40 with a short period of 30 days and a long period of 355 days did not beat the buy-and-hold strategy. This could be accounted for by the 16 trades that occurred. The transaction costs overall could have resulted in less profit than the buy-and-hold strategy.

The Best Simple Moving Average strategy for the JSE IND with a short period of 5 days and a long period of 355 days exceeded the buy-and-hold strategy by 0.0054. The profit is rather small but if leveraged correctly could be worth investing in. The Best Simple Moving Average strategy for the JSE FIN with a short period of 30 days and a long period of 205 days did outperform the buy-and-hold strategy by 0.0462. The profit is considerably high and is worth investing in. All the Best Exponential Moving Average strategies in the 3 JSE indices outperformed the buy-and-hold strategy. The Exponential Moving average captures shorter trend moves as it generally has a trend line closer to the closing prices due to the use of most recent prices.

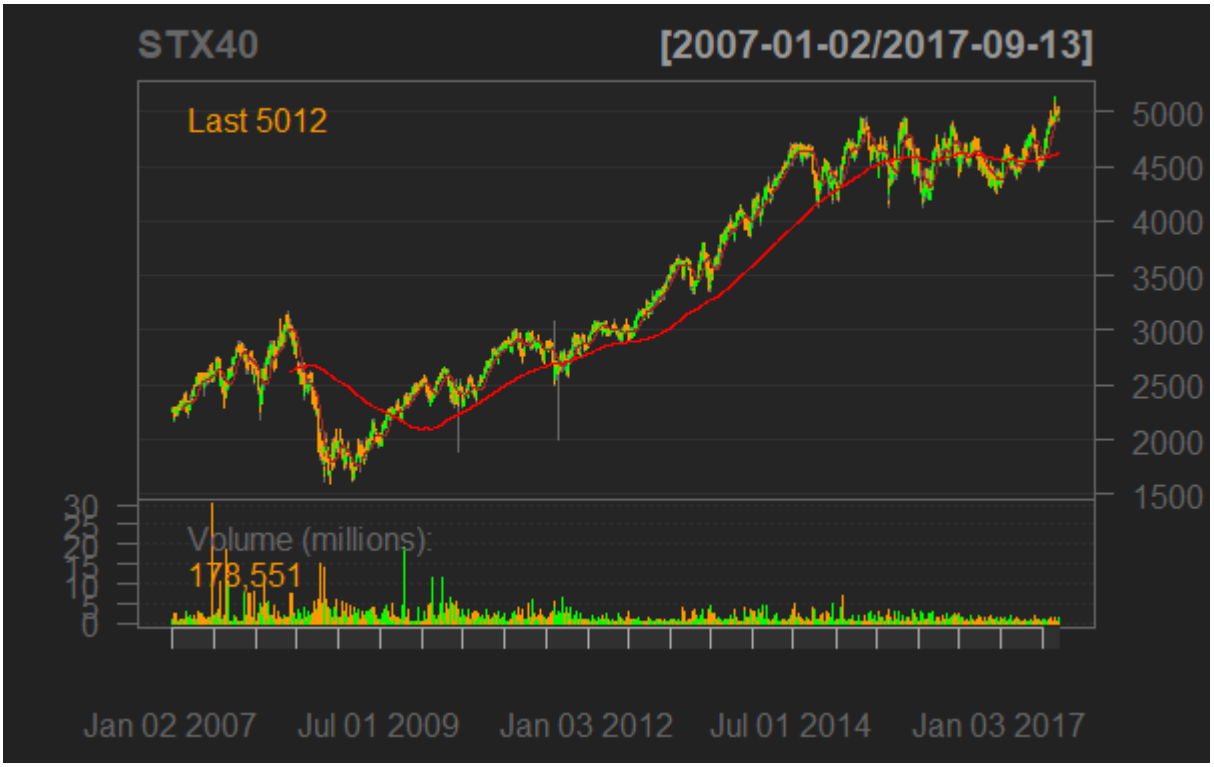

Figure 5.2: Chartseries to show Simple Moving Averages in the JSE top40

Figure 5.3: Chartseries to show Simple Moving Averages in the JSE IND

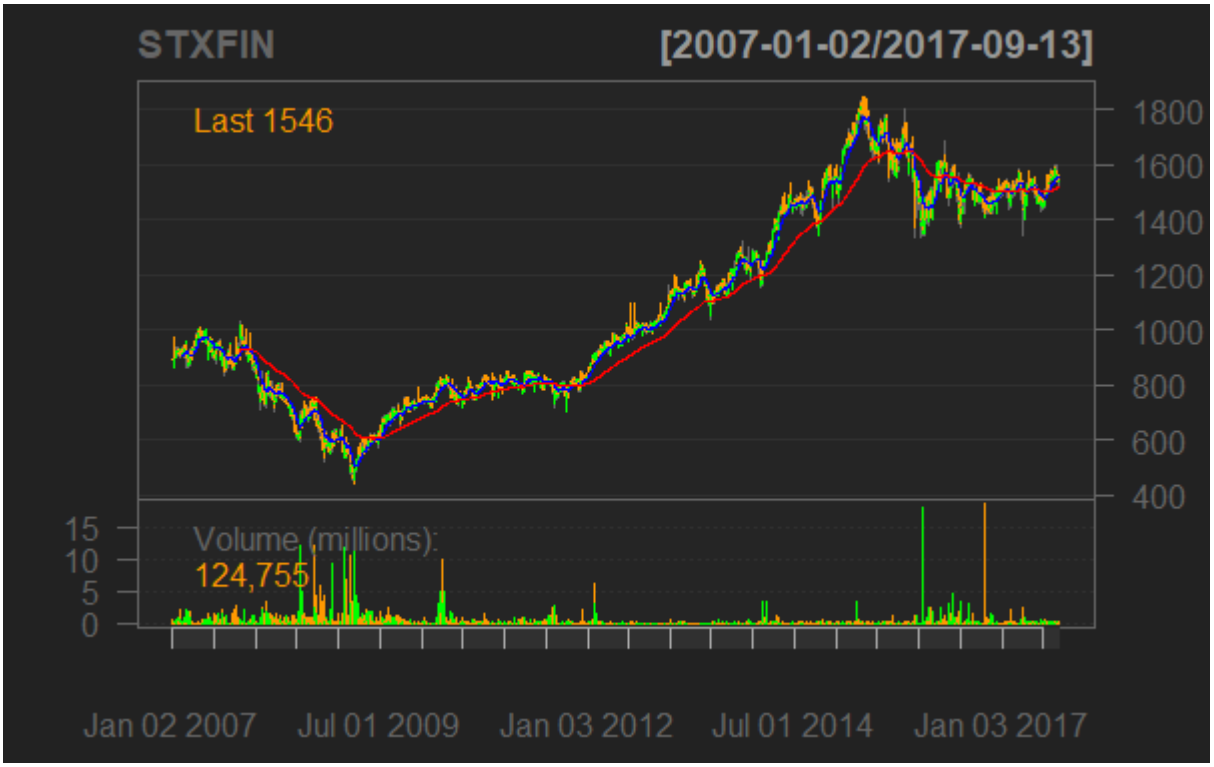

Figure 5.4: Chartseries to show Exponential Moving Averages in the JSE FIN

The Red Line indicates the long moving average in each indice

Given the chart series graphs its seen that there was minimal change in prices throughout the in-sample period resulting in the exponential moving average matching prices quite accurately causing more profit.

Strategy (Short days/Long Days)	Annual Return	Annual Standard Deviation	Annual Sharpe Ratio	Annual Buy and hold Return	Annual Buy and hold Standard deviation	Annual Buy and Hold Sharpe Ratio	Trades Buy	Trades Sell
SMA(TOP40)(30/355)	-0.0007	0.1434	-0.0052	0.0229	0.1659	0.1383	5	4
EMA(TOP40)(55/355)	-0.0229	0.1453	-0.1577	0.0229	0.1659	0.1383	3	2
SMA(INDI)(5/355)	0.0703	0.1464	0.4804	0.0856	0.1584	0.5406	2	2
EMA(INDI)(5/305)	0.0797	0.147	0.5424	0.0856	0.1584	0.5406	3	3
SMA(FIN)(30/205)	-0.001	0.1227	-0.0085	0.0026	0.1946	0.0135	3	3
EMA(FIN)(55/155)	-0.0303	0.1211	-0.2504	0.0026	0.1946	0.0135	4	4

Figure 5.5: Table to show the top strategy returns and standard deviations compared to the buy and hold returns and standard deviation and the number of buy and sell trades out-of-sample.

The out-of-sample period starts from 1st April 2014 and ends on the 31st of March 2017. Observing the prices using the chart series suggests that prices are more volatile in the out-of-sample period. All the strategies failed to beat the buy and hold strategy out-the-sample. This could either be due to Moving averages being unable to beat the buy-and-hold strategy or the increased volatility in the out-of-sample period

6 Conclusion

The best strategies out of sample all failed to beat the buy-and-hold strategy. This follows the weak form Efficient Market Hypothesis. The in-sample results only beat the buy and hold strategy as the moving averages were over optimized to the curves. Moving Averages are useful in determining trends but cannot be utilized to achieve additional profits. An issue that occurred could be the mismatch between out-of-sample and in-sample strategies having different time lengths. In-sample only had 3 years while out of sample had 8 years. This is due to the fact that only a limited amount of data is available.

7 References

Appiah-Kusi, Joe, and Kojo Menyah. 2003. "Return Predictability in African Stock Markets." *Review of Financial Economics* 12 (3). Elsevier: 247–70.

Bessembinder, Hendrik, and Kalok Chan. 1998. "Market Efficiency and the Returns to Technical Analysis." *Financial Management*. JSTOR, 5–17.

Brock, William, Josef Lakonishok, and Blake LeBaron. 1992. "Simple Technical Trading Rules and the Stochastic Properties of Stock Returns." *The Journal of Finance* 47 (5). Wiley Online Library: 1731–64.

Fama, Eugene F. 1991. "Efficient Capital Markets: II." *The Journal of Finance* 46 (5). Wiley Online Library: 1575–1617.

"FNB: FAQs - Buying and Selling." 2017. `https://www.fnb.co.za/share-investing/shares-faqs-buying-selling.html`.

Fong, Wai Mun, and Lawrence HM Yong. 2005. "Chasing Trends: Recursive Moving Average Trading Rules and Internet Stocks." *Journal of Empirical Finance* 12 (1). Elsevier: 43–76.

Gunasekarage, Abeyratna, and David M Power. 2001. "The Profitability of Moving Average Trading Rules in South Asian Stock Markets." *Emerging Markets Review* 2 (1). Elsevier: 17–33.

Lo, Andrew W, and A Craig MacKinlay. 1988. "Stock Market Prices Do Not Follow Random Walks: Evidence from a Simple Specification Test." *The Review of Financial Studies* 1 (1). Oxford University Press: 41–66.

Malkiel, Burton G, and Eugene F Fama. 1970. "Efficient Capital Markets: A Review of Theory and Empirical Work." *The Journal of Finance* 25 (2). Wiley Online Library: 383–417.

Ming-Ming, Lai, and Lau Siok-Hwa. 2006. "The Profitability of the Simple Moving Averages and Trading Range Breakout in the Asian Stock

Markets." *Journal of Asian Economics* 17 (1). Elsevier: 144–70.

Okkels, Christian Birch. n.d. "Financial Forecasting."

Park, Cheol-Ho, and Scott H Irwin. 2007. "What Do We Know About the Profitability of Technical Analysis?" *Journal of Economic Surveys* 21 (4). Wiley Online Library: 786–826.

Sobreiro, Vinicius Amorim, Thiago Raymon Cruz Cacique da Costa, Rodolfo Torbio Farias Nazrio, Jssica Lima e Silva, Eduardo Alves Moreira, Marcius Correia Lima Filho, Herbert Kimura, and Juan Carlos Arismendi Zambrano. 2016. "The Profitability of Moving Average Trading Rules in Brics and Emerging Stock Markets." *The North American Journal of Economics and Finance* 38. Elsevier: 86–101.