The profitability of moving average trading rules in the JSE financial,industrial and resource sector indices

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Abstract

The paper examines the profitability of simple and exponential moving averages on the JSE Top15 financial companies index,the JSE Top25 industrial companies index and the JSE Top10 resource companies index from 2006-2017. The research paper tests the validity of the weak form market hypothesis in the South African market and generates an optimization algorithm to determine the best short and long run moving average strategies in a training period. The optimal strategies are tested out of sample to verify the validity and feasability of the strategies. The results provided two optimal moving strategies that generated profits in the training period and in the validation period indicating the profitability of moving average trend analysis in the JSE Top15 financial companies index and the JSE Top10 resource companies index.

Keywords: JSE RES, JSE IND, JSE FIN, Moving Average, Efficient Market Hypothesis.

1 Introduction

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).

"Moving Averages 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 2016) Moving averages are defined as tools in understanding the direction of the market even if it cannot be used directly in outperforming the buy-and-hold strategy. Recent studies suggest that moving averages can generate profits. The research paper investigates 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 paper investigates three different sectors on the Johannesburg Stock Exchange, (JSE). The Johannesburg Stock Exchange is the biggest stock exchange in Africa. Performing moving average trend line analysis on three different sectors in the JSE creates a greater opportunity to exploit profits in specific economic sectors. The three sectors are the financial, resource and industrial sector indices. The paper examines Simple and Exponential moving averages to determine profitability of these three sectors while including transaction costs. The JSE IND is the Top25 industrial companies index in terms of market capitalization, the JSE RES is the Top10 resource companies index in terms of market capitalization and the JSE FIN is the Top15 financial companies index in the JSE in terms of

market capitalization. The industrial, resource and financial sectors are the three biggest sectors in South Africa. The paper aims to test moving average trend analysis in these three sectors.

Only one paper has done moving average analysis on South Africa. The paper examined the five emerging national economies of Brazil, Russia, India, China and South Africa using technical analysis (BRICS). (Sobreiro et al. 2016) The paper analyzed South Africa but did not cover the South African market extensively.

The importance of the research question can be split up into a number of specific reasons. The South African stock market is described as weak-form inefficient 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 need for Moving Average analysis in the South African Market specific to sectors. The analysis of each sector could provide crucial information for potential investors and technical traders. The paper is restricted to only simple and exponential moving averages, many of the assumptions underlying technical analysis can be ignored.

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 led to the introduction of Dow theory 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 par-

ticipants. 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) In 1992, William Brock, Josef Lakonishok and Blake LeBaron provided significant evidence in justifying the use of technical analysis. (Fong and Yong 2005) The paper found signifcant evidence that simple trading rules provide economically and statistically significant returns. Moving averages in particular, outperformed the buy-and-hold returns. This led 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 three 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 markets. The non-existence of random walks in the stock market using the NYSE-AMEX index was proved. (Lo and MacKinlay 1988) The Efficient Market Hypothesis is one of the main reasons why individuals do not regard technical analysis as profitable and has lead market participants to avoid using technical analysis to generate excess returns.

2.3 Sector Analysis

Mebane Fabor (2010) analysed ten sectors by combining different sectors together to try and exceed the overall market index returns. The results provided substantial profits. The paper indicates that analysis of specific sectors and combining sectors could results in profitable opportunities. The nature of the three different economic sectors follow unique cyclical patterns. Resource companies are cyclical companies while industrial and financial companies are only prone to impactful economic events.(Berman and Pfleeger 1997). Resource companies returns will be more volatile due to the nature of the sector.

2.4 Moving Averages

The simple and exponential moving averages are the most frequently used moving averages Both 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 moving average provides equal weighting for all stock prices in a given time period. (Okkels 2016). 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)

2.4.1 Fixed and Variable length moving averages

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 two 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 daily. 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 variable length moving average is written as VMA(S,L,B) where S is the short moving average, L is the long moving average and B is the band that allows the actual buying and selling signal to generate a transaction. B is written as a percentage. B is important as it identifies the profitability of the buy and sell signal . (Bessembinder and Chan 1998).

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. A sell (buy) signal occurs when the short (long) moving average crosses the long (short) moving average from above.

Moving Average strategies require:

$$Profit(Aftertransactioncosts) = (meanreturn * numberoftrades) - (transactioncosts)$$

The above strategy provides the profit in percentages. The strategy prevents using exact monetary values and accounts for transaction costs.(Ming-Ming and Siok-Hwa 2006) The strategy is simple to use and requires complete investment of funds into each signal. The research paper methodology uses similar strategy in determining the profitability of moving averages.

2.5 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.

6 equity indices in Asia were analysed and provided results indicating strong predictive power of moving averages in Malaysian, Thailand and Taiwan stock markets. The 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.

Ming-Ming & Siok-Hwa used the daily closing price index 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 daily closing price index commonly known as the one day short moving average. The results concluded that the best strategy was using a 60-day long moving average and the daily closing price index. The

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

The research paper will use a variable length moving average.

3 Data

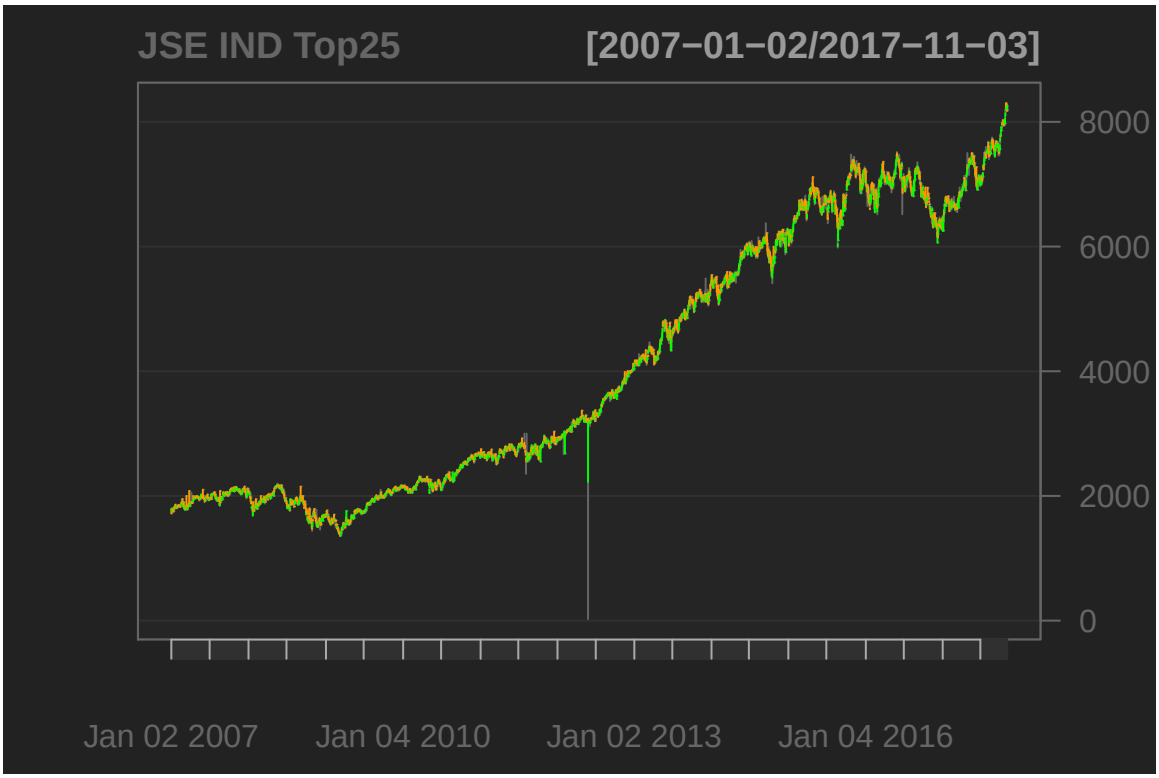
The data chosen for the study involves using closing prices from 2006 to 2017. The closing prices are split into two categories.The first set of closing prices are over an eight year period from 1st of May, 2006 to 31st of April 2014. The first set of closing prices is the training period. This period allows us to generate an optimal moving average strategy. The validation period test will occur between the 1st of May 2014 to 31st of April 2017. The second period allows us to test if our training period moving average strategy is still profitable out-of-sample.All data is taken from Google Finance and focuses on the JSE Top10 Resource companies index, JSE Top25 industrial companies index and the JSE Top15 financial companies index.

The Transaction cost used consists of four aspects:

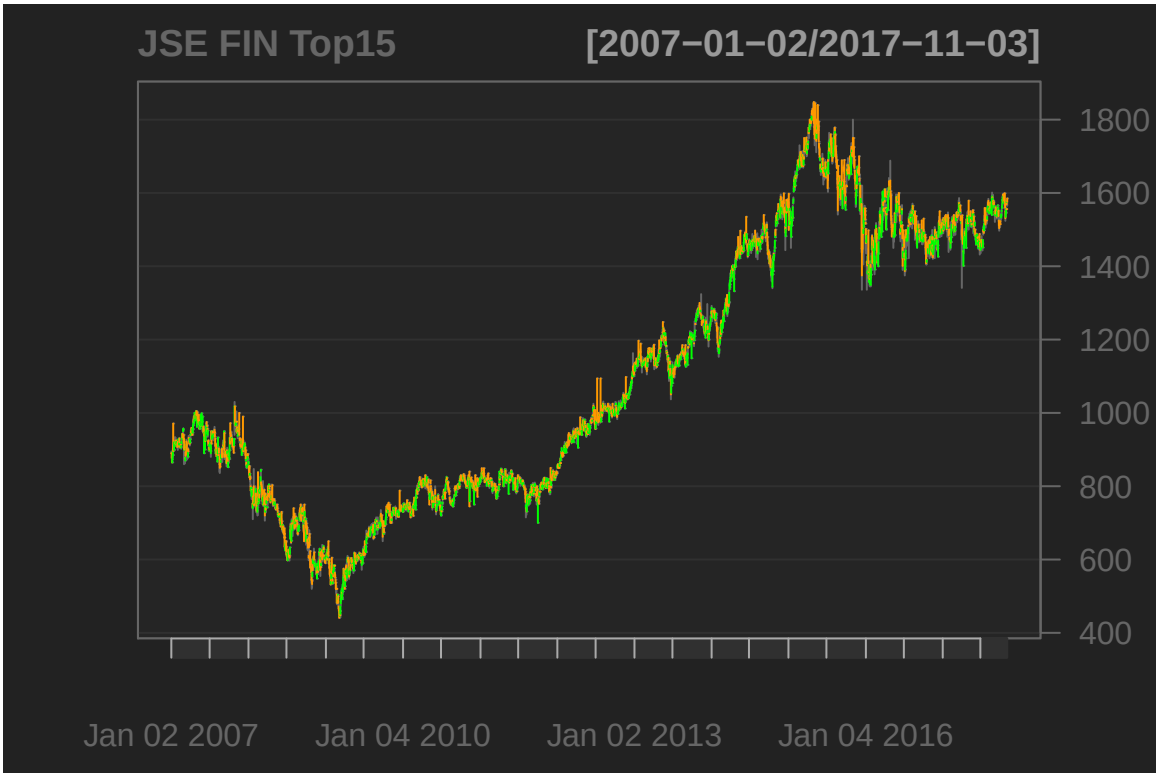
- Brockerage fee= 0.6%
- Investor protection levy = 0.0002%
- STRATE fee= 0.005459%
- Security Transfer Tax=0.25% The total transaction costs = 0.855659%.("FNB: FAQs - Buying and Selling" 2017) The closing prices used from Google finance are log prices.The R package quantmod is used to collect the data 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.

3.1 Data Analysis

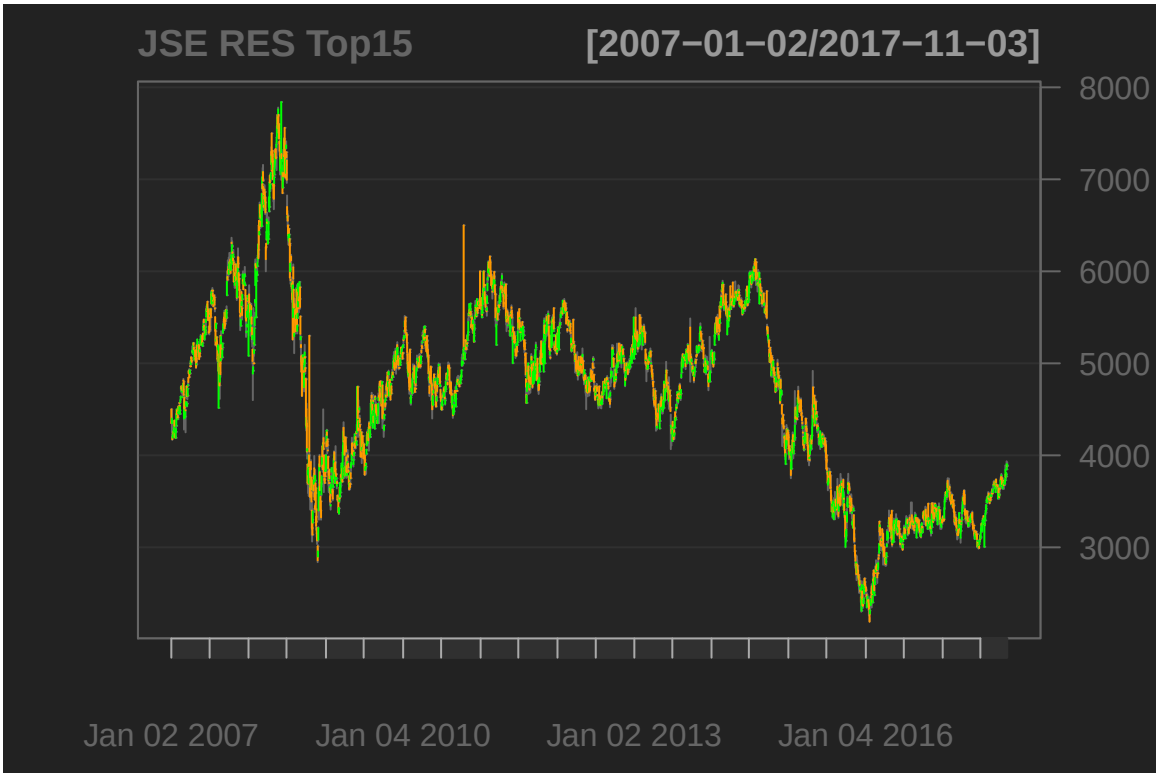
Three chartseries graphs are plotted to analyse the data. The Y-axis is the closing prices in cents and the X-axis is the date.



Chartseries to show the closing prices for the JSE Top25 Industrial companies indice.(2007-2017)



Chartseries to show the closing prices for the JSE Top15 Financial companies indice.(2007-2017)



Chartseries to show the closing prices for the JSE Top10 Resource companies indice.(2007-2017)

The three chartseries provides valuable information on each individual sector. The industrial sector seems to be in a bullish position, the market price is on the rise, for the last 10 years and continues to rise. The financial sector has been bullish since 2007 but dropped significantly in 2014 and recovered in 2016. This recovery may affect the optimal moving average strategy out of sample test as the out of sample test occurs during this recovery period. The resource sector data seems highly volatile. Moving average analysis on the JSE Top10 Resource company could provide exploitable opportunities from the multiple fluctuations shown in the chartseries.

4 Methodology

The two Moving Averages used in this research paper are simple moving averages and exponential moving averages.

4.1 Simple 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 in 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.

4.2 Exponential Moving Average

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 two methods used in the research paper are the 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, or 50 days and long moving average of either 50,100 or 200 days.

The exact methodology will be explained in a step by step algorithm in testing the profitability of moving averages in different sectors. The algorithm is used for both simple and exponential moving averages.

Algorithm:

$$Moving\ average\ function\ =\ function(Data, short, long, cost)$$

The variables in the function are defined:

- Data is the actual data from each analysed sector and the exact time frame. The data is split into a training period and a validation period.
- Short is the short run moving average
- Long is the long run moving average
- Cost is the actual transaction cost = 0.855659%

4.3 Moving Average Algorithm

The exact methodology of the function is explained in a step by step process. The function is used seperately for simple and exponential moving averages. The only change is that the short and long moving average must either be a simple or exponential moving average. The research paper does not cross test simple and exponential moving averages.

1. The function compares the short and long run moving averages by generating signals to indicate whether a buy or sell signal should occur. If the short run moving average is greater than the long run moving average a buy signal is generated. A sell signal occurs if the long run moving average is greater than the short run moving average. A signal is also generated to hold our position, if the short and long run moving averages are equal.

2. The function takes these signals and determines the exact days, trades in our data set eventuate. The data now has signals for each day in which either a buy,sell or hold our position will occur.

3. The log returns of a buy-and-hold strategy are then generated for the specific data set.

4. The transaction cost are minused from each buy signals log return generating the complete buy returns. These buy returns are added to the sells signals log returns to generate the total return.

5.The function plots a table with the short moving average length, long moving average length, strategy returns,strategy standard deviation, strategy sharpe ratio, buy-and-hold return, buy-and-hold standard deviation, the buy-and-hold strategy sharpe ratio,the number of buy trades and the number of

sell trades.

$$Simple\ Moving\ Average\ Function = function(JSEFIN, 30, 355, 0.855659)$$

The Simple moving average function calculates the returns, standard deviation and sharpe ratio for a simple moving average for the JSE Top15 financial companies using a short moving average of 30 days, long moving average of 355 days and a transaction cost of 0.855659%. The function also calculates the returns, standard deviation and sharpe ratio for the buy-and-hold strategy in the JSE Top25 financial companies. The function can also be used to calculate exponential moving averages. Section 5 provides tables of the results.

$$Exponential\ Moving\ average\ function = function(Data, short, long, cost)$$

The exponential function differs to the simple moving average function in that the short and long run moving averages are calculated only using exponential moving averages.

The large amount of financial data could not be tested for every short and long run moving average due to the computational burden. Instead specific short and long run moving average lengths were chosen based on the background empirical results. The short periods ranged from 5 to 55 days in steps of 25 days while the long periods ranged from 55 to 405 days in steps of 50 days. Resulting in 24 moving averages being calculated for each simple and exponential moving average. The empirical results will only look at the top six strategies based on returns to determine if any strategies are profitable.

The 24 moving averages are calculated for simple and exponential moving averages in the three different sectors, generating six tables of data analysis. The main area of risk that needs to be analysed is the standard deviation

and sharpe ratio. The tables will provide comparative analysis between the optimal strategies and the buy-and-hold strategy.

Back testing is 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 in our training period will be tested in a validation period to ensure the specific training period. The testing of a strategy in the validation period is forward testing. Forward testing prevents inaccurate results and verifies whether the optimal strategy is profitable out of the initial sample.

5 Empirical results

The empirical results for the best strategies in the training periods are plotted in the tables below.The headings of each column are labelled. "short" is the number of days used in the short run moving average. "long" is the number of days used in the long run moving average. "strat_return" is the overall return generated from the strategy of short and long run moving averages. "strat_sd" is the standard deviation for the strategy. "strat_sharpe" is the sharpe ratio for the specific moving average strategy. "bh" referes to the buy-and-hold strategy. "Bh_r" is the buy-and-hold strategy returns. "Bh_sd" is the buy-and-hold standard deviation."bh_sharpe" is the buy-and-hold strategy sharpe ratio. "Buy" is the number of buys that occur due to the strategy. "sells" is the number of sells that occur due to the strategy throughtout the investment period.

Table 5.1: **Table to show the top 6 strategies in the JSE Top15 Financial companies using a simple moving average between 2006-2014**

short	long	strat_r	strat_sd	strat_sharpe	bh_r	bh_sd	bh_sharpe	buy	sell
30	205	0.0709	0.1623	0.4369	0.0253	0.2371	0.1066	6	5
55	155	0.0598	0.1601	0.3738	0.0253	0.2371	0.1066	9	8
55	205	0.0586	0.1614	0.3630	0.0253	0.2371	0.1066	7	6
30	155	0.0256	0.1636	0.1564	0.0253	0.2371	0.1066	13	12
55	255	0.0240	0.2181	0.1100	0.0253	0.2371	0.1066	4	3
55	305	0.0126	0.2220	0.0566	0.0253	0.2371	0.1066	4	3

The best strategy is a 30 short day moving average and a 205 long day moving average. The profit generated is 4.56% higher than the buy-and-hold strategy. The returns are 1.8 times greater than the buy-and-hold returns. The sequence generated five profitable moving average strategies indicating that multiple moving average combinations could be tested in the validation period.The optimal moving average strategy has less volatility and more return resulting in a sharpe ratio of 0.3378 which exceeds the buy-and-hold sharpe ratio. A sharpe ratio of one is considered a good investment. The strategy is highly profitable but will have to be tested out of sample in order to be validated.

Table 5.2: **Table to show the top 6 strategies in the JSE Top15 Financial companies index using a exponential moving average between 2006-2014**

short	long	strat_r	strat_sd	strat_sharpe	bh_r	bh_sd	bh_sharpe	buy	sell
55	155	0.0542	0.1605	0.3378	0.0253	0.2371	0.1066	8	7
55	205	0.0476	0.1610	0.2959	0.0253	0.2371	0.1066	7	6
30	205	0.0443	0.1620	0.2731	0.0253	0.2371	0.1066	9	8
55	105	0.0313	0.1518	0.2064	0.0253	0.2371	0.1066	12	12
30	155	0.0291	0.1625	0.1791	0.0253	0.2371	0.1066	13	12
55	305	0.0023	0.2231	0.0101	0.0253	0.2371	0.1066	5	4

The best exponential moving average strategy is a 55 day short run moving average and a 105 day long run moving average. The strategy provides excess returns of 2.89%. The sharpe ratio is 0.3378 which is similar to th simple moving average sharpe ratio. Both the exponential and simple moving averages provide small returns in the financial companies. These returns could be leveraged to generate large profits.

Table 5.3: **Table to show the top 6 strategies in the JSE Top25 Industrial companies index using a simple moving average between 2006-2014**

short	long	strat_r	strat_sd	strat_sharpe	bh_r	bh_sd	bh_sharpe	buy	sell
5	355	0.1420	0.1524	0.9315	0.1367	0.1881	0.7265	3	3
30	305	0.1407	0.1534	0.9168	0.1367	0.1881	0.7265	3	2
5	405	0.1358	0.1851	0.7337	0.1367	0.1881	0.7265	2	1

short	long	strat_r	strat_sd	strat_sharpe	bh_r	bh_sd	bh_sharpe	buy	sell
5	305	0.1320	0.1526	0.8652	0.1367	0.1881	0.7265	8	7
30	355	0.1320	0.1534	0.8602	0.1367	0.1881	0.7265	2	2
55	305	0.1292	0.1562	0.8274	0.1367	0.1881	0.7265	3	2

Table 5.4: **Table to show the top 6 strategies in the JSE Top25 Industrial companies index using a exponential moving average between 2006-2014**

short	long	strat_r	strat_sd	strat_sharpe	bh_r	bh_sd	bh_sharpe	buy	sell
5	305	0.1511	0.1540	0.9809	0.1367	0.1881	0.7265	4	3
30	355	0.1452	0.1540	0.9427	0.1367	0.1881	0.7265	2	2
30	305	0.1432	0.1542	0.9290	0.1367	0.1881	0.7265	3	2
5	405	0.1386	0.1593	0.8698	0.1367	0.1881	0.7265	6	5
5	355	0.1329	0.1546	0.8595	0.1367	0.1881	0.7265	8	8
55	355	0.1329	0.1558	0.8529	0.1367	0.1881	0.7265	2	2

The industrial sector provided the highest returns compared to the financial and resource sectors indices.The excess returns for the simple and exponential are 0.53% and 1.44% respectively. The returns are relatively small indicating marginal profits. The sharpe ratios are close to 1 indicating a considerably good investment for investors even with small returns indicating very little risk for the given return. The optimal strategy suggests a long moving average strategy over 305 days indicating a general long term trend. The chartseries in in the data section confirms the long term bullish trend.

Table 5.5: **Table to show the top 6 strategies in the JSE Top10 Resource companies index using a simple moving average between 2006-2014**

short	long	strat_r	strat_sd	strat_sharpe	bh_r	bh_sd	bh_sharpe	buy	sell
55	105	0.0197	0.2214	0.0888	-0.059	0.318	-0.1854	12	12
30	155	0.0083	0.2118	0.0391	-0.059	0.318	-0.1854	9	9
55	205	-0.0070	0.2110	-0.0331	-0.059	0.318	-0.1854	7	7
30	405	-0.0075	0.1944	-0.0384	-0.059	0.318	-0.1854	6	6
55	255	-0.0094	0.2045	-0.0460	-0.059	0.318	-0.1854	7	7
55	155	-0.0144	0.2142	-0.0674	-0.059	0.318	-0.1854	8	8

Table 5.6: **Table to show the top 6 strategies in the JSE Top10 Resource companies index using a exponential moving average between 2006-2014**

short	long	strat_r	strat_sd	strat_sharpe	bh_r	bh_sd	bh_sharpe	buy	sell
30	105	0.0192	0.2036	0.0942	-0.059	0.318	-0.1854	10	10
55	155	-0.0088	0.2005	-0.0440	-0.059	0.318	-0.1854	7	7
30	55	-0.0118	0.2044	-0.0577	-0.059	0.318	-0.1854	19	19
55	205	-0.0178	0.1986	-0.0897	-0.059	0.318	-0.1854	8	8
55	105	-0.0238	0.2020	-0.1176	-0.059	0.318	-0.1854	9	9
30	205	-0.0248	0.1948	-0.1271	-0.059	0.318	-0.1854	11	11

The Resource sector is the most volatile sector as shown by the chartseries in the data section. The resource sector is a cyclical sector resulting in

the excess volatility. Table 5.5 and Table 5.6 indicate the Top10 Resource companies have the highest risk with the top strategies in both simple and exponential moving averages obtaining standard deviations greater than 0.2. The returns are also negative in most strategies. Only the top exponential moving average strategy had a positive return of 1.92% while the top simple moving average had a return of 1.97%. The resource sector is the only sector to have a negative buy-and-hold return of -5.9%. The results provide evidence that additional risk will provide excess returns. The resource sector experiences strong seasonal changes in demand for specific resources generating additional volatility.

All the optimal strategies provided profitable returns and further testing in a validation period is required.

5.1 Final results

The top six strategies were analysed in the validation period from the 1st of May 2014 to 31st of April 2017. The exact same moving average algorithm is used with the validation period time frame. The exact short and long periods generated in our optimal training period strategy are applied in the validation time period to reproduce new returns, standard deviations and sharpe ratios for the buy-and-hold strategy and the optimal moving average strategy. The table below uses the same variables labelled in the beginning of the empirical results section while including a new column which indicates the specific economic sector and the type of moving average.

Index, MA	short	long	strat_r	strat_sd	strat_sharpe	bh_r	bh_sd	bh_sharpe	buy	sell
JSE FIN SMA	30	205	0.0042	0.1228	0.0341	0.0077	0.1923	0.0402	3	3
JSE FIN EMA	55	105	0.0232	0.1266	0.1835	0.0077	0.1923	0.0402	3	3
JSE IND SMA	5	305	0.0998	0.1457	0.6851	0.1056	0.1567	0.6737	3	3
JSE IND EMA	5	355	0.0906	0.1451	0.6246	0.1056	0.1567	0.6737	2	2
JSE RES SMA	55	105	0.0131	0.1678	0.0783	-0.1426	0.2872	-0.4964	3	3
JSE RES EMA	30	105	-0.0931	0.1975	-0.4712	-0.1426	0.2872	-0.4964	4	3

Table 5.7: Table to show the six optimal moving average strategies tested in the validation period

The Top six strategies in the validation period provided three strategies that outperformed the buy-and-hold strategy. The exponential moving average in the financial sector and both the simple and exponential moving average in the Resource sector outperformed the buy-and-hold strategy. The exponential moving average strategy in the JSE Top10 Resource companies indice outperformed the buy-and-hold strategy by 4.95%, however the return on the strategy is -9.31%, indicating that this strategy is unprofitable. The exponential moving average in the Top 15 financial companies generated excess returns of 1.55%. The strategy provided the lowest standard deviation for a profitable strategy of 12.66%. The simple moving average strategy for the JSE Top10 Resource companies index generated returns of 1.31% which exceeded the buy-and-hold strategy by 15.57%. The strategy required additional risk in the form of a 16.78% standard deviation. The best strategy that exceeded the buy-and-hold returns required a relatively short, long moving average length of 105 days. Due to the volatile prices indicated in the chartseries, it can be seen that a long moving average of 105 days would be profitable as worthwhile trades are feasible in exploiting abnormal returns. The strategy has enough time to react to a profitable

opportunity in the market. The Industrial sector moving averages did not outperform the buy-and-hold strategy incurring additional costs in the form of transaction costs. The sharpe ratio for the two profitable strategies are both below 20%, indicating a lack of investor incentive to partake in the investment. The sharpe ratios for the profitable strategies out performed the buy-and-hold sharpe ratios. The two profitable strategies generated three buy and three sells, indicating that only a few trades generated profitable returns. If smaller transaction costs were possible the results might generate more buys and sells.

The final results indicates that moving average analysis is profitable in particular economic sectors. The industrial sector moving analysis generated returns slightly below the buy-and-hold strategy. The industrial sector results indicate that the weak form efficient hypothesis holds in specific economic sectors.

6 Conclusion

The results provided six optimal strategies. three strategies adhered to the weak form efficient market hypothesis. The Industrial sector is efficient while the financial and industrial sector provided strategies that disagreed with the weak form efficient market hypothesis.

The results provided for strategies that are unprofitable are not completely useless. The moving average analysis provided understanding of economic sectors in the form of trends, generating additional information for financial market participants. The two strategies that outperformed the buy-and-hold strategy provide evidence that sectors in the South African market are weak form inefficient. The Simple Moving average strategy in

the JSE Top10 Resource companies index provides evidence to confirm the profitability of moving averages in a specific South African economic sector.

Further analysis should be performed on the JSE Top10 Resource companies index and the JSE Top15 Financial companies index to verify the results in the research paper. The research paper is confined to only three JSE economic sectors and two moving averages. More sectors could be analysed to provide better representative results. Analysing the market as a whole or one specific sector in more detail might produce different results compared to the research paper. The financial sector generated volatile returns out of sample which could also justify why the optimal moving average strategy outperformed the buy-and-hold strategy in the validation period. Additional research could be performed to test data extending before 2006 and the moving average strategy function could apply more short and long run moving averages, requiring more computational burden.

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