Comparing the returns of technical analysis strategies with market index returns

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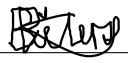
Abstract

Technical analysis techniques are measured against the performance of a buy and hold strategy. The study develops a method to test the performance of the active technical analysis strategy versus the passive buy and hold strategy augmenting existing literature. The strategies are tested on two emerging markets, JSE Top 40 (South Africa) and NIFTY 50 (India), and two developed markets, S&P 500 (USA) and FTSE 100 (London). Combinations of these indices are tested as well. The study is performed on data from 01/01/1997 to 31/12/2019. The data is split up into multiple three-year, five-year, ten-year, and twenty-year investment horizons. Different initial starting points are used to prevent data snooping biases. Nine technical indicators are used to produce returns to compare to the buy and hold strategy. These indicators include trend indicators, momentum indicators and a volatility indicator. There are six moving average-based indicators, as well as rate of change, relative strength index and bollinger bands. A combined indicator approach is also discussed and tested in the study. It is found that technical analysis techniques often outperform the buy and hold strategy. However, there is not a single indicator that performs well for all investment horizons, indices or combinations of indices. Most of the returns were eroded when considering transaction costs, but there are still some periods for which technical analysis provided superior returns to the buy and hold strategy.

Declaration

I, Bernadette Pieterse, declare that the dissertation which I hereby submit for the degree MSc Actuarial Science at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other institution.

Signature  Date 11/07/2021

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> *"I look up to the mountains; does my strength come from mountains? No, my strength comes from GOD, who made heaven, and earth, and mountains."*
>
> - Psalm 121: 1-2

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Chapter 1

Research Overview and Introduction

On a typical trading day, hundreds of billions of shares are traded worldwide. Some investors try to outperform the stock market by using active investment strategies. A popular strategy widely used by investment managers is known as technical analysis. This strategy incorporates the use of historical stock price data to generate buy and sell signals. The signals are generated from technical indicators and through studying stock price charts to identify trends and patterns in the price data. There has been a considerable debate about whether technical analysis can be used to outperform a passive investor that uses a buy and hold strategy to invest. This will be discussed in more detail in the following chapters.

One of the most well-known financial theories, known as the Efficient Market Hypothesis, states that investors are rational. Most researchers and behavioralists believe that investors are not rational at all. Two researchers, Kahneman and Tversky, introduced a new discipline called behavioural finance that attempts explain the behaviours of investors when making investment decisions.

The Efficient Market Hypothesis also states that stock markets are efficient, which means that active investment strategies cannot be used to outperform the market. The Efficient Market Hypothesis consists of three degrees or forms: weak form, semi-strong form and strong form. The weak form states that all past data is reflected in the current stock price and that technical analysis cannot be used to outperform the market. The semi-strong form states that all publicly available data is reflected in the current stock price and that fundamental analysis cannot be used to outperform the buy and hold strategy. The strong form suggests that all public and private information is reflected in the stock price and that insider trading cannot be used to outperform the market.

Although many researchers believe that the Efficient Market Hypothesis holds, many investors still use technical analysis and fundamental analysis when trading. Fundamental analysts aim to calculate the intrinsic value of a company to identify overpriced and underpriced stocks. Technical analysis on the other hand, also known as charting, studies past price history on charts in order to predict future price movements and to calculate possible buy signals and sell signals for an individual stock or an index. Technical analysts assume that the past price patterns will repeat in the future. Technical analysis comprises technical indicators and studying of chart patterns [7], [8].

The main aim of active investment strategies is to produce higher returns than the market. The buy and hold strategy represents the market return for a specific stock or index. It is extremely difficult to test fundamental analysis due to the data constraints of past financial statements and because different investors have different views on a 'fair' value for a share price. Technical analysis studies past stock prices in order to produce buy signals and sell signals. There are therefore very limited data constraints for technical analysis because historical stock price data is widely available. The study therefore focuses on the use of technical analysis as an active investment strategy to compare to the buy and hold strategy.

Many studies show that technical analysis produced returns superior to a simple buy and hold strategy ([9], [10], [11]) whereas, other studies show that it is not possible for these strategies to outperform the market [12], [13]. For most of the studies, the effect of transaction costs are excluded. The few studies that included transaction costs showed that it is close to impossible to beat the buy and hold strategy when taking transaction costs into account [11], [14]. These studies all only incorporate single technical indicators. A study showed the effectiveness of combining multiple technical indicators to outperform the buy and hold strategy. These indicators ignored the effect of transaction costs [15].

Based on the preceding information, there is evidence that support the use of both passive (buy and hold) and active strategies (technical analysis). This leaves investors wondering which of these strategies are more effective to provide the highest attainable returns when investing on the stock market [13].

1.1 Purpose of the Study

The purpose of the study is to investigate the effectiveness of using various technical analysis indicators to outperform a passive investment strategy, also referred to as the buy and hold strategy. The study uses four indices, which include two emerging markets and two developed markets. The emerging markets are the JSE Top 40 index and the NIFTY 50 index. The developed markets are the S&P 500 index and the FTSE 100 index.

The study uses nine technical indicators and only one buy and hold strategy. The technical indicators generate buy signals and sell signals throughout a given term. The indicators include: SMA, EMA, DMAC(SMA), DMAC(EMA), MACD(SMA), MACD(EMA), ROC, RSI and BB. The buy and hold strategy buys once at the start of the term and sells at the end of the term. The indicators are discussed in detail in Chapter 2.

1.2 Problem Statement

Some investors have a need to produce high investment returns over and above the returns produced by the market. To produce higher returns than the market, also referred to as a buy and hold strategy, investors have to trade actively. Two commonly used active investment strategies are technical analysis and fundamental analysis. The main problem with fundamental analysis is the limitation of financial statement data and the difference views of a 'fair' share price for a company. Therefore, the use of active trading strategy, fundamental analysis, is not studied in the research problem.

For technical analysis past share price data is used to produce signals. These signals indicate when traders should buy and sell stocks. Historical share price data is widely available and therefore the research will focus on the use of technical analysis.

The main problem that currently exists in the literature is whether it is beneficial to use technical analysis to outperform a buy and hold strategy. Various studies have been performed to compare the returns produced by technical analysis to the returns produced by a buy and hold strategy. However, the results are conflicting. Some studies conclude that it is beneficial to use technical analysis and the rest conclude the contradiction. Therefore, a very important question of whether the use of technical analysis to outperform the market remains unanswered. This question is of great importance for investors and researchers in the field of investments.

The methods used in previous studies are vague and it is not clear how to calculate and compare the returns of technical analysis techniques to a buy and hold strategy. The research aims to provide clarity on what methods to use and how to calculate the returns for both these strategies, and more importantly, how to compare these two strategies.

The research project aims to provide clarity on this question and methodology for the South African, Indian, American and London stock market over the period of 1997 to 2019.

1.3 Research Questions

In order to address the problem of whether an active investment strategy using technical analysis techniques can outperform a passive buy and hold strategy, the following research question is asked:

How to compare the returns of an active technical analysis strategy to the returns of a passive buy and hold strategy?

The research question is tested on four indices, two indices representing developing markets and two indices representing developed markets. These indices include: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 over the period of 1997 to 2019.

The following sub-questions are asked:

1. What is the effect of different transaction costs on the returns produced by the technical indicator strategies and the buy and hold strategy (section 3.7)?
2. What is the effect of investing all the available funds in the shares that produce a "buy" signal versus only investing a percentage (which is referred to as $b\%$ of the available funds) of the available funds in that share (section 3.8)?
3. Do the investment returns change when considering different indices and combinations of indices and how do the returns compare to the returns produced by a passive buy and hold strategy (section 3.5)?
4. Do the investment returns change when considering different investment horizons and initial starting points and how do the returns compare to the returns produced by a passive buy and hold strategy (section 3.5.4)?

5. Would the use of an overdraft banking facility to ensure unlimited funds have an impact on the results (section 3.11)?

6. Would the use of multiple indicators combined have an impact on the results (section 3.11)?

To address these research questions, the following steps are suggested:

1. For each index, determine the return on the buy and hold strategy over all different investment horizons and initial starting points.

2. For each index, determine the return on each technical indicator strategy over all different investment horizons and initial starting points.

3. For each index, alter the transaction costs charged on the buy and hold strategy and each technical indicator strategy for all different investment horizons and initial starting points.

4. For each index, alter the percentage of the bank account (section 3.8) invested.

5. Start with one index and add more indices one at a time and repeat objectives 1 to 4.

6. Compare the results to see which strategy obtained the best returns.

7. Determine the returns produced by alternative methods.

1.4 Importance and Benefit of the Study

The study develops a methodology for the comparison of technical indicator returns and buy and hold returns to test the effective of these techniques. The methodology focuses on different starting points and end points, which refers to different dates, for the relevant datasets to prevent most data snooping from occurring. The methodology also shows how to calculate returns using multiple indices and multiple indicators to compare to a simple buy and hold strategy.

The study could help investors choose between an active strategy using technical indicators and a passive buy and hold strategy. The study should also inform investors about the performance of the nine indicators in the markets studied. The study also shows the effectiveness of these nine indicators on four different investment markets, which include emerging markets and developed markets.

1.5 Chapter Outline

Chapter 2 provides an overview of existing literature on the Efficient Market Hypothesis, Behavioural Finance, Fundamental Analysis and most importantly, Technical Analysis. Chapter 3 outlines the modelling framework applied to address the research question. The results from the modelling process are presented and discussed in Chapter 4. The study is concluded in Chapter 5 with a summary of the work presented throughout the paper.

Chapter 2

Literature Review

This literature review will focus on already existing research on stock investments. In particular, a critique of the Efficient Market Hypothesis is given in Section 2.2. The assumptions of the Efficient Market Hypothesis state that investors are rational and that neither technical analysis nor fundamental analysis can be used to outperform the market for the relevant degree of the market efficiency (weak form, semi-strong form and strong form). More on the different degrees of market efficiency is discussed in Section 2.2.1. Section 2.3 discusses the rationality of investors by looking at behavioural finance. Sections 2.4 to 2.7 discuss technical analysis and fundamental analysis in more detail.

2.1 Introduction

The primary goal of most investors is to make profits on their investments. A lot of investors use active trading strategies to try and outperform the market. Academics have analysed the returns generated by investment managers and showed that these investors cannot outperform the market. This introduces the idea of the Efficient Market Hypothesis (EMH): investors cannot outperform a simple buy and hold strategy of an index fund by using active trading strategies.

The EMH, and many other investment theories such as modern portfolio theory and asset pricing models are built on the assumption that investors are rational. Behavioralists believe that stock market investors are not close to being rational. Daniel Kahneman and Amos Tversky developed a new economic discipline called behavioural finance in the late 1970's that aims to explain the behaviour of investors. When investors make decisions, there are different heuristics and behavioural biases that influence their decisions [2], [7].

The EMH also assumes that markets are efficient [1] and, therefore, investors cannot outperform a simple buy and hold strategy through the use of active investment strategies. Investors still attempt to predict the future of stock prices and consequently when to buy and sell stocks. Two methods are used to help investors with predicting future stock prices: technical analysis and fundamental analysis. Technical analysis utilises charts of past stock prices to generate buy and sell signals. On the other hand, fundamental analysis aims to estimate what the stock is really worth by analysing the firms' financial data [8].

The rest of the chapter will expand on the ideas discussed in the introduction.

2.2 The Efficient Market Hypothesis

The EMH states that equity prices in an efficient market fully represent all available and applicable information. EMH is based on the assumption that equity prices immediately change when new information is made available [16]. In an efficient market, the information is incorporated in a rapid and unbiased fashion. Though there is substantial evidence supporting the EMH, many still question its validity [17].

The term "efficiency" means that investors have no opportunity to outperform the market and earn abnormal profits when investing in stock markets. This means that investors can only outperform the market by chance or by taking on higher levels of risk [7].

Michael Jensen [18] describes market efficiency as:

> *"A market is efficient with respect to information set θ_t if it is impossible to make economic profits by trading on the basis of information set θ_t."*

The information set, θ_t, can consist of past and current stock prices, as well as dividends and trading volumes. The amount of information in the information set, θ_t, determines the degree of market efficiency [19].

2.2.1 The Degree of Market Efficiency

In reality, markets are neither perfectly efficient nor completely inefficient. Rather than being a black or white issue, market efficiency is more a matter of shades of grey. Government bond

[1] Stock prices reflect all available information in the price immediately and effectively [7]

markets and large capitalization stocks are extremely efficient, while small capitalization stocks and international stocks are less efficient [20]. There are three forms of the EMH:

2.2.1.1 The weak form

All past market prices and data are fully reflected in security prices, thus technical analysis will be of no use [20]. θ_t comprises of past stock information [19].

The weak form EMH is related to the idea of a "random walk", which suggests that all subsequent stock prices in a price series change randomly without reference to the previous stock price [21]. Thus, an increase in the stock price in a day does not imply a further increase or decrease the following day and stock prices for a specific equity are uncorrelated [22]. This means that information is freely available and is immediately reflected in stock prices; then tomorrow's stock price will only be influenced by tomorrow's new information and is independent of today's stock price and information. As a result, uninformed investors buying a diversified portfolio of stocks will achieve the same rate of return as achieved by experts. Burton Malkiel explained in his book, *A Random Walk Down Wall Street*, that a blindfolded chimpanzee throwing darts at the Wall Street Journal could select a portfolio that would perform the same as a portfolio selected by investment experts [21].

Statistical tests are used to test weak form efficiency. These tests include: Auto Correlation Test, Ljung Box Statistics, Runs Tests, Unit Root Tests and Variance Ratio Tests. All of the above tests produce output that indicates whether or not individual stock prices are independent and, therefore, follow a random walk. If the individual stock prices follow a random walk, the market is weak form efficient. If the individual stock prices do not follow a random walk, the market is not weak form efficient, which implies that the market is inefficient [16].

A study on the JSE Top 40 in the late 1900's concluded that the JSE Top 40 share price follows a random walk and is therefore weak form efficient. The study used the variance ratio test and tests of evolving efficiency [23]. A similar study used JSE share prices from 1997 to 2015 and proved that the JSE is weak form efficient [24]. The results are however different when considering a different emerging market, India. The study focused on historical share price from 1991 to 2006 for the Mumbai Stock Exchange and National Stock Exchange of India. The study concluded that the share prices of companies listed on these stock exchanges do not follow a random walk and is therefore not weak form efficient. The results support the common belief

that emerging economies are not efficient [25].

The weak form implies that an investor will not be able to outperform the market and produce excess returns over the market by using technical analysis techniques [7].

2.2.1.2 The semi-strong form

All publicly available data are fully reflected in security prices, thus fundamental analysis will be of no use [20]. θ_t consists of past and current stock information [19].

Different stock markets have different levels of information disclosure. Therefore, different stock markets have different levels of efficiency. There is also no fixed definition of 'public information'. A professional fund investment manager has access to senior management of companies, where private investors are unable to gain access to these managers. It is clear that professional fund managers have an advantage over the public. It is therefore difficult to test whether the market is efficient. Even if the information is publicly available, it does not mean that everyone has read it and fully understands it. The cost of obtaining the information in some cases can outweigh the extra returns obtained from the information [7]. It is extremely difficult to test for semi-strong market efficiency, however a few researchers has attempted to test for this degree of market efficiency. Some of the methods used are considering the effect of dividend announcements, merger announcements, earning announcements and financial statement releases on stock prices [26], [27].

2.2.1.3 The strong form

All information is reflected in security prices, thus insider information will be of no use [20]. θ_t consists of past and current stock information, as well as insider information [19].

It is difficult to test strong form efficiency, as this will require the researcher to have access to information that is not available to the public [7].
Each form of efficiency is gradually less restrictive and includes the information set of the previous form. Thus, if the market is strong efficient, it is also semi-strong form efficient and weak form efficient. In contradiction, if the market is weak form inefficient, it is also semi-strong form inefficient and strong form inefficient [28]. Thus, to prove that an investment market is inefficient, we have to prove that the market is weak form inefficient. Most studies test the weak form or semi-strong form of market efficiency because it is difficult to incorporate private

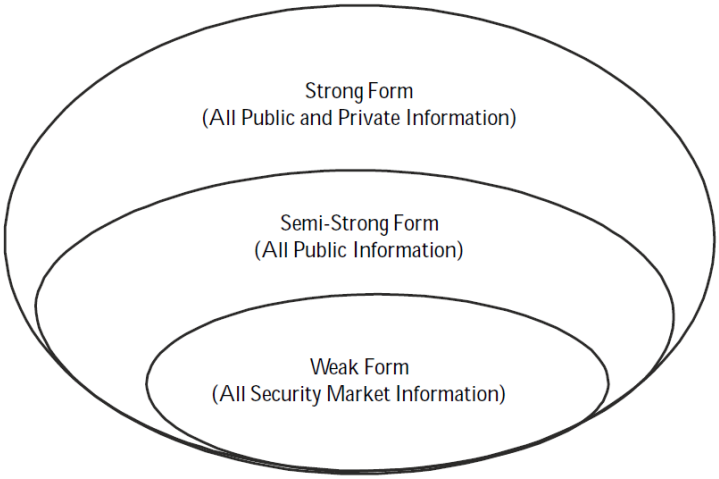


Figure 2.1: Forms of Market Efficiency (From [1]).

information in the information set, θ_t [19].

2.2.2 Evidence Against The Efficient Market Hypothesis

Large amounts of research suggest that markets are efficient. However, there are some evidence that tell a different story. Irrational investing, referred to as 'noise', affects the price of stocks. Irrational investors invest in stocks based on the 'noise' of securities, instead of the information of the stock. These irrational investors create arbitrage opportunities for more experienced investors. When an arbitrage opportunity arises, investors can exploit these opportunities and make a risk-free profit.

There are a lot of market movements, known as market anomalies' that are not explained by the EMH. Some of these anomalies include volume and volatility. If investors are rational, they would not trade too much except when they are in need of liquidity or re-shaping their portfolios. However, there are billions of shares sold every single day with no apparent reason. The EMH states that stock prices should only change when new information has arrived or if there are changes in dividend expectation. However, there are excess volatility in stock markets regularly without the presence of new information [29].

2.3 Behavioural Finance

A large amount of research on Traditional Finance Theory (TFT) has been built on the assumption that investors are rational and aim to maximise returns while minimising investment risk. The foundation of TFT is built on Modern Portfolio Theory (MPT), Capital Assets Pricing

Model (CAPM) and Efficient Market Hypothesis (EMH) [30], [31]. Modern Portfolio Theory enables investors to calculate an asset's expected return, standard deviation and correlation to other assets, which can be used to construct an efficient portfolio of equity and bonds [31], where an efficient portfolio is one in which the expected return has been maximised subject to an acceptable level of risk. Therefore, investors assess the risk and return of all possible investment options to construct an efficient portfolio. The level of risk differs for each investor and therefore each investor's efficient portfolio will differ. In the CAPM, investors hold a well-diversified portfolio of risky assets and a risk-free asset [30]. The EMH assumes that the market is efficient, which means that investment prices reflects all public and private information available about the investment, and thus investors cannot beat the market [32]. However, by using these Traditional Finance Models, investor returns have been disappointing. Consequently, much research is focused on determining why investment returns are disappointing even though the traditional models are theoretically sound. Real investors behave differently from the assumptions made in TFT [30]. Research has shown that the difference between actual returns and expected returns is due to errors made during the decision-making process [33].

The first step in the investment decision-making process is to collect and analyse all available and relevant information in which mental and emotional factors are involved. Investors then make decisions based on the analysed data. When making investment decisions, investors are subject to several cognitive illusions and emotional factors, known as behavioural finance biases [3], [34]. These illusions can be divided into two groups; (i) Prospect Theory; and (ii) Heuristic Decision Process [3].

Two psychologists, Daniel Kahneman and Amos Tversky, criticised the expected utility theory. This theory states that investors aim to maximise expected utility and investors are risk-averse and non-satiated. They invented the Prospect Theory that aims to model real life choices, instead of optimal decisions. Prospect Theory divides the decision-making process into two phases; (i) an editing phase and; (ii) a subsequent evaluation phase. The editing phase consists of analysis and ordering of possible outcomes [2]. During this phase investors are subject to framing effects that refer to the way in which possible options are presented and ordered. After the editing phase, investors move on to the evaluation phase. During this phase investors are observed to show different behavioural patterns when evaluating their decisions [7].

- **Loss Aversion**: Investors are risk-seeking when faced with possible losses and risk-loving when faced with possible gains [35].

- **Regret Aversion**: Occurs when investors fail to take action [35].
- **Mental Accounting**: Investors tend to organise information and events into mental compartments. Each compartment has a different risk appetite. Investors tend to focus on each compartment individually instead of on all the compartments as a whole [35], [36].
- **Self Control**: Investors are always subject to temptation and tend to overspend [3].

Overall, the Prospect Theory suggests that: (i) the effect on losses and gains on utility is relative to some reference point; (ii) investors are more sensitive to losses than to gains of the same amount, therefore the curve is concave for gains and steeper convex for losses; and (iii) investors show diminishing sensitivity to gains and losses [7], [2].

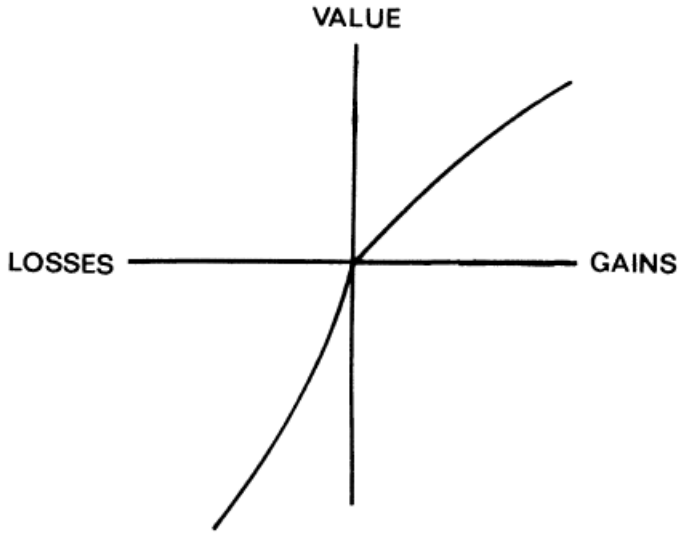


Figure 2.2: Prospect Theory Utility Function (From [2]).

Heuristic Decision Process is the process by which investors develop rules of thumb, through trial and error, which are used to make decisions in uncertain situations. Investors create mental shortcuts that the brain uses to solve complex problems quickly [37]. Heuristics can be applied consciously and unconsciously [38]. Heuristic Decision Process includes the following factors:

- **Representativeness**: A situation where a decision is made based on what the situation looks like instead of a detailed analysis of the problem [35].
- **Overconfidence**: Investors overestimate their abilities to identify investments that will offer winnings [35].
- **Anchoring**: A strong tendency that investors have to a prior belief, whether it is true or not, that is used as a reference point for upcoming decisions [34].

- **Gamblers' Fallacy**: Investors believe that an event is less likely to occur if the event has occurred recently, even if it is known that events are independent [39].
- **Availability bias**: Investors are biased by information that is easy to remember and recall. Investors form opinions based on information that is easily available to them [34].

Investors are not subject to all forms of cognitive illusions simultaneously. They can also be influenced by different cognitive illusions in different situations. These cognitive illusions lead to investors receiving a lower actual investment return than expected. The difference between the actual investment return, also known as investor return, and the expected investment return is the behaviour gap. Expected investment returns can be obtained through following a buy and hold investment strategy [40].

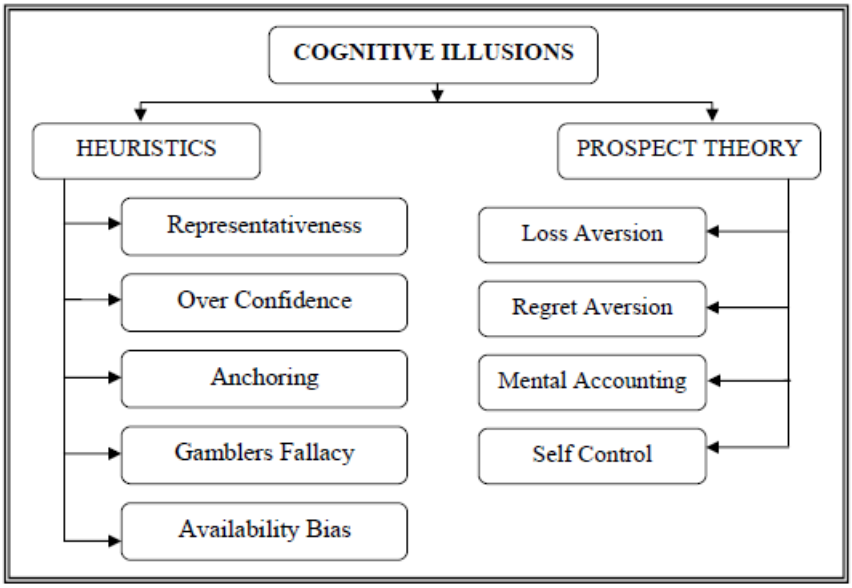


Figure 2.3: Division of Behavioural Finance cognitive illusions (From [3]).

Overconfidence leads to excessive trading. A study on 78 000 United States household investors have shown that investors who change their investments frequently earned 7.1% less return than investors that followed a buy and hold investment approach [41]. Investors underperform by 1.08% due to active trading and cash flow mistiming in comparison with investors that followed a buy and hold strategy. An investor in a U.S. Mutual Fund Database underperforms the buy and hold strategy by 0.135% per month and on average 1.62% per annum [40].

When constructing an investment portfolio, investors are faced with thousands of investment options to choose from. It is impossible for individual investors to consider all possible invest-

ments; therefore, they tend to choose from a set of investments that have caught their attention. It has been found that investors are more likely to buy stock that they owned in the past or stocks that are in the news [42]. The simplest form of learning is to repeat behaviour that brought you pleasure and avoid behaviour that brought you pain. This is known as reinforcement learning. Investors over-extrapolate from their past personal returns when deciding on an appropriate savings plan and when buying stock [42], [43]. Investors tend to buy a specific stock if they had profitable experience with the stock and avoid stock that was unprofitable in the past. They expect that the previous experience will be repeated in the future. A study on 665 533 individual investors showed that investors were twice as likely to buy a stock if they made a profit from selling it in the previous year [42]. However, there is limited evidence that past performance influences current and future performance of stocks [44].

2.4 The Adaptive Market Hypothesis

The Adaptive Market Hypothesis (AMH) was developed by a professor from MIT, Andrew Lo, in 2004. Lo suggested that the EMH and Behavioural Finance are both correct and do not have to be two conflicting ideas. Under the AMH, profits generated from trading strategies are not fixed and tend to move in cycles in response to changes in business conditions and number of other investors entering and exiting the market [45], [46].

The AMH states that the profitability of investment strategies decreases for a while and then returns to being profitable again. Therefore, market efficiency is not an "all-or-nothing" situation. It is rather a continuously changing state that varies across different markets [47].

A study tested the AMH theory on the S&P 500, FTSE 100, NIKKEI 225 and EURO STOXX 50. The study tested whether stock returns are predictable using daily data from 1990 to 2014. The study concluded that the predictability of returns varied over time and across markets which is consistent with AMH [48]. Another study on two stock indices in Tokyo (TOPIX and TSE2) from 1961 to 2015 showed that market efficiency varies over time for both indices and that the level of market efficiency differs between the two indices. The results from this study are once again consistent with the AMH [49].

2.5 Investment Management

Most investors aim to make profits from investments [50]. Two main strategies used by investors to make profits are active and passive investment management. The discussion over the performance of active investment management and passive investment management has interested investors and academics for decades [51].

Passive investment strategies are designed to deliver a return of a market index or a benchmark portfolio, such as the S&P500 index [52]. These strategies are rule-based investing strategies. The passive investor tracks an index by investing fully or partially in an index. A full replication of an index would include investing in all of the indices' constituent stocks in line with their proportions in the index. Alternatively, a partial replication of an index would include investing in a representative sample of the index [53], [54]. Passive investment strategies require no trading, hence they are buy and hold strategies. When the index composition changes, passive investment managers should change the composition of their investments as well [54]. Passive investors invest under the hypothesis that markets are efficient and that a long-term buy and hold strategy will generate the required return for a specific financial goal. These investors allocate a fixed percentage to equities, regardless of the performance of equities. Passive investment funds are attractive because they are diversified, tax efficient and have low transaction costs [54],[55].

On the other hand, active managers aim to outperform indices and benchmark portfolios by investing in undervalued stocks. Active managers believe that stocks do not fully reflect all available information, hence markets are not efficient [52]. Active strategies give portfolio managers the discretion to select stocks based on their research. Active investment managers or investors use fundamental analysis and technical analysis techniques to help them select stocks.

There are two approaches to analysing stocks. The first approach is a top down approach. This approach first analyses the general economy and then the sectors and companies inside it. The second approach is the bottom up approach. This approach first analyses the particular company and then the general market [6]. The two most used active strategies, fundamental analysis and technical analysis, is discussed in the next sections.

2.6 Fundamental Analysis

Fundamental analysis examines a company's stock price based on current and past financial reports and accounting data. Fundamental analysis uses financial reports, political data and economic data to assign an intrinsic value to a company. The basic financial statements used include the balance sheet, income statement, cash flow statement and notes to financial statements. The intrinsic value helps to identify whether the stock price is fair, overpriced or underpriced [6],[56]. This method focuses on the company rather than stock price movements [57]. Companies are strongly influenced by the economic state of the industry. It is therefore important to compare the financial indicators to those of peer companies, *i.e.* companies that perform the same activity or compete in the same markets as the company considered [6],[21]. Investing using the intrinsic value of a company is known as value investing [58].

The intrinsic value of a company can be calculated using the following methods:

1. **Discounted cashflow valuation**: The value of the share is equal to the discounted value of all future cashflows. The cashflows include dividends for stocks. Other cashflows such as interest payments and after-tax cashflows are used for bonds and projects [4].

2. **Dividend discount models**: Calculates the value of the ordinary share by discounting back the future dividend stream. If the dividend discount model is higher than the current price at which the share is trading, then the share is undervalued [59]. The model assumes that dividends are paid annually and that the first dividend is received one year after the purchase of the share [4].

3. **Relative valuation**: The value of a share is derived from other share prices of other companies in the same industry. The earnings, cashflows, book value and revenues of the companies are compared [4].

4. **Value-added methods**: There are two types of value-added methods, namely economic value-added (EVA) and market value-added (MVA). EVA is the profit earned by the company over its cost of capital. MVA is the difference between the current market value of the share and the equity capital provided by shareholders [4], [60].

The following factors influence the intrinsic value of a company [13]:

- Level of earnings and profitability;
- Dividend payout;

- Growth of earnings;
- Volatility of the share price;
- Potential company growth; and
- Company management.

The intrinsic value is determined by financial statements and financial indicators of the company, as well as macroeconomic factors. The financial statements and financial indicators are discussed first, followed by a discussion on the macroeconomic factors.

2.6.1 Financial Statements and Financial Indicators

The basic financial statements include the balance sheet, income statement, cash flow statement and notes to financial statements. When considering financial indicators, it is important to choose peer groups as a benchmark to compare the financial indicators of the company. The peer group should include companies that are in the same industry as the company studied and perform the same activity. A few financial ratios are discussed below; there are many more to consider [6].

Liquidity Ratios

Liquidity refers to the ease with which an asset can be converted to cash. Assets that can converted quickly to cash are highly liquid assets, and vice versa. Current assets are highly liquid assets that can be converted to cash in less than a year. Current liabilities refer to debts that are payable within the next year [61]. Liquidity ratios measure the company's ability to meet their obligations in the short term, and therefore avoid insolvency [6].

Table 2.1: Liquidity Ratios (From [6])

Current Ratio	$\frac{\text{Current Assets}}{\text{Current Liabilities}}$
Quick Ratio	$\frac{\text{Current Assets} - \text{Inventory}}{\text{Current Liabilities}}$
Cash Ratio	$\frac{\text{Cash}}{\text{Current Liabilities}}$

Financial Leverage Ratios

Financial leverage ratios measure a company's capital structure, therefore the number of assets financed by shareholders and debt holders [6].

Table 2.2: Financial Leverage Ratios (From [6])

Debt Ratio	$\frac{\text{Total Liabilities}}{\text{Total Assets}}$
Debt to Equity Ratio	$\frac{\text{Total Debt}}{\text{Total Equity}}$
Long-term Debt Ratio	$\frac{\text{Long-term Debt}}{\text{Long-term Debt+Total Equity}}$

Asset Turnover Ratios

Asset turnover ratios measure the efficiency of a company in managing its assets [6].

Table 2.3: Asset Turnover Ratios (From [6])

Total Asset Turnover	$\frac{\text{Sales}}{\text{Total Assets}}$
Inventory Turnover	$\frac{\text{Cost of Goods Sold}}{\text{Inventory}}$

Market Value Ratios

Market value ratios measure the value of a share on the market. [6].

Table 2.4: Market Value Ratios (From [6])

Price-Earnings Ratio	$\frac{\text{Price per Share}}{\text{Earnings per Share}}$
Earnings per Share	$\frac{\text{Net Income–Dividend on Preferred Stocks}}{\text{Average Outstanding Shares}}$
Market to Book Ration	$\frac{\text{Market Value per Share}}{\text{Book Value per Share}}$

2.6.2 Macroeconomic Factors

Companies are affected by the global economic situation. Therefore fundamental analysis must also look at the environment in which the company operates. Some sectors are more sensitive to the state of the economy than others. The key macroeconomic variables influencing stock prices include:

Gross Domestic Product (GDP) - The total of final goods and services produced in a country, within a given period of time. Real GDP takes the nominal GDP and inflation into account. The GDP gives a snapshot of the success or strength of a country.

Unemployment Rate - The percentage of people that are unemployed when looking at the total number of people that are working-age citizens.

Interest Rates - When interest rates increase, the present value of future dividends decreases. Higher interest rates also lead to lower economic activity. A decrease in interest rates leads to more investment in equity funds due to low interest earned on debt securities.

Budget Deficit - The difference between government spending and revenue. An increase in the budget deficit mainly influences the capital market.

Inflation - Inflation is a rise in the general price level. Inflation is usually measured by the consumer price index (CPI). The CPI is the average change in price of the consumers' goods basket and services in a certain time period [6].

There are three main drawbacks of fundamental analysis: firstly, information received may be incorrect. Analysts receive a large amount of fundamental information and some critics suggest that the returns made from valid news is cancelled out by losses made from bad news. Secondly, the analyst may make an incorrect estimate of the intrinsic value even if the information given is correct. Lastly, even if the information is correct and the estimated value is correct, the stock bought may still fall [8].

In the next section, the Dow Theory which led to the use of technical analysis is discussed.

2.7 Dow Theory

In the late 1800s, Charles Dow developed the "Industrial Average" of 12 blue-chip stocks and the "Rail Average" of 20 railroad enterprises. These averages are known as the Dow Jones Industrial Average and the Dow Jones Transportation Average respectively. The Dow Theory is a result of articles published at the start of the 1900s by Charles Dow in the Wall Street Journal. Charles Dow believed that stock market conditions were a reasonable measure for general business conditions. The theory was not originally intended for forecasting stock prices. However, the work from later researchers showed the usefulness of the theory in predicting stock prices. The Dow Theory consists of six assumptions [62].

2.7.1 The Six Assumptions

2.7.1.1 The Averages Discount Everything

Stock prices reflect all available and relevant information about the stock. When new information becomes available the information is spread quickly between investors and the stock price is adjusted accordingly. When this is the case there is no lag in implementing new information in the stock price. Similarly, the market averages also quickly reflect the new information [62].

2.7.1.2 The Market Consists of Three Trends

There are always three forces affecting the stock market: primary trends, secondary trends and minor trends.

The primary trend lasts the longest of all the trends. The trend lasts at least one year. The trend can either be a rising or a falling trend. When the stock price is rising, there is a bullish trend. On the other hand, when the stock price is falling, there is a bearish trend. The primary trend is up if the market is reaching consecutive higher highs and higher lows. In contrast, the primary trend is downward if the market is reaching consecutive lower highs and lower lows.

Within the primary trend, there are secondary trends. These trends last from one to three months. Within the secondary trend, there are minor trends. These trends usually last from a few days to three weeks. Both secondary trends and minor trends can be rising (bullish) or falling (bearish) [62].

2.7.1.3 Primary Trends Have Three Phases

In the first phase, informed investors buy aggressively with the expectation that the market will recover and grow in the long-term. Informed investors know that markets will definitely turn around. These investors buy aggressively from uninformed, stressed investors.

In the second phase, there is increasing corporate earnings and improved economic decisions. In this phase the stock will begin to accumulate. This means that investors are willing to buy stocks on a large scale.

In the third phase, there are record corporate earnings and top market conditions. The general public will now start to buy again, because they think that stock prices will continue to rise.

The informed investors that aggressively bought the stock in phase one will now begin to sell their stock, because they predict a downturn in the market [62].

2.7.1.4 The Averages Must Confirm Each Other

The trend is only valid when the Industrials and the Transports both have the same trend and confirm each other. Therefore the one trend must confirm the other trend [62].

2.7.1.5 The Volume Confirms the Trend

The volume should increase in the same direction as the primary trend. If the primary trend is up, the volume should increase when the market increases. If the primary trend is down, the volume should decrease when the market declines [62].

2.7.1.6 The Trend Remains Intact Until It Gives a Definite Reversal Signal

The trend will remain up while there is a series of higher highs and higher lows. When there is at least one lower high or one lower low, the trend is reversed. On the contrary, the trend will remain down while there is a series of lower highs and lowers lows. When there is at least one higher high or one higher low, the trend is reversed [62].

2.8 Technical Analysis

Technical analysis is the study of stock prices with charts in order to make better investment decisions [63]. Which means that stock prices move in trends. Stock market trends are determined by investor attitude to economic factors, political factors and psychological factors. Technical analysis aims is to identify these trends and changes in trends at an early stage [64].

Technical analysis makes the following assumptions:

- Market value is determined by supply and demand;
- Rational and irrational factors affect supply and demand;
- Stock prices move in trends when ignoring minor fluctuations in the market;
- Changes in stock price trends are caused by changes in supply and demand;
- Chart patterns repeat themselves [4].

2.8.1 Price Data

Technical analysis predicts the trend and direction of stock prices through using past data, such as the price and volume [63]. Price data for stocks include the open price, close price, high price and low price over a period. The data is used to produce lines or points on a graph [64].

Open price is the price at the first trade of the period.

High price is the highest price that the security traded for during the period. This is the point where there were more sellers than buyers

Low price is the lowest price that the security traded for during the period. This is the point where there were more buyers than sellers.

Close price is the price at the last trade for the period. The close price is usually used for TA. The relationship between the open and close price is important and shown in candlestick charts.

Volume is the number of shares that were traded during the period. The relationship between volume and prices is important [62].

'The period' referred to above is usually a day, but can be longer or shorter.

2.8.2 Charts

Analysts can analyze data in many different ways. The data can be displayed graphically or numerically. The numerical data is used to create the graphs. Analysts can use the numerical data to try to model and predict future stock data through quantitative and statistical techniques which are discussed in later sections. Most analysts, known as chartists, prefer to use charts. The charts usually show the prices on the y-axis and the time on the x-axis. Analysts using numerical data can use charts too, but it is optional [65]. True chartists do not care about any fundamental information about a company, they only study its stock charts. Many chartists will not read the newspaper or any financial news. The rationale behind charting is that history repeats itself [8]. There are three main chart types used by chartists:

1. **Line charts** are the simplest type of charts used for technical analysis. They are graphs that join together the daily closing prices of stocks. The price is on the y-axis and the time is on the x-axis.

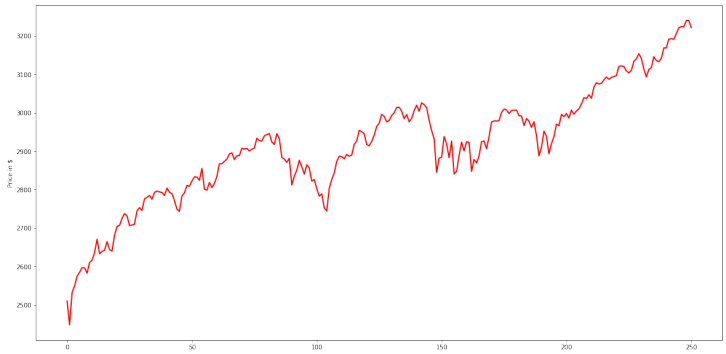


Figure 2.4: Example Line Chart on S&P500 data

2. **Bar charts** shows a bar for each day. The bar includes the open price, the high price, the low price and the closing price.

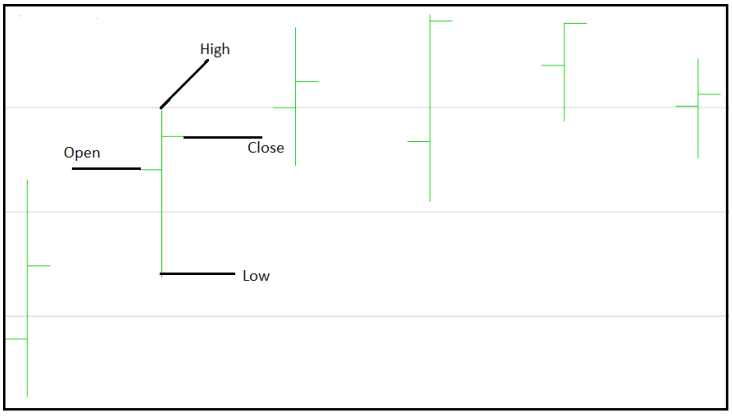


Figure 2.5: Example Bar Chart

3. **Candlestick charts** plot the high and low price for a single day on a vertical line. The open and close prices is plotted in a rectangular block. When the rectangular block is white, the market is in an uptrend and when the rectangular block is black, the market is in a downtrend. The chart can also be shown in green and orange instead of black and white [4].

The first thing chartists look at is trends [8]. The various trends that can be seen on charts are discussed in the next section.

2.8.3 Trends

Charts are used to identify trends of stock price data over the period being analysed. The trend represents the overall direction of the stock prices. The trend in the long term can be completely different from the trend in the short term of the same stock data. Trends can be shown through

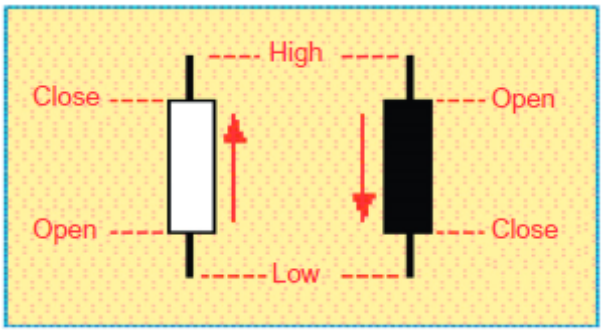


Figure 2.6: Example Candlestick charts (From [4])

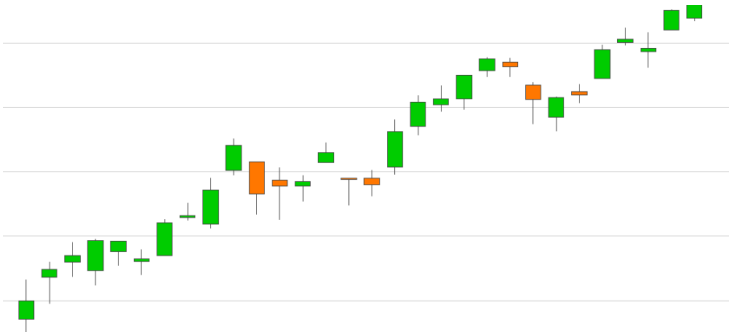


Figure 2.7: Example Candlestick charts

troughs and peaks of the price line. An upward trend is shown through a series of rising peaks and rising troughs and vice versa [4].

2.8.3.1 Trend Reversal

Trend reversal occurs when the trend changes from an upward trend to a downward trend or from a downward trend to an upward trend. If the market has shown an upward trend or a downward trend for a long time, it will take longer for a trend reversal to occur. There are two types of trend reversals. The first type is down reversal which indicates sell signals and occurs after an upward trend. The second type is up reversal which indicates buy signals and occurs after a downward trend [4].

2.8.3.2 Trend Lines

Trend lines are lines drawn to connect peaks or troughs [4]. These lines can indicate buy signals or sell signals when then price line chart crosses through it. There are three different trend line varieties:

1. **External trend lines** are lines that do not cut through the price line chart;
2. **Internal trend lines** are lines that cut through the price line chart frequently;

3. **Curved trend lines** are lines that curve around the price line chart and show the shape of the trend line [5].

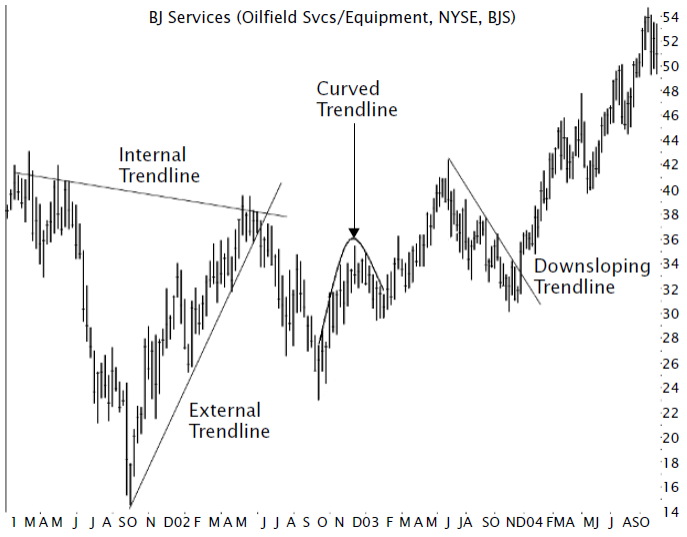


Figure 2.8: Example of a trend line (From [5]).

2.8.3.3 Support and Resistance

Support and resistance zones are when prices stall. A support zone occurs when there is big buying demand that stops the decline in the price. A resistance zone occurs when there is big selling supply that stops the increase in the price [5].

Technical analysis aims to forecast future stock trends through plotting technical indicators on price charts [64]. These indicators are split up into trend indicators, momentum indicators, volatility indicators and volume indicators.

2.8.4 Trend Indicators

2.8.4.1 Moving Averages

Moving Averages (MAs) are the most used technical indicators. They can simply be defined as the sum of the latest stock prices divided by the number of stocks [12]. MAs identify trends by eliminating noise and smoothing the stock data [66]. MAs are simply trend followers; they do not predict or forecast future trends [67]. MAs have been shown to be the most profitable indicators in past studies [68]. There are a lot of different types of MA indicators, but Simple Moving Average and Exponential Moving Average are mostly used in the industry [12]. The

various MA indicators include:

The Simple Moving Average (SMA) gives the same weight to each past stock price, which makes the calculation easy, this is also one of the biggest disadvantages of the SMA indicator. An n-period SMA is defined as:

$$SMA_n = \frac{1}{n}\sum_{i=0}^{n-1} P_{t-i} \tag{2.1}$$

where P_t is the closing price on day t and n is the input period [69].

The Exponential Moving Average (EMA) indicator gives more weight and higher priority to more recent prices. The weight increases exponentially as the past price gets closer to the current time. An n-period EMA is defined as:

$$EMA_n = \sum_{i=0}^{n-1} w_i P_{t-i} \tag{2.2}$$

where w_i is the weight given to past stock price P_{t-i} and $\sum_{i=0}^{n} w_i = 1$.

The Double Exponential Moving Average (DEMA) produces a curve very close to the actual price chart. This means that curve is more smooth [66].

$$DEMA = 2 \times EMA_n - EMA_m \tag{2.3}$$

where $m = EMA_n$.

The Volume Adjusted Moving Average (VAMA) uses the volume of trade each day as the weighting factor for the closing price of the same day. This means that days with higher trading volume will have more weight.

$$VAMA = \frac{\sum_{i=0}^{n} P_i \times V_i}{\sum_{i=0}^{n} V_i} \tag{2.4}$$

where V_i is the volume of trading day i [66].

For all of the above MA indicators, the trading strategy is as follows: when the closing price line is above the MA line, the market is in an upward trend and the investor should buy. If the closing price line is below the MA line, the market is in a downward trend and the investor

should sell [66], [67].

The Dual Moving Average Crossover (DMAC) uses the crossing points of two MAs [68]. It could be two SMAs or two EMAs, usually a fast MA and a slow MA. The fast MA refers to a MA with a short input period n and the slow MA refers to a MA with a long input period n. If the fast MA crosses over the slow MA, the stock is in an upward trend and the investor should buy stocks. When the fast MA crosses below the slow MA, the stock is in a downward trend and the investor should sell their stocks [67].

2.8.4.2 Average Directional Movement Index

The Average Directional Movement Index (ADX) is used to measure the strength of a trend and not the direction of the trend [62]. To calculate the ADX, the Positive Directional Movement (+DM), the Negative Directional Movement (-DM) and true range should be calculated first. The Directional Movements calculate the daily price movements.

$$+DM = \begin{cases} PH_t - PH_{t-1}, & \left\{ \begin{array}{l} PH_t - PH_{t-1} > 0 \quad \text{and} \\ PH_t - PH_{t-1} > PL_{t-1} - PL_t \end{array} \right\} \\ 0, & \text{otherwise} \end{cases}$$

and

$$-DM = \begin{cases} PL_{t-1} - PL_t, & \left\{ \begin{array}{l} PL_{t-1} - PL_t > 0 \quad \text{and} \\ PL_{t-1} - PL_t > PH_t - PH_{t-1} \end{array} \right\} \\ 0, & \text{otherwise} \end{cases}$$

where PH_t and PL_t are the high and low prices on the same day t respectively and $+DM \geq 0$ and $DM \geq 0$.

The true range is the daily trading ranges. The true range is defined as the maximum of the difference between today's high price (PH_t) and today's low price (PL_t), the difference

between today's high price (PH_t) and yesterday's closing price (P_{t-1}) and the difference between yesterday's closing price (P_{t-1}) and today's low price (PL_t).

$$TR_t = \max\{PH_t - PL_t, PH_t - P_{t-1}, P_{t-1} - PL_t\} \tag{2.5}$$

where $TR_t \geq 0$. The N-day Directional Indicators at time t are calculated by:

$$+DI_N(t) = \frac{\sum_{i=t-N+1}^{t} +DM_i}{\sum_{i=t-N+1}^{t} TR_i} \tag{2.6}$$

and

$$-DI_N(t) = \frac{\sum_{i=t-N+1}^{t} -DM_i}{\sum_{i=t-N+1}^{t} TR_i} \tag{2.7}$$

The Directional Indicators show the upward and downward movements of the stock price as a fraction of the trading range over N days of the stock. Using $+DI$ and $-DI$, the N-day Directional Movement Index (DX) at time t is defined as:

$$DX_N(t) = \left| \frac{(+DI_N(t)) - (-DI_N(t))}{(+DI_N(t)) + (-DI_N(t))} \right| \times 100 \tag{2.8}$$

where DX is a value between 0 and 100. Using DX, the value of ADX can be calculated as:

$$ADX_N(t) = \frac{\sum_{i=t-N+1}^{t} DX_N(i)}{N} \tag{2.9}$$

where ADX is a value between 0 and 100 [70].

2.8.4.3 Trend Detection Index

The Trend Detection Index (TDI) is used to spot when trends begin and end. The usual setting for TDI is 20 days.

$$TDI(20) = AV20 - (\sum AM40 - \sum AM20) \tag{2.10}$$

where

- AV20 = the absolute value of the 20-day momenta of the last 20 days;
- $\sum AM40$ = the total of the last 40 days' 20-day momenta;
- $\sum AM20$ = the total of the last 20 days' 20-day momenta [71].

2.8.4.4 Aroon Indicator

The Aroon Indicator's hypothesis states that the stock is trending up. The indicator consists of an up line and a down line. The formulas are calculated using the standard 14-day time period [72]:

$$\text{Aroon Up} = 100 \times \frac{14 - \text{Days since the 14-day High}}{14} \tag{2.11}$$

$$\text{Aroon Down} = 100 \times \frac{14 - \text{Days since the 14-day Low}}{14} \tag{2.12}$$

$$\text{Aroon Oscillator} = \text{Aroon Up} - \text{Aroon Down} \tag{2.13}$$

2.8.5 Momentum Indicators

Momentum is an indicator of the strength of a trend and how the strength of the trend increases or decreases. The changes in trends and strengths of trends are measured by momentum indicators. These indicators identify when trends move into an overbought or oversold range. These ranges are when reversals of trends are most likely to occur. When the share is overbought, it means that the price went up too fast. This will result in price reversal and prices will move back to the middle ranges. When a share is oversold, it means the price went too low, too fast. This will result is a price reversal and prices will move back to the middle ranges. Momentum oscillators show a clear distinction between overbought, oversold and middle ranges [73]. These indicators include Rate of Change, Moving Average Convergence Divergence, Relative Strength Index, Stochastic Oscillator and Commodity Channel Index.

2.8.5.1 Rate of Change

The Rate of Change (ROC) indicator shows the difference between today's closing price and the closing price x-days ago [62].

$$ROC = \frac{\text{Today's Close} - \text{Close x-days ago}}{\text{Close x-days ago}} \times 100 \tag{2.14}$$

2.8.5.2 Moving Average Convergence Divergence

The Moving Average Convergence Divergence (MACD) was invented by Gerald Appel in the 1970s [74]. The MACD indicator shows the strength of the current trend and changes in trends. The MACD also oscillates around zero [66], [75]. The MACD method uses three EMAs. It is represented as $MACD(k, s, l)$. First we have to calculate the EMA for a short period s and a long period l. The MACD line is calculated by subtracting the long EMA from the short EMA.

$$\text{MACD line} = EMA_s - EMA_l \tag{2.15}$$

where the subscript s and l represent the short EMA and long EMA respectively. The short MA is also known as the fast MA and the long MA is known as the slow MA. Therefore, the MACD line looks at the difference between a fast MA and a slow MA [66], [74].

After calculating the MACD line, the signal line is calculated. This is calculated as the k-day EMA for the MACD line.

A normal setting is $MACD(9, 12, 26)$. This means that the MACD line is calculated as the difference between a 12-day MA and a 26-day MA, and the signal line is calculated as the 9-day MA of the MACD line [66].

2.8.5.3 Relative Strength Index

The Relative Strength Index (RSI) measures the speed of price movements and the change in prices. It also considers when the market is overbought or oversold. The value of the RSI should be between zero and 100. If the value of RSI is greater than 70, the market is overbought. On the other hand, when the value of the RSI is less than 30, the market is oversold. RSI is usually calculated with a delay of 14-days [76].

$$RSI = 100 - \frac{100}{1 + RS} \tag{2.16}$$

where

$$RS = \frac{\text{Average Gain}}{\text{Average Loss}} \tag{2.17}$$

$$\text{Average Gain} = \frac{\sum \text{Gains over the past 14 days}}{14} \tag{2.18}$$

$$\text{Average Loss} = \frac{\sum \text{Loss over the past 14 days}}{14} \tag{2.19}$$

2.8.5.4 Stochastic Oscillator

A Stochastic Oscillator (SO) compares the value of the current closing price to the range prices of the past n trading days. SO is a value between zero and 100. When SO is above 80, the market is overbought and when SO is below 20, the market is oversold [77],[78]. Another option

for trading is above 75 and below 25, for overbought and oversold respectively. [66]. The SO indicator has two lines, %D and %K:

$$\%D(n) = SMA(\%K(n)) \tag{2.20}$$

$$\%K(n) = \frac{P - L_n}{H_n - L_n} \tag{2.21}$$

where P is the most recent closing price, L_n is the lowest price of the past n trading days and H_n is the highest price of the past n trading days. The recommended value of n is 14 days [79].

There are two different ways to calculate buy signals and sell signals for SO. An investor should buy when %K and %D fall below 20 (or 25) and sell when %K and %D rise above 80 (or 75). Another option is to buy when %K rises above %D and sell when %K falls below %D [80].

2.8.5.5 Commodity Channel Index

The Commodity Channel Index (CCI) is used to identify stock trends. When the CCI is above 100, the market is overbought and when the CCI is below -100, the market is oversold.

$$CCI = \frac{TP - ATP}{0.015 \times MD} \tag{2.22}$$

where TP is known as the Typical Price, ATP is known as the Average Typical Price and MD is the Mean Deviation of the ATP. TP is calculated as:

$$TP = \frac{P_t + \mathrm{PH}_t + \mathrm{PLLow}_t}{3} \tag{2.23}$$

where P_t is the closing price for the day, PH_t is the highest price for the day and PL_t is the lowest price for the day [66], [81].

2.8.6 Volatility Indicators

Volatility refers to uncertainty and swings in price movements. It represents the risk involved with investing. When volatility is high, the risk associated with investing is high but so is the possible profit from the investment. Even if the volatility is low, prices can still move up. When tracking a primary trend, high volatility could mean the end of a trend. When tracking secondary trends, high volatility could mean a quick return to the primary trend [73]. Possible volatility indicators include: Average True Range and Bollinger Bands.

2.8.6.1 Average True Range

The Average True Range (ATR) is the moving average of the true range [66]. A high ATR occurs after the markets 'panic' sell their shares and the markets hit bottom. A low ATR occurs during extended sideways periods [62].

The true range is the daily trading ranges. The true range is defined as the maximum of the difference between today's high price (PH_t) and today's low price (PL_t), the difference between today's high price (PH_t) and yesterday's closing price (P_{t-1}) and the difference between yesterday's closing price (P_{t-1}) and today's low price (PL_t).

$$TR_t = \max\{PH_t - PL_t, PH_t - P_{t-1}, P_{t-1} - PL_t\} \tag{2.24}$$

where $TR_t \geq 0$ [70].

The ATR is calculated as [66]:

$$ATR_t = \frac{(n-1) \times ATR_{t-1} + TR_t}{n} \tag{2.25}$$

2.8.6.2 Bollinger Bands

Trading bands are one of the most powerful concepts for trading. These bands do not give an absolute buy or sell signal; they rather suggest that the prices are high or low relative to a basis. Trading bands are lines around the stock price to form an "envelope'. We are interested when the prices get close to the "envelope". Bollinger Bands (BB) build on the concept of trading bands or "envelopes" [82]. BB calculates three lines: one SMA (usually 20 days) and two standard deviation lines, one above and one below the SMA line [83], [82]. The middle band is equal to SMA(20), the upper band is equal to the middle band plus one standard deviation and the lower band is equal to the middle band minus one deviation. The number of deviations can be increased from one to two or three [66].

There are two basic BB methods, namely the volatility breakout method and the squeeze method [84]. In the volatility breakout method, when the stock price is above the upper band, the market is overbought and the investor should sell the stock. If the stock price is below the lower band, the market is oversold and the investor should buy the stock [85]. The squeeze method introduces

another parameter known as the bandwidth, given by:

$$\text{bandwidth} = \frac{\text{upper band} - \text{lower band}}{\text{middle band}}, \tag{2.26}$$

which will generate a sell (buy) signal under two conditions: (1) the price is below the lower (upper) band and (2) the bandwidth drops to its lowest in six months [84].

2.8.7 Volume Indicators

Volume is the number of shares that were traded during the period. The relationship between volume and prices is important [62]. The strength of a trend increases as the volume of a share increases [66].

2.8.7.1 On Balance Volume

On Balance Volume (OBV) is the running total of the daily volume. When the stock price closes higher than the previous day, the day's volume is "up-volume". In contrast, if the stock prices close lower than the previous day, the day's volume is "down-volume". If the volume is "up-volume", the day's volume is added to the running total and vice versa.

If today's close price is higher than yesterday's close price then:

$$OBV_t = OBV_{t-1} + V_t \tag{2.27}$$

If today's close price is lower than yesterday's close price then:

$$OBV_t = OBV_{t-1} - V_t \tag{2.28}$$

If today's close price is equal to yesterday's close price then:

$$OBV_t = OBV_{t-1} \tag{2.29}$$

where OBV_t and OBV_{t-1} is the OBV for time t and time $t-1$ respectively and V_t is the volume at time t [62], [66].

2.8.8 Past Studies on Technical Analysis Techniques

Technical analysis started from Charles Dow. He investigated the prices and averages of the industrial and transportation industries. The Dow Theory originated from further research by William Peter Hamilton. The theory states that markets move in continuing bull and bear

trends, and by charting past price data, primary market movements and trends can be identified [86].

In active trading, TA is the leading method of study deciding on buy, hold and sell strategies. Investors investigate the market by using TA techniques to predict future market trends. There is a big debate about whether TA techniques are efficient. A lot of research has been done on this matter and the results are conflicting. Some of the research shows that TA can outperform the buy and hold strategy, others are not so sure [87].

A paper investigating past studies performed to test the profitability of TA categorised the studies into early studies and modern studies. Early studies showed that TA techniques performed poorly in stock markets. More modern studies showed positive results for TA techniques. Out of the 95 modern studies considered, 56 studies showed positive results, 20 studies showed negative results and 19 studies showed mixed results. The paper also pointed out that the results are dependent on the testing procedures applied, such as data snooping, technical indicators used and the estimation of transaction costs. The paper concludes that there is still a lot of research to be done in this particular field of study [88].

2.8.8.1 Developed Markets

Work on 60 years of trading data, from 1935 to 1994, on the London Stock Exchange FT30 index showed that simple trading rules such as MACD, RSI and trading range break-out produced excess returns over the market in most of the cases. One study showed that the buy and hold strategy exceeded the trading indicator returns from the 1980s. Both of these studies did not take transaction costs into account [9], [10]. A similar study done on the FT30 index from 1935 to 1994 concluded that technical indicators cannot outperform the buy and hold strategy in the presence of transaction costs [11].

A study using nine technical indicators on the S&P 500 from 1950 to 2008 showed that only the DMAC strategy was able to outperform the buy and hold strategy when taking transaction costs into account. The study also implemented a Combined Signal Approach of the nine indicators which showed impressive results. This method proved to create more profitable trading signals [15].

The Australian stock market is found to be weak form inefficient by a study done on the Aus-

tralian All Ordinaries Index. The study investigated the MACD and RSI. It was found that the MACD performed poorly, but the RSI showed potential profit in some periods in the presence of short selling. The study concluded that the RSI performed well in comparison to the buy and hold strategy due to the small number of transactions per year [89].

A study using the Moving Average Oscillator and the Trading Break-out rule on the Hong Kong Stock Exchange from 1985 to 1997 showed that these indicators provided abnormal returns when there are no transaction costs or opportunity costs. When including these costs, the indicators fail to provide positive abnormal returns. The study also split the data into two sub-samples and got the same results as for the whole investigation period [14].

2.8.8.2 Emerging Markets

A study on the stock markets of the BRICS (Brazil, Russia, India, China and South Africa) member nations showed that the use of MAs produced higher returns than the buy and hold strategy for a small portion of the stocks traded. The study looked at data from 2000 to 2016 for South Africa, China and India and data from 2007 to 2016 for Brazil and Russia. The study used an automated system that used the DMAC indicator to produce buy and sell signals [87]. In comparison, a similar study was done on the BRICS member nations and other emerging markets like Argentina and Mexico, from the year 2000 to 2015, using an automated DMAC indicator system. The results also showed that MAs produced higher results than the buy and hold strategy in some of the markets like Brazil, Russia and Argentina. In general, the buy and hold strategy beat the MA strategy for most of the markets [12].

A study on the JSE All Share Index in South Africa over the period of 1988 to 2007 showed that technical indicators outperform the buy and hold strategy, even when considering transaction costs. The excess returns (excluding transaction costs) are 4.6% per annum. The excess returns reduced to 1.5% per annum after considering transaction costs. The study conducted a t-statistic test on the hypothesis that the excess returns generated by technical indicators over the buy and hold strategy are zero. There was not enough evidence to reject the hypothesis at a significance level of 90%. However, the study concluded that technical indicators outperformed the market and that the South African market is inefficient [90].

The buy and hold strategy proved to be more efficient than the MACD indicator when tested

on the FTSE/JSE Top 40 Index. The study was tested on 32 of the 40 companies of the Top 40 index for a ten-year period of 2001 to 2010. The study concluded that the MACD indicator only did well in the years when the share prices are falling. The indicator performed poorly to start with and even more poorly when considering transaction costs up to 0.7%. The MACD indicator also performed better on certain equities than others [13].

TA proved to be more profitable than the buy and hold strategy when tested on the Egyptian stock market from 1998 to 2016. When considering short term (10 days), long term (100 days), bull markets and bear markets, TA outperformed the buy and hold strategy [91].

The AMH suggest that the performance of investment strategies may decline for a while and then become profitable again when market conditions become more favourable to these strategies. This means that market efficiency is not an "all-or-nothing" situation. Market efficiency varies over time and differs from market to market. A study on the Dow Jones Industrial Average (DIJA) stock index over the period of 1928 to 2012 is consistent with the AMH. The study showed that technical analysis indicators' performance are temporary. The study considered market conditions such as: volatility, recession, crisis, illiquidity and uncertainty. When markets are in favour of technical analysis indicators and they perform well, this could spark the interest for technical trading and ultimately profits will return to zero again which is consistent with the EMH [47], [92].

2.8.9 Chapter Summary

The chapter focused on the existing body of research on the EMH and it's assumptions. The EMH assumes that investors are rational and that active investment strategies cannot be used to outperform the market. Behavioural finance contradicts the assumption that investors are rational. Behavioural finance shows that investors are not rational when making investment decisions and different behavioural patterns affect decision making. The chapter also introduced the use of active investment strategies versus passive investment strategies. The active investment strategies, fundamental- and technical analysis, are commonly used techniques by investors to try and outperform the market. The remainder of the chapter focused on past studies done on technical analysis techniques. The results for these studies are mixed and there are limited methodology on how these studies approached the problem. The remainder of the document focuses on the use of technical analysis as an active investment strategy to outperform the market and how to improve the methodology of the previous studies.

Chapter 3

Methodology

3.1 Introduction

There is a big debate about whether an active investment strategy can outperform a passive buy and hold strategy. This leads to the main research question of whether technical analysis techniques can be used to outperform a buy and hold strategy. This chapter will focus on the modelling framework applied to address the research question.

3.2 Research Questions and Objectives

In order to address the problem of whether an active investment strategy using technical analysis techniques can outperform a passive buy and hold strategy, the following research question is asked:

How do you compare the returns of an active technical analysis strategy to the returns of a passive buy and hold strategy?

Due to limited time and data constraints, the research question is tested on four indices. These indices include: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 over the period of 1997 to 2019.

The research question is expanded to the following sub-questions:

1. What is the effect of different transaction costs on the returns produced by the technical indicator strategies and the buy and hold strategy?
2. What is the effect of investing different percentages of the bank account?
3. Do the results change when looking at different indices and combinations of indices?

4. Do the results change when looking at different investment time periods and lengths?

5. Can using alternative methods alter the results produced?

3.3 Overview of the methodology

Figure 3.1 summarises the approach taken to assess the effectiveness of technical analysis techniques.

Figure 3.1: Chapter 3 Outline

Section 3.4 focuses on previous work done by researchers in order to address a similar research question. Section 3.5 discusses the data and how it is analysed and prepared for the modelling steps to follow. Section 3.6 describes the technical indicators used in the model and provides clarification on how to apply these methods to generate buy and sell signals. Sections 3.7 and 3.8 discuss the assumptions made about transaction costs and the risk-free bank account used in the modelling phase. Sections 3.9 to 3.12 explain the approach taken to calculate the returns provided for the buy and hold strategy and the technical indicators. These sections also discuss the various approaches applied to invest using technical indicators.

In the next section, previous work done by researchers will be discussed.

3.4 Previous work

In this section methods used by previous researchers to address a similar research question are discussed. The methodology used in this study is derived from the methodology of the studies discussed below. The methods discussed below are adjusted in order to answer the research question posed in this study.

The first study is on the Finnish stock market over the period 1996 to 2012 [68]. The study concluded that technical analysis strategies outperformed the buy and hold strategy. For this study, one of the most popular technical analysis techniques was used: the Dual Moving Average Crossover (DMAC). This technique is based on the crossing of two moving averages. The

DMAC analysis was tested on a trading portfolio of individual stocks using dividends and closing prices. The DMAC strategy was tested against a buy and hold portfolio that was updated semi-annually according to changes of companies. To prevent data-snooping bias and to avoid forward-looking bias, the data was divided into two 8-year subsequent data sets. Dividends were included since it is particularly important in the context of trading individual stocks. Dividend distribution affects the price of stocks significantly. Dividend payouts received from individual stocks were reinvested in the same stock on the payout day unless the sell signal was received between the ex-dividend day and the payout day. The cash inflows from paid out dividends and sale of stocks were invested in a risk-free asset. When a buy signal is received, the proportion of cash assets invested is determined by the number of assets that have a sell signal and the total number of cash assets available. For example, if there are n sell signals, an amount of $\frac{1}{n} \times$cash assets is invested in the particular stock that generated a buy signal. Restrictions of the study include: tax was ignored, and a low, constant transaction cost of 0.1% per trade was assumed [68].

The second study is on the young and dynamic Vietnamese stock market for the investment period from 01/01/2009 to 01/01/2012 [64]. The study concluded that technical indicators could maximise returns during up-trend periods and minimise losses during down-trend periods. The data used for the study included open prices, close prices, high prices and low prices on a daily basis and trade volumes for 140 stocks listed on Ho Chi Minh Stock Exchange. The buy and hold strategy is used as a benchmark to evaluate the performance of the active strategy. The active strategy traded actively over the three years, and "buy" and "sell" decisions were made continuously based on the "buy" and "sell" signals of three technical indicators: MACD, RSI and DMAC. Each trading cycle begins with a "buy" decision and ends with a "sell" decision. When more than one "sell" signal is seen, only the first signal is used. Therefore only the first "sell" signal that follows the "buy" signal is used. Similarly, if more than one "buy" signal is seen, only the first "buy" signal is used. At the end of the investment period, all stocks were sold. For MACD, the "buy" signal occurs when the MACD line rises above the 9-day period signal line and the "sell" signal occurs when the MACD line falls below the signal line. For MA, the "buy" signal occurs when the 30-day DMAC line crosses over the 120-day MA line and a "sell" signal occurs when the 30-day DMAC line crosses under the 120-day MA line. The RSI indicator used a 14-day period. The "buy" signal occurred when the RSI line fell below 30, and the "sell" signal occurred when the RSI line rose above 70. To ensure the feasibility of the research, all transactions were done by an account in May-Bank Kim Eng Securities Company.

The transaction costs were calculated in accordance with the standards of the security company. The transaction fee was 0.35% of the total transaction value. The returns were calculated as the capital gain (or loss) plus any dividends received. A 0.1% personal income tax applied to the closing price of the stock at the time the "sell" action is done.
The gain or loss for each transaction was calculated by using the following formula:

$$G = \frac{S - B + D}{B} \times 100\% \tag{3.1}$$

where:

- G is the % gain/loss per transaction,
- S is the close price when the stock is sold net of transaction cost and personal tax,
- B is the close price when the stock is bought plus the transaction fee, and
- D is the dividend received during the trading cycle.

Whenever stocks were sold and not reinvested, the excess money was invested in a bank account where interest, equivalent to a non-term deposit's interest, was earned on the money. The excess money earned an interest rate of 0.1% per day.
The total return for each stock over the whole investment period is calculated using the following formula:

$$R = \sum G + (N - n) \times R \tag{3.2}$$

where:

- R is the average % daily gain/loss for the whole investment period,
- G is the % gain/loss per transaction,
- N is the total number of days for the whole investment period,
- n is the total number of non-trading days in the investment period and
- R is 0.01% [64].

3.5 Data preparation and data analysis

The methodology focuses on indices instead of individual shares. Four indices, as well of combinations of these indices, are used to investigate the performance of technical indicators versus a buy and hold strategy:

3.5.1 Indices

The study focuses on four different indices. These indices include two emerging markets (South Africa and India) and two developed markets (USA and London). The indices used are JSE Top 40, NIFTY 50, S&P 500 and FTSE 100. The numbers '40', '50', '500' and '100' represent the number of top companies included in the relevant index. The study aims to incorporate indices with equal market capitalisation in the relevant country. The JSE Top 40 represents roughly 80% of the South African stock market, the NIFTY 50 index represents roughly 65% of the Indian stock market, the FTSE 100 index represents approximately 80% of the London stock exchange and the S&P 500 represents approximately between 70% and 80%. Therefore, even though these indices do not have the same number of companies represented in each index, the market capitalisation for these indices are roughly the same.

3.5.1.1 S&P 500 Index

The S&P 500 Index measures the equity or stock performance of the top 500 largest companies listed on the Unites States Stock Exchange.

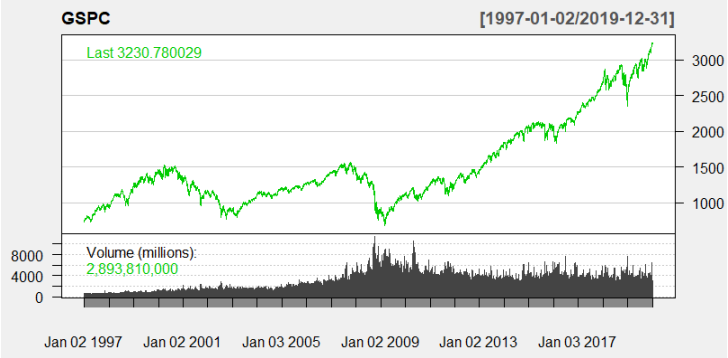


Figure 3.2: Closing Price of S&P 500 from 1997 to 2019

3.5.1.2 JSE Top 40 Index

The JSE Top 40 Index measures the equity of stock performance of the top 40 largest companies listed on the Johannesburg Stock Exchange, or simply JSE, in South Africa.

Figure 3.3: Closing Price of JSE Top 40 from 1997 to 2019

3.5.1.3 NIFTY 50

The NIFTY 50 Index measures the equity of stock performance of the top 50 largest companies listed on the India Stock Exchange.

Figure 3.4: Closing Price of NIFTY 50 from 1997 to 2019

3.5.1.4 FTSE 100

The FTSE 100 Index measures the equity of stock performance of the top 100 largest companies listed on the London Stock Exchange.

3.5.1.5 Combination of Indices

The study also tests the profitability of a combination of indices. The four indices used can be divided into emerging markets (JSE Top 40 and NIFTY 50) and developed markets (S&P 500 and FTSE 100). Three different combinations are used in the study. The first combination starts with an emerging market, the JSE Top 40, and a developed market, the S&P 500. For the second combination, another emerging market, the NIFTY 50 index, is added to the first

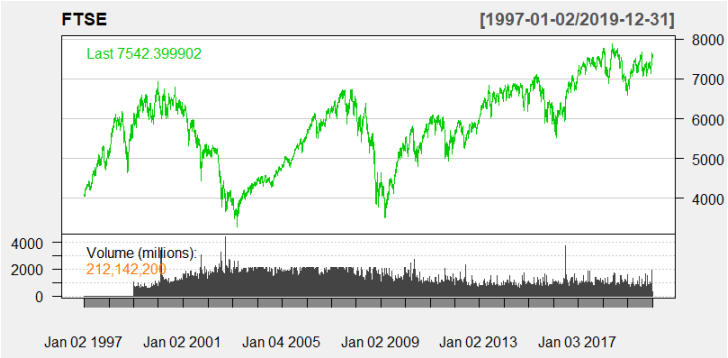


Figure 3.5: Closing Price of FTSE 100 from 1997 to 2019

combination. For the last combination, the remaining developed market, the FTSE 100, is added to the second combination. For the buy and hold strategy, equal amounts of each index is bought. For the active trading strategy, the amount bought in each index is equal to available balance in the bank account divided by the number of buy signals produced at the time of a buy-signal, hence equal amounts of each index that produced a buy signal is bought.

3.5.2 Data Collection

A secondary data collection method is used to obtain the indices' stock prices. The data sets are available through Yahoo Finance [1] and Investing.com [2]. The data consists of the daily open prices, daily high prices, daily low prices, daily closing prices and daily trading volumes. Only the daily closing price is used in the model.

The secondary data collection method is advantageous because it saves time. The main disadvantages are that the data may not be reliable and there may be missing values. [13].

3.5.3 Data Cleaning and Preparation

The first step in any model is to clean the data. It is an extremely important step as it will influence the quality of the models' results. This links directly to the concept: garbage in, garbage out (GIGO). If poor quality data is used as an input, the model will produce poor quality output even if you use a good quality model. Similarly, if good quality data is used as input, the model will produce good quality output.

After downloading the data from Yahoo Finance using the *quantmod* package [3] in R or down-

[1] https://finance.yahoo.com/
[2] https://www.investing.com/
[3] https://bookdown.org/kochiuyu/Technical-Analysis-with-R/quantmod.html

loading the data manually from Investing.com and importing the data into R, the data for each individual index is plotted from 1997 to 2019. It is important to study the data visually first. The plotted data should show a general upward trend over time.

The second step is to check the daily returns of the closing prices. The daily return is calculated as the percentage increase/decrease from the previous closing price to the current closing price. This will also show if there are any outliers in the data. If the daily returns are very big, the specific data points should be investigated further. There were no dates where the returns were very big. It is, however, difficult to spot outliers in share price data as shares are extremely volatile.

Thirdly, the data is checked for any missing values. If a closing price is missing, the closing price from the previous day is used as seen in figure 3.6.

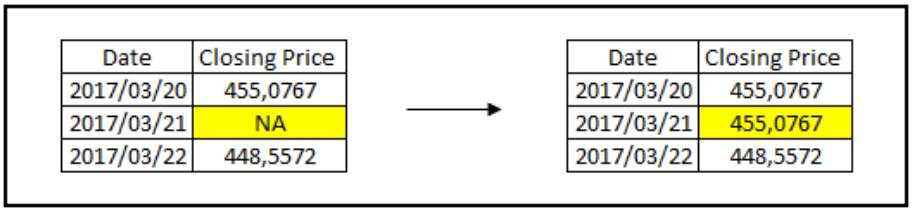


Figure 3.6: Data Cleaning - Missing Values

The last step is to delete any duplicate values. No duplicate values are observed in the data.

3.5.3.1 Combination of Indices

The model is run on individual indices, as well as a combination of indices. When the model is run on a combination of indices, a further data cleaning step is needed. When considering two or more indices, the dates did not match up in the different datasets. This is because indices from different countries other that South Africa are used in the model. The stock exchange is closed on weekends and public holidays. Each country has their own set of public holidays. To correct this problem we assume that all the dates, from both (or more) indices are used when trading. All of the relevant indices dataset dates are merged to ensure that the individual datasets contain all the dates from the other datasets as well. When data is missing for a specific date in the new combined dataset, the data from the previous day is used.

3.5.3.2 Exchange Rates

The closing prices from indices overseas are in the relevant exchange rate. For example, the S&P 500 closing prices are in US dollars. Since the trading takes place from South Africa the closing prices are converted to South African Rand, or simply ZAR. Two different approaches are followed in terms of the exchange rates: the first approach, known as the constant exchange rate method, uses a constant exchange rate throughout the chosen investment period. This constant rate is equal to the exchange rate at the start of the investment period. The constant exchange rate is used to ensure that the change in exchange rates over time does not offset the returns generated from the technical indicators. Hence, this method is used to purely investigate the returns generated from the technical indicators without any external influences.

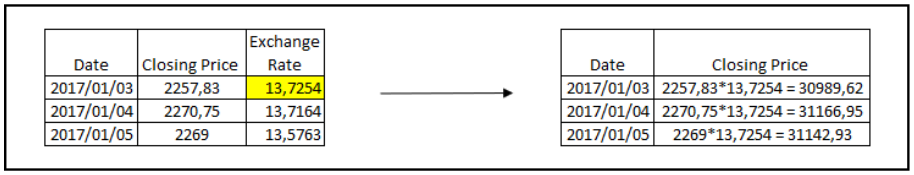


Figure 3.7: Data Cleaning - Constant Exchange Rate Method

In reality, exchange rates will have an effect on the returns if we were to trade from South Africa, in ZAR, in an overseas market. Therefore, the second approach, known as the varying exchange rate method, uses the relevant daily exchange rates for each trading day throughout the investment period.

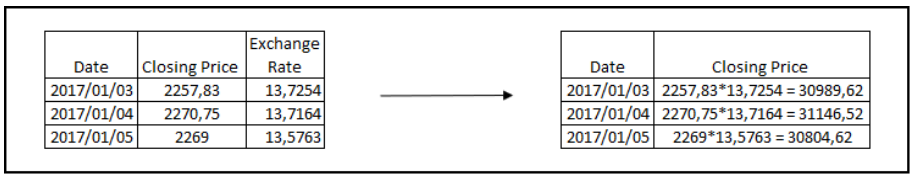
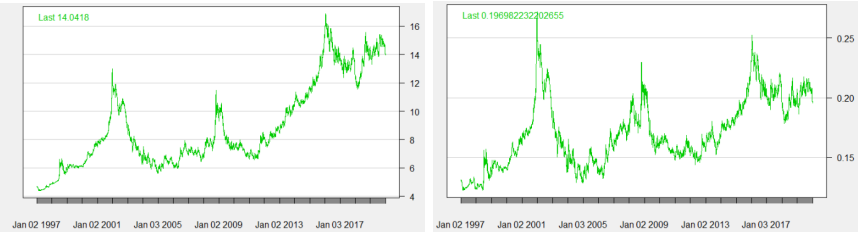


Figure 3.8: Data Cleaning - Varying Exchange Rate Method

For the S&P 500 index, the closing prices are converted from United States Dollar to ZAR. For the NIFTY 50 index, the closing prices are converted from Indian Rupee to ZAR. For the FTSE 100 index, the closing prices are converted from Pounds to ZAR. All of the exchange rate data is obtained from the South African Reserve Bank website [4].

[4]https://www.resbank.co.za/Research/Rates/Pages/SelectedHistoricalExchangeAndInterestRates.aspx



(a) USD to ZAR (b) Rupee to ZAR

(c) Pounds to ZAR

Figure 3.9: Exchange Rates from 1997 to 2019

3.5.4 Investment Periods and Lengths

The model uses daily data from 01/01/1997 to 31/12/2019 for all the different indices. 1997 is the earliest year that has available data for all the four indices. 2020 is not included due to the effects of Covid-19 on the stock market. These effects are excluded because they will skew the results. The data is split up into 3-year, 5-year, 10-year and 20-year periods. A big problem in most previous methodologies is data snooping. The study aims to prevent data snooping biases from occurring by changing the start date and end date for the relevant periods. The use of different periods aims to prevent results being dependent on a particular start point or end point when the market is low or high.

3-Year Periods	
Period A	01/01/1997 - 31/12/1999, 01/01/2000 - 31/12/2002, 01/01/2003 - 31/12/2005, 01/01/2006 - 31/12/2008, 01/01/2009 - 31/12/2011, 01/01/2012 - 31/12/2014, 01/01/2015 - 31/12/2017
Period B	01/01/1998 - 31/12/2000, 01/01/2001 - 31/12/2003, 01/01/2004 - 31/12/2006, 01/01/2007 - 31/12/2009, 01/01/2010 - 31/12/2012, 01/01/2013 - 31/12/2015, 01/01/2016 - 31/12/2018
Period C	01/01/1999 - 31/12/2001, 01/01/2002 - 31/12/2004, 01/01/2005 - 31/12/2007, 01/01/2008 - 31/12/2010, 01/01/2011 - 31/12/2013, 01/01/2014 - 31/12/2016, 01/01/2017 - 31/12/2019
5-Year Periods	
Period A	01/01/1998 - 31/12/2002, 01/01/2003 - 31/12/2007, 01/01/2008 - 31/12/2012, 01/01/2013 - 31/12/2017
Period B	01/01/1999 - 31/12/2003, 01/01/2004 - 31/12/2008, 01/01/2009 - 31/12/2013, 01/01/2014 - 31/12/2018
Period C	01/01/2000 - 31/12/2004, 01/01/2005 - 31/12/2009, 01/01/2010 - 31/12/2014, 01/01/2015 - 31/12/2019
10-Year Periods	
Period A	01/01/1998 - 31/12/2007, 01/01/2008 - 31/12/2017
Period B	01/01/1999 - 31/12/2008, 01/01/2009 - 31/12/2018
Period C	01/01/2000 - 31/12/2009, 01/01/2010 - 31/12/2019
20-Year Periods	
Period A	01/01/1998 - 31/12/2017
Period B	01/01/1999 - 31/12/2018
Period C	01/01/2000 - 31/12/2019

3.6 Trading rules

Technical indicators are used to calculate buy and sell signals. Technical indicators can be calculated quickly using the TTR package in R. R is programming language that provides a wide variety of statistical and graphical techniques [5]. R has been chosen because of the pre-loaded TTR package that calculates the technical indicators and because R is an open source software.

Nine technical indicators are used to calculate the trading signals. Each indicator calculates a trading signal that is used individually to produce returns for the main approach and a combination of these indicators are used for the first alternative approach. These indicators are widely used in the industry and previous research [9], [10], [12], [13], [15], [64], [68], [87], [89] .

3.6.1 Moving Averages

Two types of moving averages are used in the model. SMA and EMA use the same method to calculate the trading signals. When the SMA is greater than the closing price, at a lag of one day, we buy and when the SMA is less than the closing price, at a lag of one day, we sell. Similarly for EMA, if the EMA is greater than the closing price, at a lag of one day, we buy and when the EMA is less than the closing price, at a lag of one day, we sell. It is important to take the signal and closing price from the previous day, because we do not have the closing price of the current day available when we trade during the day.

Algorithm 1: Calculating signals for SMA

1 **if** $SMA_{i-1} > Closing\ Price_{i-1}$ **then**
2 $\quad signal_i = 1$;
3 **else**
4 $\quad signal_i = -1$

The algorithm for EMA is the same as for SMA.

Algorithm 2: Calculating signals for EMA

1 **if** $EMA_{i-1} > Closing\ Price_{i-1}$ **then**
2 $\quad signal_i = 1$;
3 **else**
4 $\quad signal_i = -1$

Figure 3.10 shows an example of buy and sell signals produced by a 30-day SMA indicator on

[5] https://www.r-project.org/

Figure 3.10: Buy and sell signals produced by the 30-day SMA indicator

JSE Top 40 data. The green line represents the closing price data and the blue line represents the 30-day SMA. Not all of the buy and sell signals are shown on the graph.

3.6.2 Dual Moving Average Crossover

There are two DMAC methods, DMAC(SMA) and DMAC(EMA), which also use the same method to calculate the trading signals. For these methods, a short MA and a long MA should be calculated. Periods of 30 days and 90 days are chosen for the short term and long term respectively. When the 30-day SMA crosses over the 120-day SMA, we buy. In contrast, we sell when when the 120-day SMA crosses over the 30-day SMA. We follow a similar approach for DMAC(EMA).

Algorithm 3: Calculating signals for DMAC(SMA)

if $SMA30_{i-1} > SMA120_{i-1}$ **then**
    $signal_i = 1$;
else
    $signal_i = -1$

Figure 3.11 shows an example of buy and sell signals produced by a DMAC(SMA) indicator on JSE Top 40 data. The green line represents the closing price data , the blue line represents the 30-day SMA and the red line represents the 12-day SMA.

3.6.3 Moving Average Convergence Divergence

For the MACD two different approaches can be used to calculate the buy and sell signals. The first approach is known as the zero line crossover - the strategy is to buy when the MACD

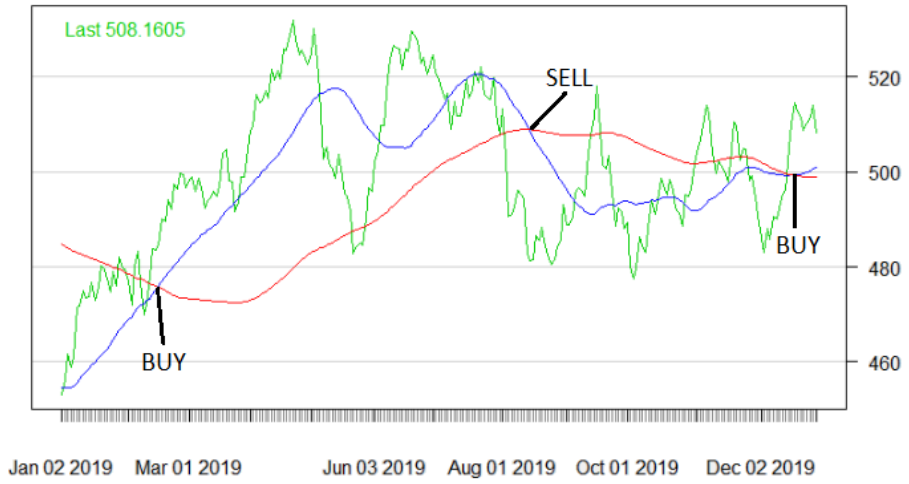


Figure 3.11: Buy and sell signals produced by the DMAC(SMA) indicator

crosses over the zero line and sell when the MACD crosses below the zero line. Another strategy is known as the signal line crossover - this is the method used in the model. When the MACD crosses over the signal line, a buy signal occurs. In contrast, when the MACD crosses below the signal line, a sell signal occurs [66].

Algorithm 4: Calculating signals for MACD

if $MACD_{i-1} > SIGNAL_{i-1}$ **then**
    $signal_i = 1$;
else
    $signal_i = -1$

3.6.4 Rate of Change

The ROC is calculated using the SMA of today minus the SMA of N-periods ago. When the ROC crosses over zero, a buy signal occurs. When the ROC crosses below zero, a sell signal occurs.

Algorithm 5: Calculating signals for ROC

if $ROC_{i-1} > 0$ **then**
    $signal_i = 1$;
else
    $signal_i = -1$

Figure 3.12 shows the buy and sell signals generated by the ROC indicator on JSE Top 40 data. The figure does not show all the buy and sell signals generated.

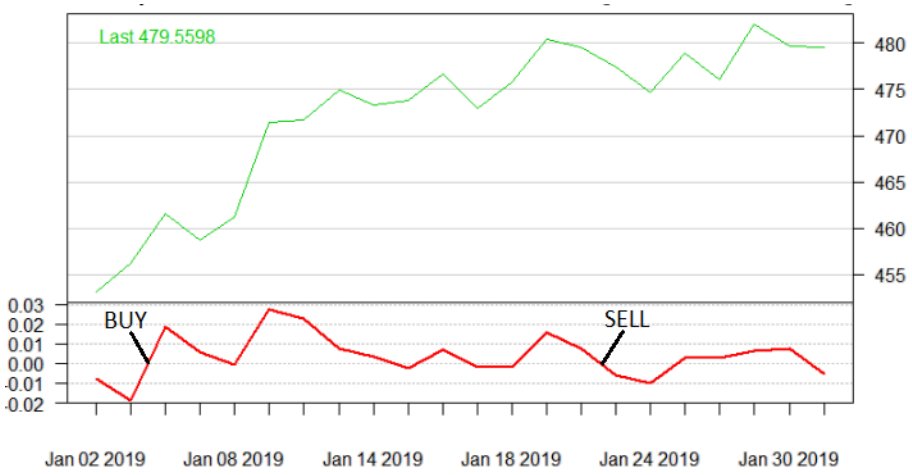


Figure 3.12: Buy and sell signals produced by the ROC indicator

3.6.5 Relative Strength Index

RSI is calculated using the average gains and losses over the last 14 days. When the RSI crosses below 30, a buy signal occurs and when RSI crosses over 70, a sell signal occurs.

Algorithm 6: Calculating signals for RSI

if $RSI_{i-1} < 30$ **then**
    $signal_i = 1$;
else if $RSI_{i-1} > 70$ **then**
    $signal_i = -1$;
else
    $signal_i = 0$

Figure 3.13 shows the buy and sell signals generated by the RSI indicator on JSE Top 40 data. The figure does not show all the buy and sell signals generated.

3.6.6 Bollinger Bands

An upper BB and lower BB are calculated for this method. When the closing price rises above the upper BB, a sell signals occurs. When the closing price crosses below the lower BB, a buy signal occurs.

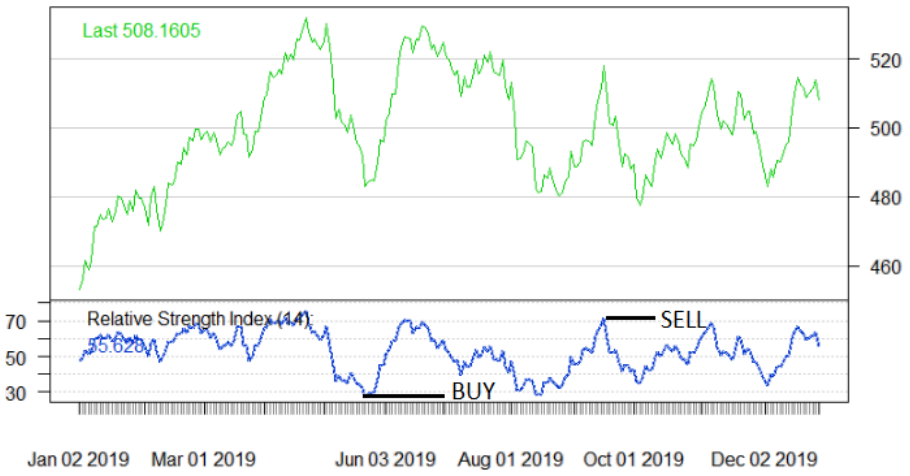


Figure 3.13: Buy and sell signals produced by the RSI indicator

Algorithm 7: Calculating signals for BB

if *Closing Price*$_{i-1}$ < *Lower band*$_{i-1}$ **then**
  $signal_i = 1$;
else if *Closing Price*$_{i-1}$ > *Upper band*$_{i-1}$ **then**
  $signal_i = -1$;
else
  $signal_i = 0$

Figure 3.14 shows the buy and sell signals generated by the BB indicator on JSE Top 40 data. The figure does not show all the buy and sell signals generated.

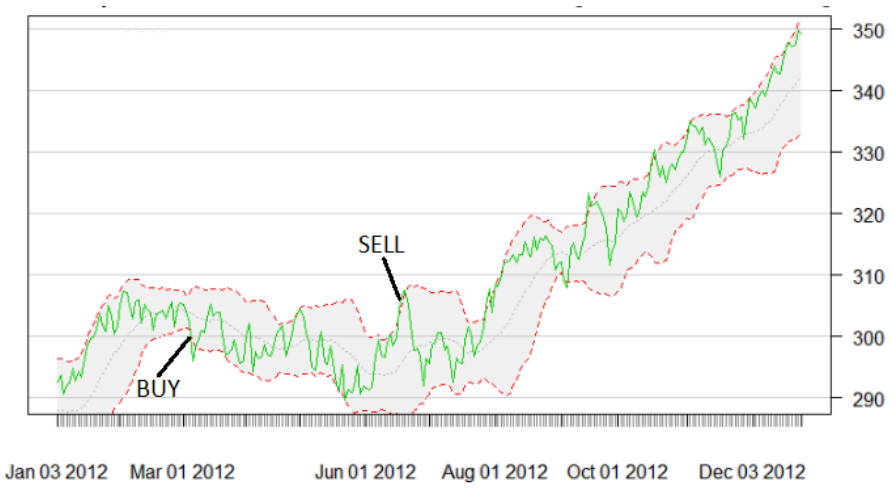


Figure 3.14: Buy and sell signals produced by the BB indicator

3.7 Transaction Costs

Transaction costs are expressed as a percentage of the closing price. For a buy price, the transaction costs are added to the buy price and for a sell price, the transaction costs are deducted.

$$G_{\text{buy}} = P_{\text{buy}} \times (1 + \text{fee}\%) \tag{3.3}$$

$$G_{\text{sell}} = P_{\text{sell}} \times (1 - \text{fee}\%) \tag{3.4}$$

where G_{buy} and G_{sell} represent the closing price after the transaction costs are incorporated and P_{buy} and P_{sell} represent the closing price before the transaction costs are incorporated.

Four different scenarios regarding transaction costs are considered. The first scenario is no transaction costs, or equivalently transaction cost of 0%. The remaining scenarios include transaction costs of 0.15%, 0.25% and 0.35% per transaction. The use of a transaction cost of 0.35% is consistent with past studies [64], [68]. Previous studies showed that technical indicators performed poorly in the presence of transaction costs [13], [90]. The research therefore includes lower transaction costs than 0.35% to test the sensitivity of technical analysis performance to lower transaction costs.

3.8 Risk-Free Investment and Borrowing

The trading takes place from a transaction bank account. The start of the bank account is equal to the price of one share on the first day of trading when only a single index is considered. When considering the different combinations of indices, the start of the bank account is equivalent to the largest share price of the indices considered multiplied by the number of indices considered. This is to ensure that the starting amount of the buy and hold strategy and the active strategy using technical analysis techniques are the same.

$$\text{amount} = \max(P_1, P_2, ..., P_n) \times n \tag{3.5}$$

where $P_1, P_2, ..., P_n$ is the closing price of index $1, 2, ..., n$ respectively at the start of the relevant time frame.

The risk-free bank account earns a daily interest rate of 0.01%, or equivalently 3.7% per annum [64] and the daily overdraft rate of the borrowing facility is 0.02%, or equivalently 7.6% per

annum, which are consistent with the risk-free rate and borrowing rate of South Africa [6].

The stock market is not open over weekends, hence no trading took place over weekends. However, if the money is in the risk-free investment, the trader would earn interest over the weekends.

3.9 Buy and Hold Strategy

For the buy and hold strategy, there are only two transactions. The first transaction is at the start of the investment period and the second transaction is at the end of the investment period. The different time periods and transaction costs scenarios described above are applied for the buy and hold strategy as well. Hence for each period and transaction cost combination, the buy and hold strategy is calculated as a benchmark portfolio.

The buy and hold strategy also makes use of a transaction bank account. The starting bank account amount is equal to the starting bank amount of the active trading strategy as described in the previous section.

At the start of the investment period, an amount of $\frac{1}{n}$ of the bank account at the start of the investment period is invested in each index. If there is only one index, the full bank amount is invested in that index. The number of shares per index is equal to the amount invested per index divided with the G_{buy}.

3.10 Main Approach

For the main approach, the investor has access to a transaction account that offers an interest rate of 0.01% per annum and a borrowing rate of 0.02%, but the investor does not use the overdraft facility. The starting bank account amount is equal to:

$$\text{amount} = \max(P_1, P_2, ..., P_n) \times n \tag{3.6}$$

where $P_1, P_2, ..., P_n$ is the closing price of index $1, 2, ..., n$ respectively at the start of the relevant time frame when investing in multiple indices. The bank account is equivalent to P_i when investing in index i only.

[6] https://www.resbank.co.za/en/home/what-we-do/statistics/key-statistics/current-market-rates

When a buy signal occurs, the investor buys b% of the transaction account amount in the index. Different percentages of b are considered in the study. The different values of b are 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100%.

When a buy signal occurs the number of shares bought is equal to $\frac{b\% \times \text{Bank Amount}}{G_{\text{buy}}}$.

When investing in multiple indices, the proportion of cash invested in the index is determined by the number of buy signals at that point. If there are n buy signals, the amount of cash invested is $\frac{1}{n} \times b\% \times$ Bank Amount.

When the technical indicator shows a sell signal, an amount of $G_{\text{buy}} \times$ number of shares is added to the bank account.

At the end of the investment period, all shares are sold and the money is added to the bank account total.

Each technical indicator has a different portfolio and are individually studied. The use of a combination of indices are suggested in the alternative approach discussed next.

3.11 Alternative Approaches

3.11.1 Multiple Technical Indicators Approach

For the first alternative approach the investor has access to a transaction account that offers an interest rate of 0.01% per annum and a borrowing rate of 0.02%. The starting bank account amount is equal to:

$$\text{amount} = \max(P_1, P_2, ..., P_n) \times n \tag{3.7}$$

where $P_1, P_2, ..., P_n$ is the closing price of index $1, 2, ..., n$ respectively at the start of the relevant time frame when investing in multiple indices. The bank account is equivalent to P_i when investing in index i only.

The investor does not make use of the overdraft facility.

The approach uses three indicators, a trend indicator (EMA), a momentum indicator (MACD(SMA)),

and a volatility indicator (BB). The buy and sell signals are calculated for each individual indicator. The combined signal of the three indicators is the sum of the individual signals. The combined signal is the "new" signal used for trading and the individual signals are ignored.

This strategy employs three different decision rules. For the first decision rule, if the combined signal is more than 0, the investor should buy. Alternatively, if the combined signal is less than 0, the investor should sell. This means that at least one indicator should show a buy signals or at least one indicator should show a sell signal. For the second decision rule, the investor should buy if the combined signal is more than 1 and the investor should sell if the combined signal is less than -1. This means that at least two indicator should show a buy signals or at least two indicator should show a sell signal. For the final decision rule, the investor should buy if the combined signal is more than 2, and the investor should sell if the combined signal is less than -2. This means that all three indicators should show a buy signal before the investor should buy and all three indicators should show a sell signal before the investor should sell.

The approach uses the varying exchange rate method and the JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 combination as the dataset. The combined signal is calculated for each index and the four indices are traded together.

The amount of money bought in each index that shows a buy signal is equivalent to $\frac{1}{n}$, where n is the number of buy signals generated by the four indices.

Trading starts on the first day of the investment period; therefore the data from the previous year is used to calculate signals to ensure that trading can start on the first day. At the end of the period, all shares are sold. When an investor buys, the amount gets deducted from the bank account. When a share is sold the money gets added back into the bank account. At the end of the period, the annual return for the relevant period is calculated.

For this approach, only the twenty-year periods are considered.

3.11.2 Overdraft Facility Approach

For the second alternative approach the investor has access to a transaction account that offers an interest rate of 0.01% per annum and a borrowing rate of 0.02%. The starting bank account amount is equal to:

$$\text{amount} = \max(P_1, P_2, ..., P_n) \times n \tag{3.8}$$

where $P_1, P_2, ..., P_n$ is the closing price of index $1, 2, ..., n$ respectively at the start of the relevant time frame when investing in multiple indices. The bank account is equivalent to P_i when investing in index i only.

The investor makes use of the overdraft facility for this assumption. The investor buys an amount of X in the relevant index when a buy signal occurs.

$$X = \max(P_1, P_2, ..., P_n) \tag{3.9}$$

where $P_1, P_2, ..., P_n$ is the closing price of index $1, 2, ..., n$ respectively at the start of the relevant time frame.

If the amount X is bigger that the amount of money in the transaction account, the overdraft facility is used.

The number of shares for the relevant index is equal to $\frac{X}{G_{\text{buy}}}$

When investing in multiple indices, the amount of cash invested in each is X.

The biggest share amount is used to ensure that a share with a low closing price still adds value to the return. If only 1 share is bought, the shares with low closing prices will add little to no value in the return calculations.

3.12 Return calculation

For each technical indicator, the bank start amount is set equal to:

$$\text{Bank Amount} = \max(P_1, P_2, ..., P_n) \times n \tag{3.10}$$

where $P_1, P_2, ..., P_n$ is the closing price of index $1, 2, ..., n$ respectively at the start of the relevant time frame when investing in multiple indices. The bank account is equivalent to P_i when investing in index i only.

When a buy signal occurs, the number of shares $\times$ G_{buy} is subtracted from the bank amount. When a sell signal occurs, the number of shares $\times$ G_{sell} is added to the bank amount.

At the end of the investment period, all shares are sold immediately and the number of shares $\times$ G_{sell} is added to the bank amount.

The return on a strategy is calculated by looking at the amount of money in the bank at the start of the investment period versus the amount of money in the bank at the end of the investment period. The total return for the whole sub-period is calculated as follow:

$$r = \frac{BS - BE}{BS} \times 100 \tag{3.11}$$

where BS is the bank amount at the start, BE is the bank amount at the end and r is the total percentage return for the investment sub-period. To compare different investment periods, the annual return for each sub-period is calculated as:

$$r_n = (1 + r)^{\frac{1}{n}} - 1 \tag{3.12}$$

where r_n is the annual return for each sub-period and n is the number of years in the investment sub-period. The possible values of n are 3, 5, 10 and 20.

Within each period (A, B and C), the geometric return is calculated as:

$$\text{Return}_j = ((1 + r_1) \times (1 + r_2) \times ... \times (1 + r_n))^{\frac{1}{n}} - 1 \tag{3.13}$$

where Return_j is the annual return for period j, j =A, B, C. $r_1, r_2, ..., r_n$ are the annual returns for each sub-period within a period and n is the number of sub-periods. For the 3-year period, n is 7, for the 5-year period, n is 4, for the 10-year period, n is 2 and for the 20-year period, n is 1. The geometric returns is used because the sub-periods are disjoint periods.

The final arithmetic return for 3 years, 5 years, 10 years and 20 years is:

$$\text{Return}_x = \frac{\sum_{j=1}^{n} \text{Return}_j}{n} \tag{3.14}$$

where Return_x is the final return for the x years period where x can be equal to 3, 5, 10 and 20. An arithmetic return calculation is used to calculate the average return of the different three, five, ten and twenty year strategies respectively. Return_x is the final return showed in the Results Chapter.

Chapter 4

Results

In this chapter, the results obtained from the modelling framework are presented and discussed. The introduction section summarises the key points of the methodology and explains how the results are presented throughout the chapter.

4.1 Introduction

This chapter will focus on the results produced by the model discussed in the methodology chapter. Figure 4.1 summarises the approach taken to present the results.

Figure 4.1: Chapter 4 Outline

Before jumping into the results, the key points of the methodology are summarised. The study considers four individual indices, as well as combinations of these indices. There are two emerging markets and two developing markets. The study starts by applying the trading rules to each index separately and then compares the results to the benchmark portfolio, which is the buy and hold strategy, for the relevant index. After the individual indices are studied, the model examines the effect on the returns when combining the indices and trading multiple indices at once. The model starts with an emerging market, the JSE Top 40 index, and a developed market, the S&P 500 index. The model then trades using the JSE Top 40 index and S&P 500 index simultaneously according to the main approach described in the methodology chapter. The results from the two indices are compared to the buy and hold strategy returns for this

combination. The model then adds another emerging market, the NIFTY 50 index, and repeats the process. Finally, the remaining developed index, FTSE 100, is added to the existing combination of indices and the process is repeated. The study concludes with a combination of JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 traded simultaneously to provided returns for an active technical analysis strategy and a passive buy and hold strategy. Figure 4.2 visually presents the different indices and combinations of indices studied in this paper.

Figure 4.2: The indices and combinations used to calculate returns

The model aims to prevent data snooping biases, therefore different investment period lengths are studied. The possible lengths are three, five, ten and twenty-year periods. To further prevent data snooping, there are three different start and end points chosen for each possible investment period length. The different subperiods are shown in the methodology section. The results are presented for each individual period, denoted by A, B and C, as well as the average returns for the three periods. Figure 4.3 illustrates the results that will be shown for each index and each combination of indices.

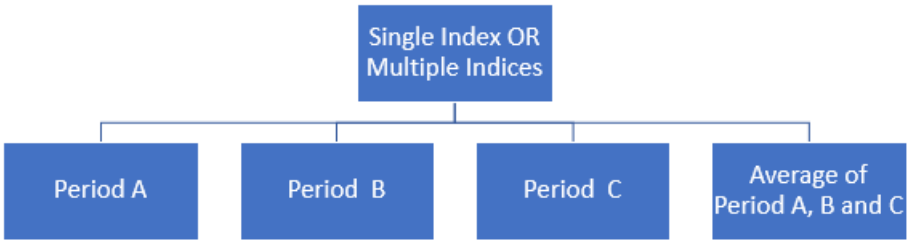


Figure 4.3: The results presented for each individual index and combination of indices

The alternative approaches are discussed next. These include the use of multiple indicators to produce a single buy and sell signal and an overdraft facility approach. Only a few periods are shown for these approaches and they are specified in the relevant sections.

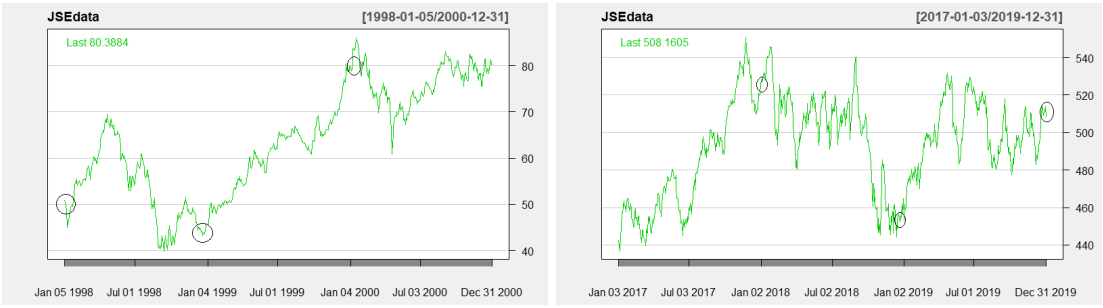
In the next section the data is studied before the results are presented.

4.2 Initial Data Analysis

In this section the data for each index over three different 20-year periods is discussed. The JSE Top 40 index is presented first.

(a) 1998-2017 (b) 1999-2018 (c) 2000-2019

Figure 4.4: JSE Top 40 - Data for 20-year periods



(a) 1998-2000 (b) 2017-2019

Figure 4.5: JSE Top 40 - Data for 20-year period different start points and end points

Figure 4.4 illustrates the data over the 20-year periods for the JSE Top 40. The data shows a general upward trend for all the cases. In figure 4.5 the circles show the different start points and end points for the individual periods. The starting points are varying for the three periods. The highest starting point is in 2000, with the second highest in 1998 and the third highest in 1999. The end points are varying as well. The end point for 2017 is the highest with 2019 second highest and 2018 third highest. From the figures it can be seen that the chosen starting points and end points are substantially different and we therefore expect that the relevant start points and end points will influence our results. To confirm this we look at the buy and hold strategy for the relevant periods. We can see that the buy and hold returns differ slightly for the different start point and end point, but there is not a large difference over the entire period. We follow the same approach for the S&P500 data.

Figure 4.6 illustrates the data over the 20-year periods for the S&P 500. The data shows a

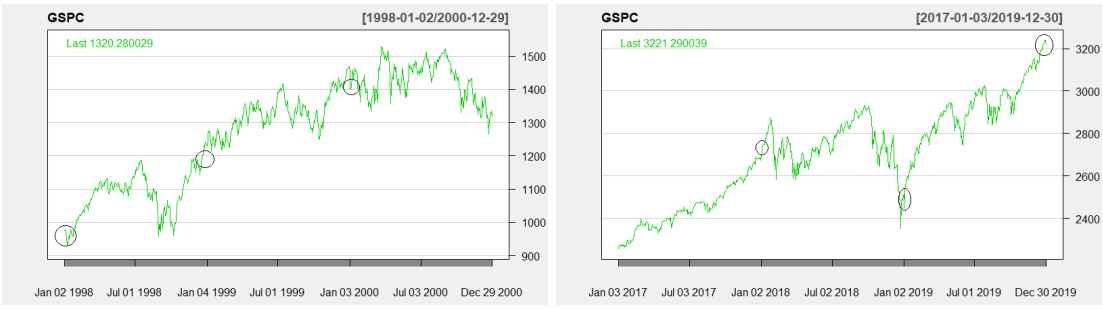
Table 4.1: JSE Top 40 - Returns on Buy and Hold for 20-year periods

Period 1	Period 2	Period 3
12,39%	11,71%	12,20%

(a) 1998-2017 (b) 1999-2018 (c) 2000-2019

Figure 4.6: S&P 500 - Data for 20-year periods

general upward trend for all cases. Figure 4.7 shows the different start points and end points. The starting points are ascending from 1997 to 2000. The end point of 2019 is the highest, with 2018 second highest and 2017 third highest. It can be seen that the chosen start points and end points will influence the returns. To confirm this we will once again look at the buy and hold strategy returns. The returns vary from 4.78% to 6.16% for the buy and hold strategy. This confirms that the start point and end point will influence the returns.



(a) 1998-2000 (b) 2017-2019

Figure 4.7: S&P 500 - Data for 20-year period different start points and end points

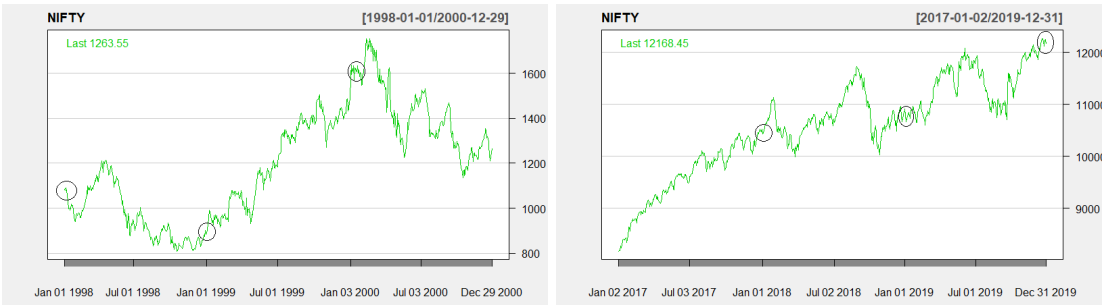
For the NIFTY 50 index, the data again shows an upward trend.

Figure 4.8 illustrates the data over the 20-year periods for the NIFTY 50. The data shows that the highest start point is 2000, with 1998 second highest and 1997 third highest. The end points are ascending with time. We would expect that the returns would vary because of the start points, but the buy and hold returns show that the difference in returns is very similar.

Figure 4.10 illustrates the data over the 20-year periods for the FTSE 100. For this index, the data shows an upward trend with a lot of upward and downward trends. When looking at the start points and end points, the start points are ascending as expected since the data shows an upward trend. But for the end points, the 2018 endpoint is the lowest and 2019 is the highest.

(a) 1998-2017 (b) 1999-2018 (c) 2000-2019

Figure 4.8: NIFTY 50 - Data for 20-year periods

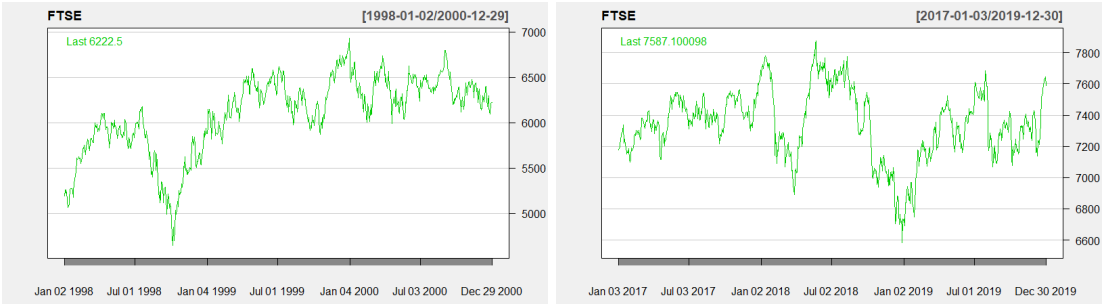


(a) 1998-2000 (b) 2017-2019

Figure 4.9: NIFTY 50 - Data for 20-year period different start points and end points

(a) 1998-2017 (b) 1999-2018 (c) 2000-2019

Figure 4.10: FTSE 100 - Data for 20-year periods



(a) 1998-2000 (b) 2017-2019

Figure 4.11: FTSE 100 - Data for 20-year period different start points and end points

The buy and hold returns for the FTSE index range from 1.31% to 1.98%. The difference is not too big and therefore the chosen start points and end points would not influence the returns a lot.

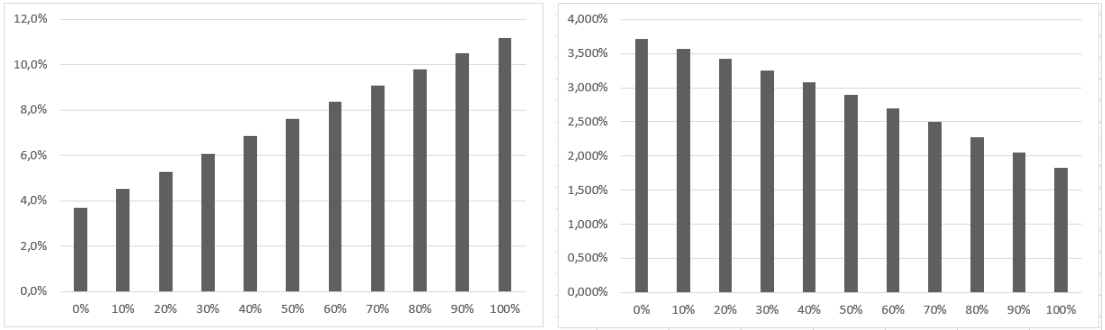
Table 4.2: S&P 500, NIFTY 50 and FTSE 100 - Returns on Buy and Hold for 20-year periods

Index	Period 1	Period 2	Period 3
S&P 500	5,17%	4,79%	6,16%
NIFTY 50	12,05%	12,23%	12,87%
FTSE 100	1,98%	1,31%	1,91%

In general, the effect of the different start points and end points are not very big for these specific indices and investment periods. However, if there was a financial crisis or an event like COVID 19 that influences the stock prices at the start or end of the period, the returns will be heavily influenced. Also, when considering large investments, a small difference in returns can have a big influence. It is best to therefore study the average of these returns to prevent any bias because of the start point or end point. In the next section the returns produced by the technical indicators for the single indices are presented.

4.3 Single Indices

For the main approach the value of b can take on values of 0%,10%,...,90% and 100%. Figure 4.12 shows the effect of investing in different percentages on two single indices.



(a) JSE Top 40 - 3-Years SMA percentage example

(b) S&P500 - 3-Years MACD(EMA) percentage example

Figure 4.12: Percentage examples single indices

For the JSE Top 40, we consider the return for the SMA indicator for the three-year period C. As we increase the percentage invested in the index, the return increases. We would expect the investor to invest 100% when the index is performing well. For the S&P 500, we consider the return for the MACD(EMA) indicator for the three-year period C. As we increase the percentage invested in the index, the return decreases. It would be best to invest the money in the risk-free

bank account when the market performs poorly. In this section we will only consider the 100% scenario, because we want to invest everything if the market performs well. We will not consider the 0% scenario, because then no trading takes place and we only receive the risk-free rate of return. We will now look at the results produced by the single indices and various indicators for $b = 100\%$.

4.3.1 JSE Top 40

For the JSE Top 40 index, all the possible investment period lengths are studied. The results for the three-year, five-year, ten-year and twenty-year periods are similar. Therefore, only the results for the twenty-year period is shown in this section. The rest of the results are presented in Appendix A section A.1.1. All of the tables show the two extreme transaction cost scenarios (0% and 0.35%) next to each other because it represents a no transaction cost scenario and a realistic transaction cost scenario of 0.35% next to each other. Thereafter the rest of the transaction costs scenarios (0.25% and 0.15%) is shown to illustrate whether a lower transaction cost will influence the results and profitability of the technical indicators.

4.3.1.1 Twenty-Year Periods

Table 4.3 summarises the return for each indicator for each period.

For period A: the buy and hold achieved the highest return for all possible transaction cost percentages.

For period B: the SMA indicator outperformed the buy and hold strategy when there are no transaction costs (0%). In the presence of transaction costs, the buy and hold strategy is unbeaten.

For period C: SMA, EMA and BB outperforms the buy and hold strategy (in descending order) when there are no transaction costs. The buy and hold strategy is unbeaten for transaction costs of 0.35% and 0.25%. When lowering the transaction costs to 0.15%, BB outperformed the buy and hold strategy.

For the average returns of period A, B and C: the SMA indicator outperformed the buy and hold strategy when there are no transaction costs (0%). In the presence of transaction costs, the buy and hold strategy is unbeaten.

Table 4.3: JSE Top 40: Summary of period A, B & C returns for twenty years

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,13%	2,85%	5,15%	7,50%
EMA	8,97%	-0,09%	2,42%	4,99%
DMAC(SMA)	11,41%	10,59%	10,82%	11,06%
DMAC(EMA)	10,16%	9,35%	9,58%	9,81%
MACD(SMA)	6,83%	0,37%	2,18%	4,01%
MACD(EMA)	10,20%	2,90%	4,93%	7,01%
ROC	4,56%	-21,58%	-14,86%	-7,57%
RSI	7,95%	7,16%	7,39%	7,61%
BB	11,12%	9,01%	9,61%	10,21%
Buy and Hold	12,39%	12,37%	12,38%	12,38%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	13,04%	4,40%	6,80%	9,25%
EMA	11,19%	1,59%	4,24%	6,97%
DMAC(SMA)	11,22%	10,40%	10,64%	10,87%
DMAC(EMA)	9,58%	8,70%	8,95%	9,20%
MACD(SMA)	4,96%	-1,41%	0,37%	2,18%
MACD(EMA)	8,51%	1,14%	3,20%	5,29%
ROC	4,25%	-22,03%	-15,29%	-7,96%
RSI	6,69%	5,98%	6,18%	6,39%
BB	11,12%	9,12%	9,69%	10,26%
Buy and Hold	12,33%	12,31%	12,32%	12,32%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,94%	4,06%	6,52%	9,04%
EMA	10,81%	1,07%	3,76%	6,52%
DMAC(SMA)	8,38%	7,51%	7,76%	8,01%
DMAC(EMA)	6,83%	5,87%	6,14%	6,42%
MACD(SMA)	3,73%	-2,54%	-0,79%	1,00%
MACD(EMA)	7,39%	0,23%	2,22%	4,26%
ROC	3,14%	-23,02%	-16,31%	-9,01%
RSI	7,51%	6,76%	6,98%	7,19%
BB	10,73%	8,65%	9,24%	9,83%
Buy and Hold	9,71%	9,69%	9,70%	9,71%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,37%	3,77%	6,16%	8,60%
EMA	10,32%	0,86%	3,47%	6,16%
DMAC(SMA)	10,34%	9,50%	9,74%	9,98%
DMAC(EMA)	8,86%	7,97%	8,23%	8,48%
MACD(SMA)	5,17%	-1,19%	0,59%	2,40%
MACD(EMA)	8,70%	1,42%	3,45%	5,52%
ROC	3,98%	-22,21%	-15,49%	-8,18%
RSI	7,38%	6,64%	6,85%	7,06%
BB	10,99%	8,93%	9,51%	10,10%
Buy and Hold	11,48%	11,46%	11,47%	11,47%

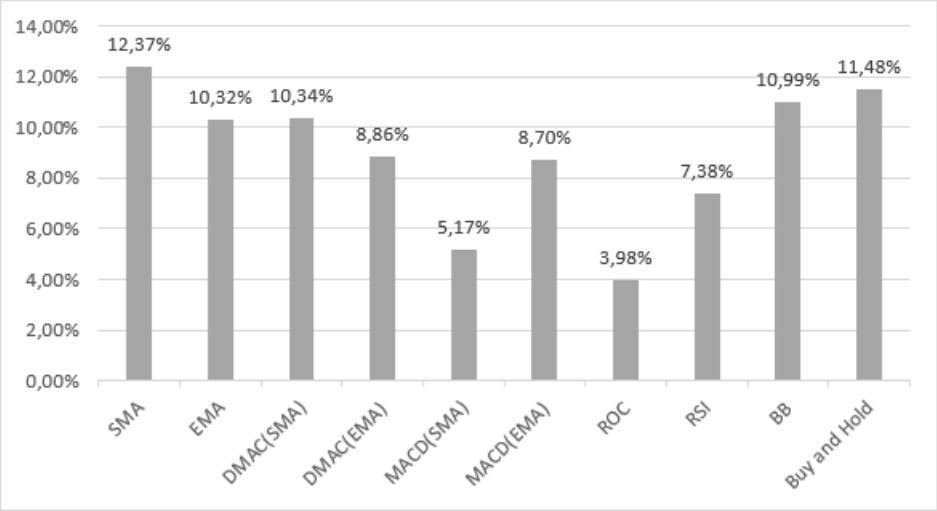


Figure 4.13: JSE Top 40 - Average returns on the twenty-year data for no transaction fees

4.3.2 S&P 500

The S&P 500 index will now be considered. The constant exchange rate scenario and varying exchange rate scenario are presented. The results are similar across the different investment period lengths. Therefore, only the twenty-year periods are shown in this chapter and the rest of the results are discussed in Appendix A section A.1.2.

Figure 4.14: JSE Top 40 - Average returns on the twenty-year data for all transaction fees

4.3.2.1 Twenty-Year Periods

Constant Exchange Rate

Table 4.4 summarises the returns for each of the three periods.

Table 4.4: S&P 500: Summary of period A, B & C returns for twenty years (Constant Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,94%	-1,17%	1,35%	3,94%
EMA	7,57%	-2,06%	0,60%	3,33%
DMAC(SMA)	4,78%	3,83%	4,10%	4,38%
DMAC(EMA)	6,55%	5,84%	6,04%	6,24%
MACD(SMA)	4,71%	-1,65%	0,13%	1,93%
MACD(EMA)	1,80%	-5,38%	-3,38%	-1,34%
ROC	1,39%	-25,04%	-18,28%	-10,92%
RSI	5,39%	4,81%	4,97%	5,14%
BB	5,34%	3,54%	4,05%	4,56%
Buy and Hold	5,17%	5,15%	5,16%	5,17%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,03%	-2,00%	0,50%	3,06%
EMA	6,72%	-2,73%	-0,12%	2,56%
DMAC(SMA)	4,22%	3,27%	3,54%	3,81%
DMAC(EMA)	6,06%	5,40%	5,59%	5,78%
MACD(SMA)	4,17%	-2,19%	-0,41%	1,40%
MACD(EMA)	1,16%	-6,08%	-4,07%	-2,01%
ROC	1,14%	-25,07%	-18,37%	-11,06%
RSI	4,94%	4,32%	4,50%	4,67%
BB	4,13%	2,35%	2,86%	3,36%
Buy and Hold	3,59%	3,57%	3,58%	3,58%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,28%	-2,28%	0,09%	2,52%
EMA	5,92%	-3,09%	-0,60%	1,96%
DMAC(SMA)	4,46%	3,52%	3,79%	4,06%
DMAC(EMA)	6,28%	5,61%	5,80%	5,99%
MACD(SMA)	4,56%	-1,75%	0,01%	1,81%
MACD(EMA)	2,38%	-4,88%	-2,86%	-0,80%
ROC	2,13%	-24,47%	-17,67%	-10,26%
RSI	5,76%	5,09%	5,28%	5,47%
BB	4,73%	2,95%	3,46%	3,97%
Buy and Hold	4,05%	4,03%	4,04%	4,05%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,09%	-1,82%	0,65%	3,18%
EMA	6,74%	-2,63%	-0,04%	2,62%
DMAC(SMA)	4,49%	3,54%	3,81%	4,08%
DMAC(EMA)	6,30%	5,62%	5,81%	6,00%
MACD(SMA)	4,48%	-1,86%	-0,09%	1,71%
MACD(EMA)	1,78%	-5,44%	-3,43%	-1,38%
ROC	1,55%	-24,86%	-18,11%	-10,75%
RSI	5,36%	4,74%	4,92%	5,10%
BB	4,73%	2,95%	3,46%	3,96%
Buy and Hold	4,27%	4,25%	4,26%	4,26%

For period A: there are five indicators that outperform the buy and hold strategy. SMA produced the highest return. EMA, DMAC(EMA), RSI and BB also outperformed the buy and hold strategy. When we consider transaction costs, only the DMAC(EMA) outperformed the buy and hold strategy. The RSI indicator produced the closest return to the buy and hold strategy of the remaining indicators in the presence of transaction costs.

For period B and C: the returns are lower than for period A, with all but two indicators (MACD(EMA) and ROC) outperforming the buy and hold strategy in the absence of transaction costs. When considering transaction costs the DMAC(EMA) indicator and RSI indicator are the only indicators to outperform the buy and hold strategy for transaction cost percentage. For a transaction cost of 0.15%, the DMAC(SMA) also outperformed the buy and hold strategy.

For the average returns of period A, B and C: the returns are lower than for period A, with all but two indicators (MACD(EMA) and ROC) outperforming the buy and hold strategy in the absence of transaction costs. When considering transaction costs the DMAC(EMA) indicator and RSI indicator are the only indicators to outperform the buy and hold strategy for transaction cost percentage.

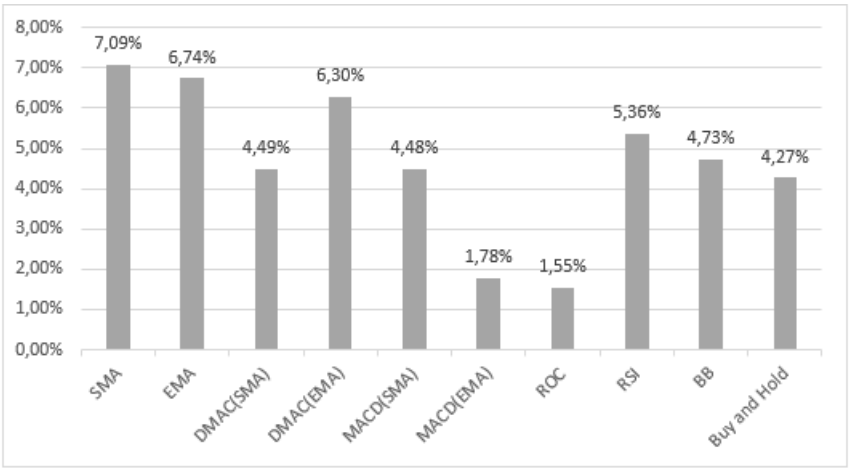


Figure 4.15: S&P 500 - Average returns on the twenty-year data for no transaction fees (Constant Exchange Rates)

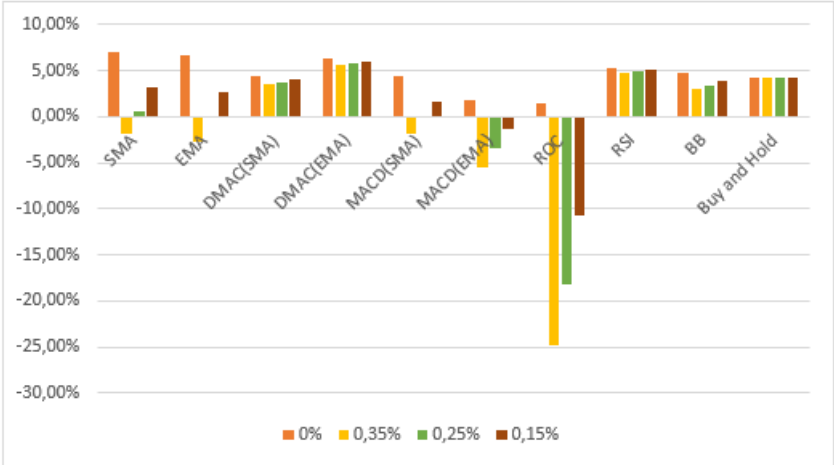


Figure 4.16: S&P 500 - Average returns on the twenty-year data for all transaction fees (Constant Exchange Rates)

Varying Exchange Rate

Table 4.5 summarises the returns for each of the three periods.

Table 4.5: S&P 500: Summary of period A, B & C returns for twenty years (Varying Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	8,04%	-1,08%	1,44%	4,03%
EMA	7,41%	-2,21%	0,45%	3,18%
DMAC(SMA)	8,69%	7,71%	7,99%	8,27%
DMAC(EMA)	10,08%	9,35%	9,55%	9,76%
MACD(SMA)	8,17%	1,60%	3,44%	5,30%
MACD(EMA)	7,47%	-0,11%	2,00%	4,15%
ROC	8,31%	-19,93%	-12,71%	-4,84%
RSI	6,82%	6,23%	6,40%	6,57%
BB	7,42%	5,60%	6,11%	6,64%
Buy and Hold	10,15%	10,14%	10,14%	10,15%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,06%	-1,98%	0,52%	3,09%
EMA	6,38%	-3,05%	-0,44%	2,23%
DMAC(SMA)	6,54%	5,58%	5,85%	6,13%
DMAC(EMA)	8,79%	8,10%	8,30%	8,49%
MACD(SMA)	7,72%	1,15%	2,98%	4,85%
MACD(EMA)	7,32%	-0,35%	1,78%	3,96%
ROC	7,50%	-20,36%	-13,23%	-5,47%
RSI	7,79%	7,15%	7,33%	7,51%
BB	6,06%	4,25%	4,77%	5,28%
Buy and Hold	8,33%	8,31%	8,32%	8,32%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,03%	-2,51%	-0,15%	2,28%
EMA	5,67%	-3,32%	-0,83%	1,72%
DMAC(SMA)	6,58%	5,61%	5,89%	6,16%
DMAC(EMA)	8,92%	8,24%	8,43%	8,63%
MACD(SMA)	7,04%	0,58%	2,38%	4,22%
MACD(EMA)	7,39%	-0,22%	1,90%	4,06%
ROC	8,47%	-19,78%	-12,56%	-4,69%
RSI	8,37%	7,69%	7,88%	8,08%
BB	6,58%	4,77%	5,28%	5,80%
Buy and Hold	8,43%	8,42%	8,42%	8,43%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,04%	-1,86%	0,61%	3,13%
EMA	6,48%	-2,86%	-0,28%	2,38%
DMAC(SMA)	7,27%	6,30%	6,58%	6,85%
DMAC(EMA)	9,26%	8,56%	8,76%	8,96%
MACD(SMA)	7,64%	1,11%	2,93%	4,79%
MACD(EMA)	7,39%	-0,23%	1,89%	4,06%
ROC	8,09%	-20,02%	-12,83%	-5,00%
RSI	7,66%	7,02%	7,20%	7,39%
BB	6,69%	4,87%	5,39%	5,91%
Buy and Hold	8,97%	8,95%	8,96%	8,97%

For period A: the buy and hold strategy is unbeaten with and without transaction costs.

For period B: the DMAC(EMA) indicator outperformed the buy and hold strategy when there are no transaction costs. For transaction costs of 0.35% and 0.25%, the buy and hold strategy is unbeaten. When lowering the transaction costs to 0.15%, the DMAC(EMA) indicator outperformed the buy and hold strategy.

For period C: DMAC(EMA) and ROC outperformed the buy and hold strategy when there are no transaction costs. For a transaction cost of 0.35%, the buy and hold strategy is unbeaten. When lowering the transaction costs to 0.25% and 0.15%, the DMAC(EMA) indicator outperformed the buy and hold strategy.

For the average returns of period A, B and C: only the DMAC(EMA) indicator outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

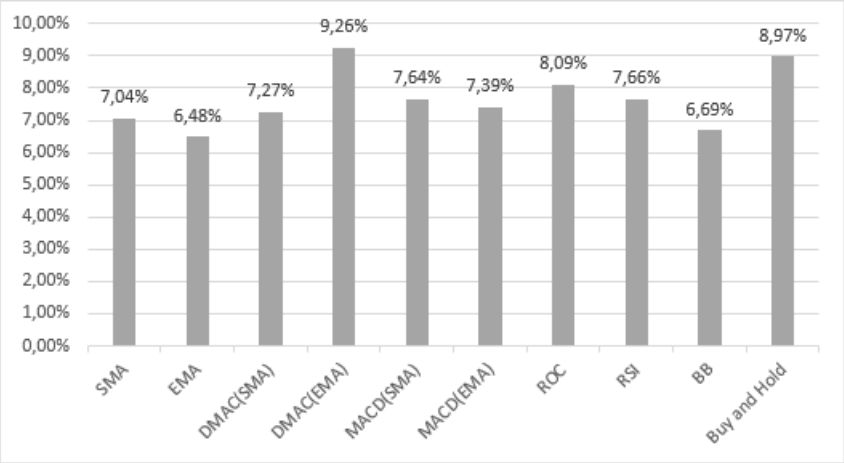


Figure 4.17: S&P 500 - Average returns on the twenty-year data for no transaction fees (Varying Exchange Rate)

4.3.3 NIFTY 50

The NIFTY 50 index will now be considered for three-, five-, ten- and twenty-year periods individually. For each period the constant exchange rate and varying exchange rate scenarios are also presented. For both scenarios, the three-, five-, ten- and twenty-year periods produced similar results. Therefore, only the twenty-year periods are shown in this chapter and the three-, five- and ten-year periods are shown in Appendix A section A.1.3.

Figure 4.18: S&P 500 - Average returns on the twenty-year data for all transaction fees (Varying Exchange Rate)

4.3.3.1 Twenty-Year Periods

Constant Exchange Rate

Table 4.6 summarises the returns for each of the twenty periods.

Table 4.6: NIFTY 50: Summary of period A, B & C returns for twenty years (Constant Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,06%	-3,40%	-1,59%	0,24%
EMA	2,32%	-5,46%	-3,30%	-1,09%
DMAC(SMA)	11,04%	10,15%	10,41%	10,66%
DMAC(EMA)	11,35%	10,57%	10,80%	11,02%
MACD(SMA)	14,76%	8,05%	9,93%	11,84%
MACD(EMA)	10,86%	3,69%	5,69%	7,73%
ROC	10,12%	-16,51%	-9,64%	-2,20%
RSI	12,05%	12,01%	12,03%	12,04%
BB	7,52%	6,65%	6,90%	7,15%
Buy and Hold	12,05%	12,03%	12,04%	12,05%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,60%	-2,97%	-1,13%	0,73%
EMA	2,90%	-5,06%	-2,85%	-0,59%
DMAC(SMA)	11,29%	10,40%	10,65%	10,90%
DMAC(EMA)	11,62%	10,84%	11,07%	11,29%
MACD(SMA)	14,63%	7,89%	9,78%	11,69%
MACD(EMA)	10,79%	3,55%	5,57%	7,63%
ROC	10,99%	-15,97%	-9,02%	-1,49%
RSI	13,32%	13,28%	13,29%	13,30%
BB	7,48%	6,66%	6,89%	7,13%
Buy and Hold	13,32%	13,30%	13,31%	13,31%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	2,95%	-3,64%	-1,80%	0,07%
EMA	2,97%	-5,03%	-2,81%	-0,54%
DMAC(SMA)	8,86%	7,91%	8,18%	8,45%
DMAC(EMA)	9,13%	8,29%	8,53%	8,77%
MACD(SMA)	11,81%	5,20%	7,05%	8,93%
MACD(EMA)	9,80%	2,63%	4,63%	6,66%
ROC	8,49%	-17,60%	-10,86%	-3,57%
RSI	10,70%	10,66%	10,68%	10,69%
BB	6,93%	6,11%	6,35%	6,58%
Buy and Hold	10,70%	10,68%	10,69%	10,70%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,20%	-3,33%	-1,51%	0,35%
EMA	2,73%	-5,18%	-2,98%	-0,74%
DMAC(SMA)	10,40%	9,48%	9,74%	10,00%
DMAC(EMA)	10,70%	9,90%	10,13%	10,36%
MACD(SMA)	13,73%	7,05%	8,92%	10,82%
MACD(EMA)	10,48%	3,29%	5,29%	7,34%
ROC	9,87%	-16,69%	-9,84%	-2,42%
RSI	12,03%	11,99%	12,00%	12,01%
BB	7,31%	6,48%	6,71%	6,95%
Buy and Hold	12,03%	12,01%	12,01%	12,02%

For period A, B, C and the average returns of the three periods: the MACD(SMA) indicator and RSI indicator outperformed the buy and hold strategy in the absence of transaction costs. The buy and hold strategy is unbeaten in the presence of transaction costs.

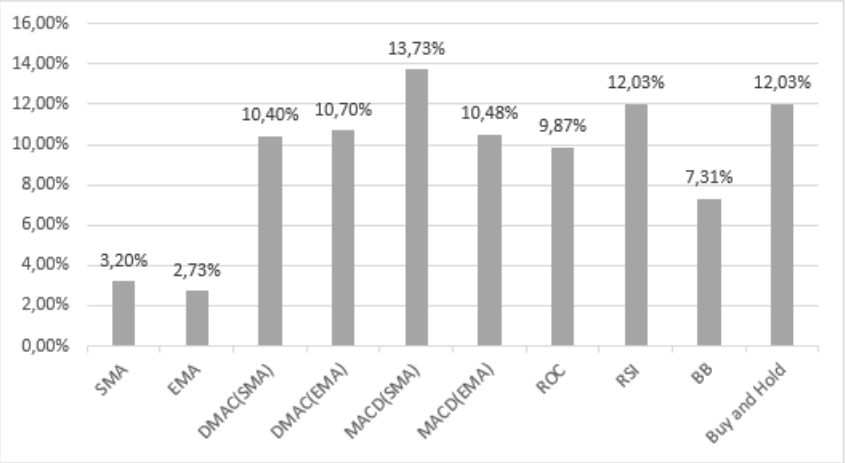


Figure 4.19: NIFTY 50 - Average returns on the twenty-year data for no transaction fees (Constant Exchange Rate)

Figure 4.20: NIFTY 50 - Average returns on the twenty-year data for all transaction fees (Constant Exchange Rate)

Varying Exchange Rate

Table 4.7 summarises the returns for each of the twenty periods.

For period A: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs and the RSI indicator produced the same returns as the buy and hold strategy. For all possible transaction costs,

Table 4.7: NIFTY 50: Summary of period A, B & C returns for twenty years (Varying Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,51%	-2,98%	-1,17%	0,67%
EMA	2,09%	-5,68%	-3,52%	-1,32%
DMAC(SMA)	10,78%	9,89%	10,15%	10,40%
DMAC(EMA)	10,94%	10,16%	10,39%	10,61%
MACD(SMA)	12,84%	6,25%	8,09%	9,97%
MACD(EMA)	7,00%	0,08%	2,01%	3,98%
ROC	7,40%	-18,58%	-11,87%	-4,62%
RSI	9,62%	9,59%	9,60%	9,61%
BB	4,33%	3,49%	3,73%	3,97%
Buy and Hold	9,62%	9,60%	9,61%	9,62%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	5,21%	-1,46%	0,40%	2,30%
EMA	3,76%	-4,26%	-2,04%	0,24%
DMAC(SMA)	11,11%	10,22%	10,47%	10,73%
DMAC(EMA)	11,08%	10,30%	10,52%	10,75%
MACD(SMA)	11,42%	4,88%	6,71%	8,57%
MACD(EMA)	5,71%	-1,19%	0,73%	2,70%
ROC	8,75%	-17,66%	-10,85%	-3,47%
RSI	11,06%	11,02%	11,03%	11,04%
BB	4,60%	3,80%	4,03%	4,26%
Buy and Hold	11,06%	11,04%	11,04%	11,05%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	4,56%	-2,13%	-0,26%	1,64%
EMA	3,92%	-4,16%	-1,92%	0,38%
DMAC(SMA)	8,71%	7,76%	8,03%	8,30%
DMAC(EMA)	8,26%	7,43%	7,67%	7,90%
MACD(SMA)	9,78%	3,29%	5,10%	6,95%
MACD(EMA)	4,58%	-2,25%	-0,34%	1,60%
ROC	6,19%	-19,35%	-12,75%	-5,62%
RSI	8,89%	8,85%	8,86%	8,87%
BB	3,98%	3,18%	3,41%	3,64%
Buy and Hold	8,89%	8,87%	8,87%	8,88%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	4,43%	-2,19%	-0,34%	1,54%
EMA	3,25%	-4,70%	-2,49%	-0,23%
DMAC(SMA)	10,20%	9,29%	9,55%	9,81%
DMAC(EMA)	10,09%	9,30%	9,52%	9,75%
MACD(SMA)	11,35%	4,81%	6,63%	8,50%
MACD(EMA)	5,77%	-1,12%	0,80%	2,76%
ROC	7,45%	-18,53%	-11,83%	-4,57%
RSI	9,85%	9,82%	9,83%	9,84%
BB	4,30%	3,49%	3,72%	3,95%
Buy and Hold	9,85%	9,84%	9,84%	9,85%

DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy. When lowering the transaction costs to 0.15%, the MACD(SMA) indicator also outperformed the buy and hold strategy.

For period B: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy again (in descending order) when there are no transaction costs and the RSI indicator produced the same returns as the buy and hold strategy. In the presence of transaction costs, DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy.

For period C: the MACD(SMA) indicator outperformed the buy and hold strategy in the absence of transaction costs and the RSI indicator produced the same returns as the buy and hold strategy. The buy and hold strategy is unbeaten in the presence of transaction costs.

For the average returns of period A, B and C: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs and the RSI indicator produced the same returns as the buy and hold strategy. The buy and hold strategy is unbeaten in the presence of transaction costs.

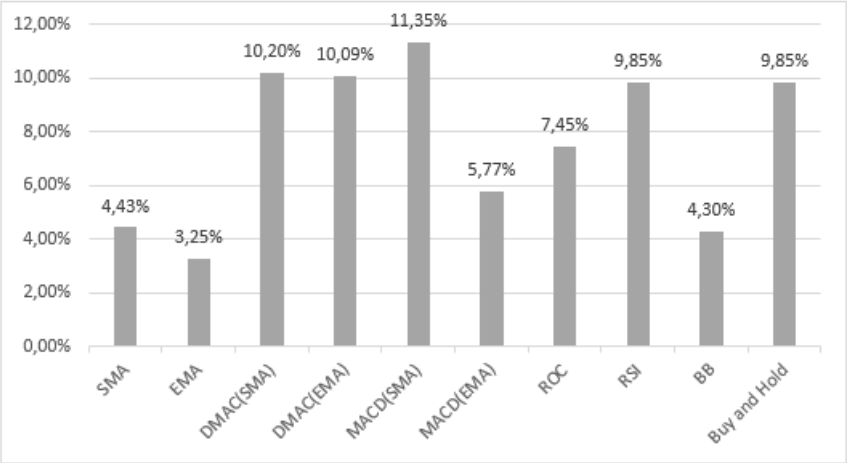


Figure 4.21: NIFTY 50 - Average returns on the twenty-year data for no transaction fees (Varying Exchange Rate)

Figure 4.22: NIFTY 50 - Average returns on the twenty-year data for all transaction fees (Varying Exchange Rate)

4.3.4 FTSE 100

The FTSE 100 index will now be considered for three-, five-, ten- and twenty-year periods individually. For each period the constant exchange rate and varying exchange rate scenarios are also presented. For both scenarios, the three-, five-, ten- and twenty-year periods produced similar results. Therefore, only the twenty-year periods are shown in this chapter and the three-, five- and ten-year periods are shown in Appendix A section A.1.4.

4.3.4.1 Twenty-Year Periods

Constant Exchange Rate

Table 4.8 summarises the returns for each of the three periods.

Table 4.8: FTSE 100: Summary of period A, B & C returns for twenty years (Constant Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,91%	-2,02%	0,45%	2,99%
EMA	5,97%	-4,59%	-1,68%	1,31%
DMAC(SMA)	3,84%	2,86%	3,14%	3,42%
DMAC(EMA)	2,33%	1,16%	1,49%	1,83%
MACD(SMA)	2,53%	-3,69%	-1,95%	-0,18%
MACD(EMA)	-0,43%	-7,84%	-5,78%	-3,67%
ROC	-2,68%	-27,97%	-21,50%	-14,45%
RSI	2,08%	1,61%	1,75%	1,88%
BB	5,54%	3,75%	4,26%	4,77%
Buy and Hold	2,04%	2,02%	2,03%	2,03%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,29%	-2,61%	-0,15%	2,38%
EMA	5,43%	-5,11%	-2,21%	0,78%
DMAC(SMA)	2,68%	1,71%	1,99%	2,26%
DMAC(EMA)	1,47%	0,30%	0,63%	0,97%
MACD(SMA)	2,99%	-3,06%	-1,37%	0,35%
MACD(EMA)	0,48%	-6,77%	-4,76%	-2,70%
ROC	-2,40%	-27,92%	-21,40%	-14,29%
RSI	1,95%	1,45%	1,60%	1,74%
BB	4,21%	2,44%	2,94%	3,45%
Buy and Hold	0,68%	0,66%	0,67%	0,67%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,39%	-2,45%	0,00%	2,51%
EMA	5,43%	-5,08%	-2,19%	0,79%
DMAC(SMA)	2,26%	1,26%	1,55%	1,83%
DMAC(EMA)	0,99%	-0,24%	0,11%	0,46%
MACD(SMA)	3,55%	-2,53%	-0,83%	0,90%
MACD(EMA)	0,43%	-6,78%	-4,77%	-2,72%
ROC	-1,98%	-27,61%	-21,06%	-13,92%
RSI	2,65%	2,11%	2,27%	2,42%
BB	5,13%	3,27%	3,80%	4,33%
Buy and Hold	0,45%	0,44%	0,44%	0,45%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,53%	-2,36%	0,10%	2,63%
EMA	5,61%	-4,93%	-2,03%	0,96%
DMAC(SMA)	2,93%	1,95%	2,23%	2,51%
DMAC(EMA)	1,60%	0,41%	0,75%	1,09%
MACD(SMA)	3,02%	-3,10%	-1,39%	0,35%
MACD(EMA)	0,16%	-7,13%	-5,10%	-3,03%
ROC	-2,35%	-27,83%	-21,32%	-14,22%
RSI	2,23%	1,73%	1,87%	2,01%
BB	4,96%	3,15%	3,67%	4,18%
Buy and Hold	1,06%	1,04%	1,04%	1,05%

For period A: SMA, EMA, BB, MACD(SMA), DMAC(SMA), RSI and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB, DMAC(SMA) and RSI outperformed the buy and hold strategy for all possibilities of transaction costs. When lowering the transaction costs to 0.15%, the SMA indicator also outperformed the buy and hold strategy.

For period B: SMA, EMA, BB, MACD(SMA), DMAC(SMA), RSI and DMAC(EMA) outperformed the buy and hold strategy (in descending order) in the absence of transaction costs. BB, RSI and DMAC(SMA) outperformed the buy and hold strategy for all possibilities of transaction costs. DMAC(EMA) outperformed the buy and hold strategy for 0.25% and 0.15% transaction costs. For a transaction cost of 0.15%, SMA, DMAC(EMA) and EMA also outperformed the buy and hold strategy.

For period C: SMA, EMA, BB, MACD(SMA), RSI, DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) in the absence of transaction costs. BB, RSI and DMAC(SMA) outperformed the buy and hold strategy for all possibilities of transaction costs. When lowering the transaction costs to 0.15%; SMA, EMA, MACD(SMA) and DMAC(EMA) outperformed the buy and hold strategy.

For the average returns of period A, B and C: SMA, EMA, BB, MACD(SMA), DMAC(SMA), RSI and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB, RSI and DMAC(SMA) outperformed the buy and hold strategy for all possibilities of transaction costs. When lowering the transaction costs to 0.15%, SMA and DMAC(EMA) outperformed the buy and hold strategy.

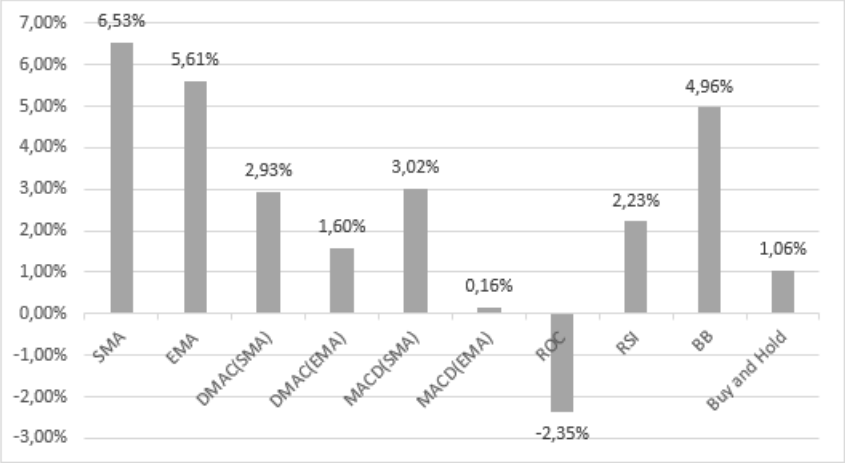


Figure 4.23: FTSE 100 - Average returns on the twenty-year data for no transaction fees (Constant Exchange Rate)

Varying Exchange Rate

Table 4.9 summarises the returns for each of the three periods.

For period A: BB, SMA, DMAC(SMA), DMAC(EMA) and EMA outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB and DMAC(SMA) outperformed the buy and hold strategy for all possible transaction costs percentages.

For period B: BB, SMA, DMAC(SMA), EMA and DMAC(EMA) outperformed the buy and

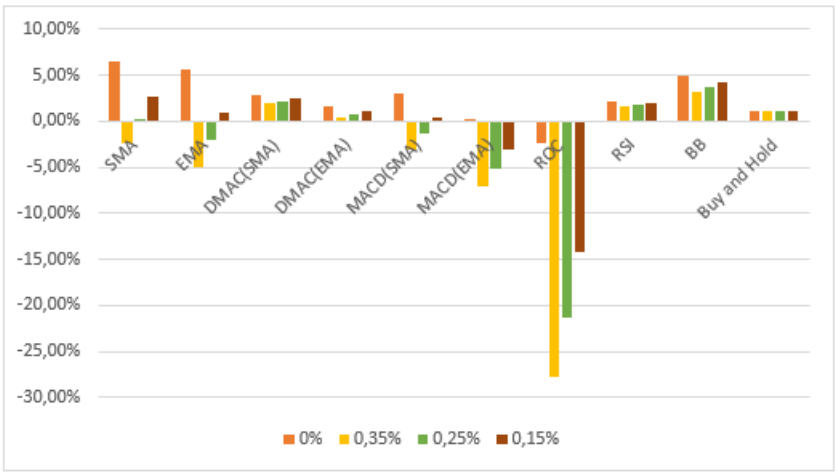


Figure 4.24: FTSE 100 - Average returns on the twenty-year data for all transaction fees (Constant Exchange Rate)

Table 4.9: FTSE 100: Summary of period A, B & C returns for twenty years (Varying Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,88%	-1,12%	1,37%	3,93%
EMA	5,93%	-4,63%	-1,73%	1,26%
DMAC(SMA)	6,82%	5,81%	6,10%	6,38%
DMAC(EMA)	5,95%	4,74%	5,08%	5,43%
MACD(SMA)	2,54%	-3,69%	-1,95%	-0,18%
MACD(EMA)	-2,24%	-9,51%	-7,49%	-5,42%
ROC	3,58%	-23,34%	-16,46%	-8,96%
RSI	3,26%	2,79%	2,92%	3,06%
BB	8,50%	6,65%	7,17%	7,70%
Buy and Hold	5,78%	5,76%	5,77%	5,78%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,31%	-2,60%	-0,13%	2,39%
EMA	4,54%	-5,92%	-3,04%	-0,08%
DMAC(SMA)	4,68%	3,69%	3,97%	4,25%
DMAC(EMA)	4,42%	3,22%	3,57%	3,91%
MACD(SMA)	2,35%	-3,66%	-1,98%	-0,27%
MACD(EMA)	-1,52%	-8,63%	-6,65%	-4,63%
ROC	3,06%	-23,89%	-17,01%	-9,50%
RSI	2,24%	1,75%	1,89%	2,03%
BB	7,00%	5,18%	5,70%	6,21%
Buy and Hold	3,92%	3,90%	3,91%	3,91%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,75%	-2,13%	0,33%	2,85%
EMA	4,59%	-5,84%	-2,97%	-0,01%
DMAC(SMA)	4,08%	3,07%	3,36%	3,65%
DMAC(EMA)	3,52%	2,26%	2,61%	2,97%
MACD(SMA)	2,60%	-3,43%	-1,74%	-0,03%
MACD(EMA)	-2,15%	-9,18%	-7,23%	-5,23%
ROC	3,43%	-23,61%	-16,70%	-9,17%
RSI	3,08%	2,54%	2,69%	2,85%
BB	7,62%	5,72%	6,26%	6,80%
Buy and Hold	3,59%	3,57%	3,58%	3,59%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,98%	-1,95%	0,52%	3,06%
EMA	5,02%	-5,46%	-2,58%	0,39%
DMAC(SMA)	5,19%	4,19%	4,48%	4,76%
DMAC(EMA)	4,63%	3,41%	3,75%	4,10%
MACD(SMA)	2,50%	-3,59%	-1,89%	-0,16%
MACD(EMA)	-1,97%	-9,11%	-7,12%	-5,10%
ROC	3,36%	-23,62%	-16,72%	-9,21%
RSI	2,86%	2,36%	2,50%	2,64%
BB	7,71%	5,85%	6,38%	6,91%
Buy and Hold	4,43%	4,41%	4,42%	4,42%

hold strategy (in descending order) when there are no transaction costs. BB outperformed the buy and hold strategy for all possible transaction costs percentages. For transaction costs of 0.25% and 0.15%, DMAC(SMA) outperformed the buy and hold strategy. For a low transaction cost of 0.15%, DMAC(EMA) also outperformed the buy and hold strategy.

For period C: BB, SMA, EMA and DMAC(SMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB outperformed the buy and hold strategy for all possible transaction costs percentages. For a low transaction cost of 0.15%, the DMAC(SMA) indicator also outperformed the buy and hold strategy.

For the average returns of period A, B and C: BB, SMA, DMAC(SMA), EMA and DMAC(EMA) outperformed the buy and hold strategy (in descending order) in the absence of transaction costs. BB outperformed the buy and hold strategy for all possible transaction costs percentages. For transaction costs of 0.25% and 0.15%, DMAC(SMA) also outperformed the buy and hold strategy.

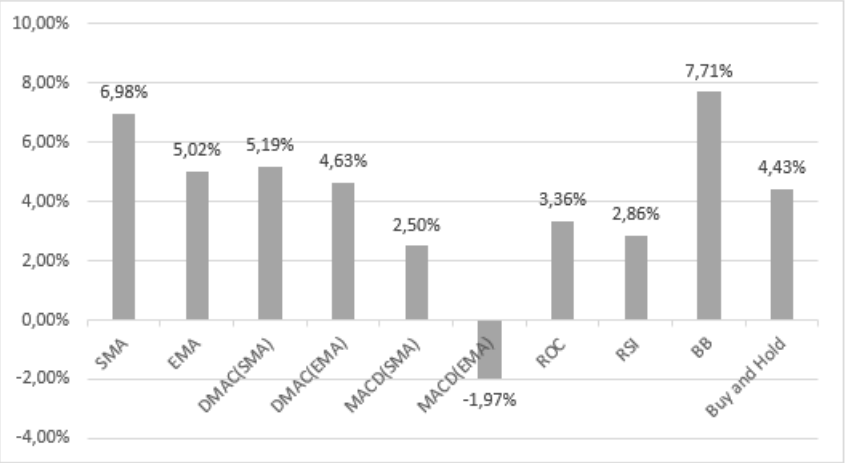


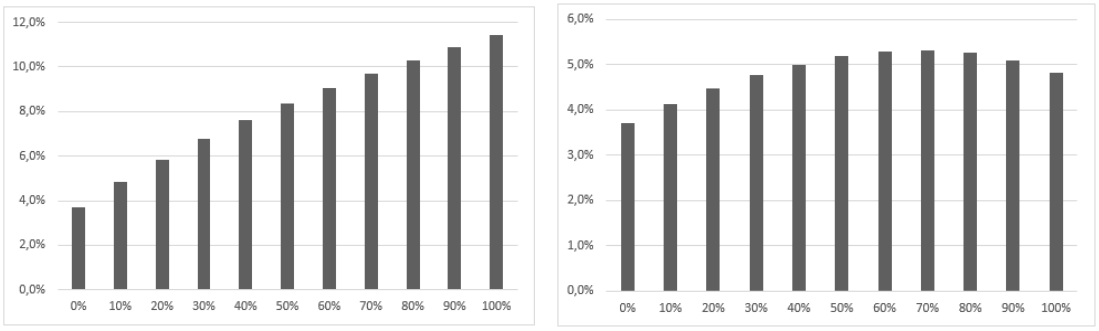
Figure 4.25: FTSE 100 - Average returns on the twenty-year data for no transaction fees (Varying Exchange Rate)

Figure 4.26: FTSE 100 - Average returns on the twenty-year data for all transaction fees (Varying Exchange Rate

4.4 Multiple Indices

In this section the results of the different combinations of indices are discussed. The JSE Top 40 and S&P 500 combination results are studied. The NIFTY 50 index is then added. The results of the JSE Top 40, S&P 500 and NIFTY 50 combination is then studied. Lastly, the FTSE 100 index is added. The JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 combination is then studied.

For the multiple indices, $b = 100\%$ is studied and other relevant $b\%$ that performed well in the relevant periods. For example, if $b = 70\%$ performed well for the JSE Top 40 and S&P 500 combination, then both $b = 100\%$ and $b = 70\%$ are discussed. The $b = 100\%$ scenario is discussed to ensure consistency between the single indices and multiple indices periods. This also makes it easy to compare the results throughout the chapter. In figure 4.27 the $b = 100\%$ scenario performed the best for the SMA indicator. In figure 4.27 the $b = 60\%, 70\%, 80\%$ scenarios performed the best for MACD(EMA) indicator. It is therefore relevant to study other possible b's% in the multiple indices cases.



(a) JSE Top 40 and S&P 500 - 3 Years SMA percentage example

(b) JSE Top 40 and S&P 500 - 3 Years MACD(EMA) percentage example

Figure 4.27: Percentage examples multiple indices

4.4.1 JSE Top 40 and S&P 500 combination

The results for the JSE Top 40 and S&P 500 combinations for three-, five- and twenty-year periods are similar for the constant exchange rate approach. Therefore only the ten-year and twenty-year periods are shown in this chapter. For the varying exchange rate, the patterns are similar and once again only the ten-year and twenty-year periods are shown in this chapter. The rest of the results are shown in Appendix A section A.2.1.

4.4.1.1 Ten Year Periods

Constant Exchange Rate

Table 4.10 summarises the returns for each of the three periods for $b = 100\%$.

Table 4.10: JSE Top 40 and S&P 500 - Summary of period A, B & C returns for ten years (Constant Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,38%	0,38%	3,40%	6,52%
EMA	9,77%	-1,92%	1,29%	4,60%
DMAC(SMA)	8,79%	7,80%	8,08%	8,37%
DMAC(EMA)	9,97%	9,13%	9,37%	9,61%
MACD(SMA)	7,51%	0,10%	2,16%	4,27%
MACD(EMA)	5,54%	-2,76%	-0,46%	1,90%
ROC	4,48%	-24,68%	-17,30%	-9,19%
RSI	5,50%	4,76%	4,97%	5,18%
BB	7,95%	5,63%	6,29%	6,95%
Buy and Hold	9,72%	9,64%	9,66%	9,69%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,09%	0,76%	3,88%	7,09%
EMA	10,42%	-1,49%	1,77%	5,15%
DMAC(SMA)	8,27%	7,32%	7,59%	7,86%
DMAC(EMA)	8,85%	7,98%	8,23%	8,48%
MACD(SMA)	5,84%	-1,46%	0,57%	2,65%
MACD(EMA)	4,26%	-4,09%	-1,78%	0,60%
ROC	3,95%	-25,24%	-17,85%	-9,74%
RSI	8,12%	7,19%	7,46%	7,72%
BB	7,73%	5,60%	6,20%	6,81%
Buy and Hold	9,63%	9,56%	9,58%	9,60%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,94%	-0,16%	2,89%	6,04%
EMA	9,50%	-2,17%	1,03%	4,34%
DMAC(SMA)	7,70%	6,71%	6,99%	7,28%
DMAC(EMA)	7,93%	6,96%	7,23%	7,51%
MACD(SMA)	5,39%	-1,79%	0,21%	2,25%
MACD(EMA)	4,17%	-4,01%	-1,74%	0,58%
ROC	3,23%	-25,86%	-18,51%	-10,42%
RSI	8,01%	7,10%	7,36%	7,62%
BB	7,82%	5,50%	6,16%	6,82%
Buy and Hold	8,11%	8,03%	8,05%	8,07%

Summary of Average Returns for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,47%	0,33%	3,39%	6,55%
EMA	9,90%	-1,86%	1,36%	4,69%
DMAC(SMA)	8,25%	7,28%	7,56%	7,83%
DMAC(EMA)	8,92%	8,02%	8,28%	8,53%
MACD(SMA)	6,25%	-1,05%	0,98%	3,06%
MACD(EMA)	4,66%	-3,62%	-1,32%	1,03%
ROC	3,89%	-25,26%	-17,89%	-9,79%
RSI	7,21%	6,35%	6,60%	6,84%
BB	7,83%	5,58%	6,22%	6,86%
Buy and Hold	9,15%	9,08%	9,10%	9,12%

For period A: SMA and DMAC(EMA) outperformed the buy and hold strategy when ignoring transaction costs. The buy and hold strategy is unbeaten when we consider transaction costs. The DMAC(EMA) indicator is the only indicator that produced returns close to the buy and hold strategy when considering transaction costs.

For period B and C and the average of the three periods: the SMA indicator and EMA indicator outperformed the buy and hold strategy for no transaction costs. The buy and hold strategy is unbeaten when considering transaction costs.

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

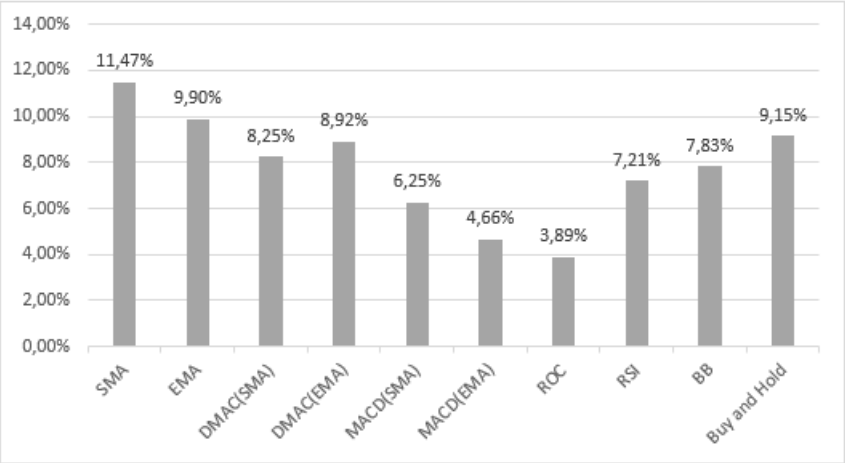


Figure 4.28: JSE Top 40 and S&P 500 - Average returns on the ten-year data for no transaction fees (Constant Exchange Rate)

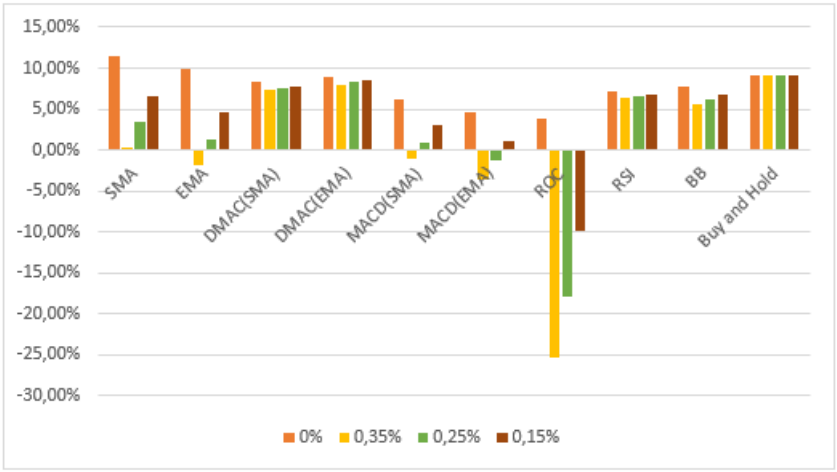


Figure 4.29: JSE Top 40 and S&P 500 - Average returns on the ten-year data for all transaction fees (Constant Exchange Rate)

Varying Exchange Rate

Table 4.11 summarises the returns for each of the three periods for $b = 100\%$.

For period A: the buy and hold strategy produce high returns and only the DMAC(EMA) indicator could outperform it. For transaction costs, none of the indicators outperformed the buy and hold strategy. The DMAC(EMA) indicator produced returns close to the buy and hold strategy in the presence of transaction costs.

For period B, period C and the average returns of the three periods: the SMA indicator outperformed the buy and hold strategy for no transaction costs. In the presence of transaction costs,

Table 4.11: JSE Top 40 and S&P 500 - Summary of period A, B & C returns for ten years (Varying Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,93%	-0,02%	2,99%	6,10%
EMA	9,27%	-2,36%	0,83%	4,13%
DMAC(SMA)	11,44%	10,43%	10,71%	11,00%
DMAC(EMA)	12,06%	11,20%	11,44%	11,69%
MACD(SMA)	10,39%	2,77%	4,89%	7,06%
MACD(EMA)	9,80%	1,16%	3,56%	6,01%
ROC	9,74%	-20,89%	-13,14%	-4,62%
RSI	7,79%	6,96%	7,20%	7,43%
BB	10,71%	8,24%	8,94%	9,64%
Buy and Hold	12,00%	11,92%	11,94%	11,97%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,32%	0,96%	4,09%	7,31%
EMA	10,26%	-1,64%	1,62%	4,99%
DMAC(SMA)	9,29%	8,34%	8,61%	8,88%
DMAC(EMA)	9,16%	8,28%	8,53%	8,78%
MACD(SMA)	8,61%	1,12%	3,20%	5,33%
MACD(EMA)	8,15%	-0,52%	1,88%	4,34%
ROC	8,39%	-22,05%	-14,35%	-5,89%
RSI	7,87%	6,95%	7,21%	7,48%
BB	9,08%	6,73%	7,40%	8,07%
Buy and Hold	11,46%	11,38%	11,40%	11,43%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,99%	-0,11%	2,94%	6,09%
EMA	9,55%	-2,12%	1,08%	4,39%
DMAC(SMA)	8,35%	7,35%	7,64%	7,92%
DMAC(EMA)	7,81%	6,84%	7,11%	7,39%
MACD(SMA)	7,94%	0,58%	2,63%	4,72%
MACD(EMA)	7,62%	-0,84%	1,51%	3,91%
ROC	8,28%	-22,24%	-14,52%	-6,04%
RSI	7,94%	7,10%	7,34%	7,58%
BB	6,55%	4,70%	5,23%	5,75%
Buy and Hold	10,65%	10,57%	10,59%	10,61%

Summary of Average Returns for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,41%	0,28%	3,34%	6,50%
EMA	9,69%	-2,04%	1,18%	4,50%
DMAC(SMA)	9,69%	8,71%	8,99%	9,27%
DMAC(EMA)	9,67%	8,77%	9,03%	9,29%
MACD(SMA)	8,98%	1,49%	3,58%	5,70%
MACD(EMA)	8,52%	-0,07%	2,31%	4,75%
ROC	8,80%	-21,73%	-14,00%	-5,52%
RSI	7,87%	7,00%	7,25%	7,50%
BB	8,78%	6,56%	7,19%	7,82%
Buy and Hold	11,37%	11,29%	11,31%	11,34%

the buy and hold strategy is unbeaten.

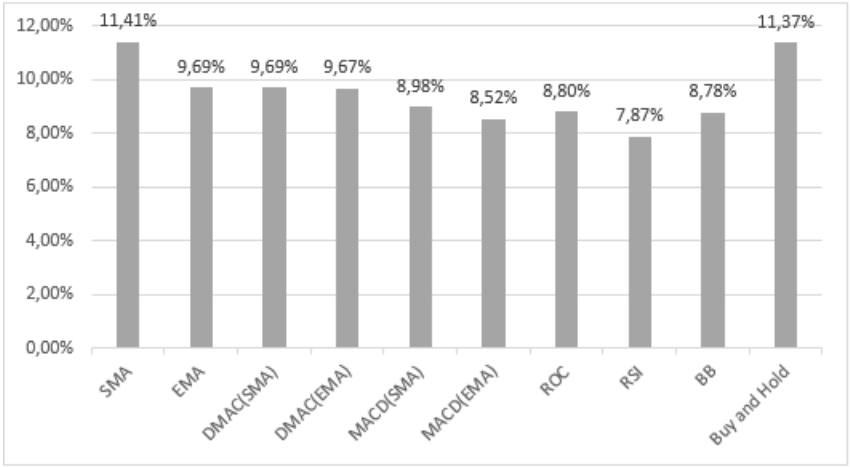


Figure 4.30: JSE Top 40 and S&P 500 - Average returns on the ten-year data for no transaction fees (Varying Exchange Rate)

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

Figure 4.31: JSE Top 40 and S&P 500 - Average returns on the ten-year data for all transaction fees (Varying Exchange Rate)

4.4.1.2 Twenty-Year Periods

Constant Exchange Rate

Table 4.12 summarises the returns for each of the three periods for $b = 100\%$.

Table 4.12: JSE Top 40 and S&P 500 - Summary of period A, B & C returns for twenty years (Constant Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,38%	0,38%	3,40%	6,52%
EMA	9,77%	-1,92%	1,29%	4,60%
DMAC(SMA)	8,85%	7,91%	8,18%	8,45%
DMAC(EMA)	10,04%	9,23%	9,46%	9,69%
MACD(SMA)	7,51%	0,10%	2,16%	4,27%
MACD(EMA)	5,46%	-2,81%	-0,52%	1,83%
ROC	4,48%	-24,68%	-17,30%	-9,19%
RSI	6,16%	5,46%	5,66%	5,86%
BB	5,95%	4,07%	4,60%	5,14%
Buy and Hold	9,85%	9,81%	9,82%	9,83%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,10%	0,76%	3,88%	7,09%
EMA	10,50%	-1,42%	1,85%	5,22%
DMAC(SMA)	8,27%	7,32%	7,59%	7,86%
DMAC(EMA)	8,86%	7,98%	8,23%	8,48%
MACD(SMA)	5,90%	-1,40%	0,63%	2,71%
MACD(EMA)	4,06%	-4,28%	-1,97%	0,40%
ROC	4,09%	-25,11%	-17,73%	-9,61%
RSI	7,33%	6,45%	6,70%	6,95%
BB	7,72%	5,52%	6,14%	6,77%
Buy and Hold	9,49%	9,45%	9,46%	9,47%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,94%	-0,16%	2,89%	6,04%
EMA	9,50%	-2,16%	1,04%	4,34%
DMAC(SMA)	7,73%	6,77%	7,04%	7,32%
DMAC(EMA)	7,99%	7,04%	7,31%	7,58%
MACD(SMA)	5,43%	-1,74%	0,26%	2,29%
MACD(EMA)	4,12%	-4,06%	-1,79%	0,53%
ROC	3,23%	-25,86%	-18,51%	-10,42%
RSI	8,25%	7,33%	7,59%	7,85%
BB	7,82%	5,50%	6,16%	6,82%
Buy and Hold	7,57%	7,53%	7,54%	7,55%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,47%	0,33%	3,39%	6,55%
EMA	9,92%	-1,84%	1,39%	4,72%
DMAC(SMA)	8,28%	7,33%	7,60%	7,88%
DMAC(EMA)	8,96%	8,09%	8,34%	8,59%
MACD(SMA)	6,28%	-1,02%	1,02%	3,09%
MACD(EMA)	4,55%	-3,71%	-1,42%	0,92%
ROC	3,94%	-25,22%	-17,84%	-9,74%
RSI	7,25%	6,41%	6,65%	6,89%
BB	7,16%	5,03%	5,64%	6,24%
Buy and Hold	8,97%	8,93%	8,94%	8,95%

For period A: SMA and DMAC(EMA) outperformed the buy and hold strategy when ignoring transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

For period B: SMA and EMA outperformed the buy and hold strategy when ignoring transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

For period C: SMA, EMA, DMAC(EMA), RSI, BB and DMAC(SMA) outperformed the buy and hold strategy. For transaction costs of 0.35%, the buy and hold strategy is unbeaten. When the transaction costs are lowered to 0.25%, the RSI indicator outperformed the buy and hold strategy. When the transaction costs are lowered even further to 0.15%, the DMAC(EMA) indicator also outperformed the buy and hold strategy.

For the average returns of period A, B and C: SMA and EMA outperformed the buy and hold strategy in the absence of transaction costs. The buy and hold strategy is unbeaten when taking transaction costs into account.

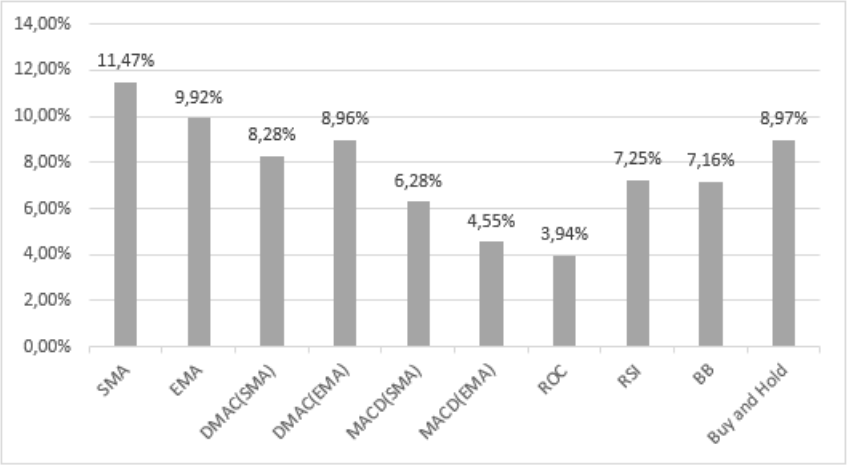


Figure 4.32: JSE Top 40 and S&P 500 - Average returns on the twenty-year data for no transaction fees (Constant Exchange Rate)

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

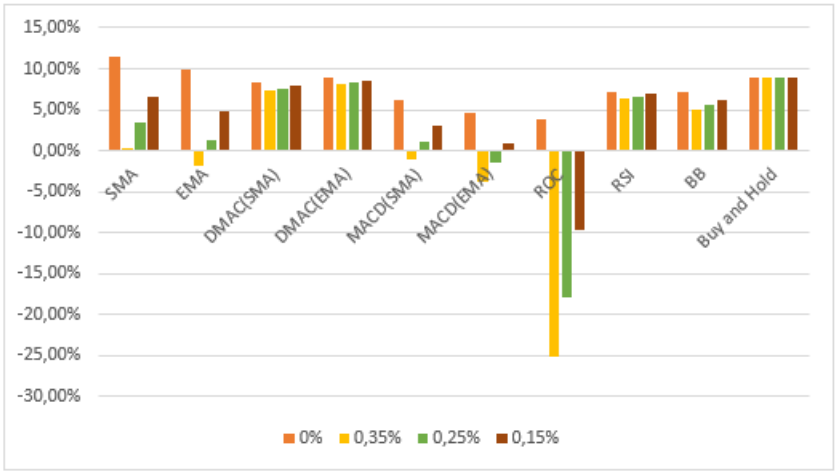


Figure 4.33: JSE Top 40 and S&P 500 - Average returns on the twenty-year data for all transaction fees (Constant Exchange Rate)

Varying Exchange Rate

Table 4.13 summarises the returns for each of the three periods for $b = 100\%$.

Table 4.13: JSE Top 40 and S&P 500 - Summary of period A, B & C returns for twenty years (Varying Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,93%	-0,02%	2,99%	6,10%
EMA	9,27%	-2,36%	0,83%	4,13%
DMAC(SMA)	11,50%	10,53%	10,81%	11,09%
DMAC(EMA)	12,12%	11,30%	11,54%	11,77%
MACD(SMA)	10,39%	2,77%	4,89%	7,06%
MACD(EMA)	9,76%	1,16%	3,54%	5,99%
ROC	9,74%	-20,89%	-13,14%	-4,62%
RSI	8,15%	7,21%	7,47%	7,74%
BB	8,73%	6,73%	7,30%	7,87%
Buy and Hold	11,38%	11,34%	11,35%	11,36%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,32%	0,97%	4,09%	7,31%
EMA	10,34%	-1,57%	1,69%	5,07%
DMAC(SMA)	9,29%	8,34%	8,61%	8,88%
DMAC(EMA)	9,16%	8,28%	8,53%	8,78%
MACD(SMA)	8,68%	1,18%	3,27%	5,40%
MACD(EMA)	7,56%	-1,06%	1,33%	3,78%
ROC	8,70%	-21,80%	-14,09%	-5,61%
RSI	7,51%	6,63%	6,88%	7,13%
BB	10,25%	7,88%	8,55%	9,23%
Buy and Hold	10,67%	10,63%	10,65%	10,66%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,99%	-0,11%	2,94%	6,09%
EMA	9,55%	-2,11%	1,09%	4,39%
DMAC(SMA)	8,23%	7,25%	7,53%	7,81%
DMAC(EMA)	7,70%	6,75%	7,02%	7,29%
MACD(SMA)	8,00%	0,66%	2,70%	4,79%
MACD(EMA)	7,52%	-0,92%	1,42%	3,82%
ROC	8,28%	-22,23%	-14,52%	-6,04%
RSI	6,31%	5,57%	5,78%	5,99%
BB	5,87%	4,08%	4,59%	5,10%
Buy and Hold	9,11%	9,07%	9,08%	9,10%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,42%	0,28%	3,34%	6,50%
EMA	9,72%	-2,01%	1,20%	4,53%
DMAC(SMA)	9,67%	8,71%	8,98%	9,26%
DMAC(EMA)	9,66%	8,78%	9,03%	9,28%
MACD(SMA)	9,02%	1,54%	3,62%	5,75%
MACD(EMA)	8,28%	-0,28%	2,10%	4,53%
ROC	8,91%	-21,64%	-13,91%	-5,42%
RSI	7,32%	6,47%	6,71%	6,96%
BB	8,29%	6,23%	6,81%	7,40%
Buy and Hold	10,39%	10,35%	10,36%	10,37%

For period A: both the DMAC indicators outperformed the buy and hold strategy when ignoring transaction costs. For a transaction cost of 0.35%, the buy and hold strategy is unbeaten. When the transaction costs are lowered, the DMAC(EMA) indicator outperforms the buy and hold strategy.

For period B: only the SMA indicator outperformed the buy and hold strategy, but these returns are eroded in the presence of transaction costs. Therefore, the buy and hold strategy is unbeaten when considering transaction costs.

For period C: SMA and EMA outperformed the buy and hold strategy. But when taking transaction costs into account, none of the indicators outperformed the buy and hold strategy.

For the average returns of period A, B and C: SMA outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

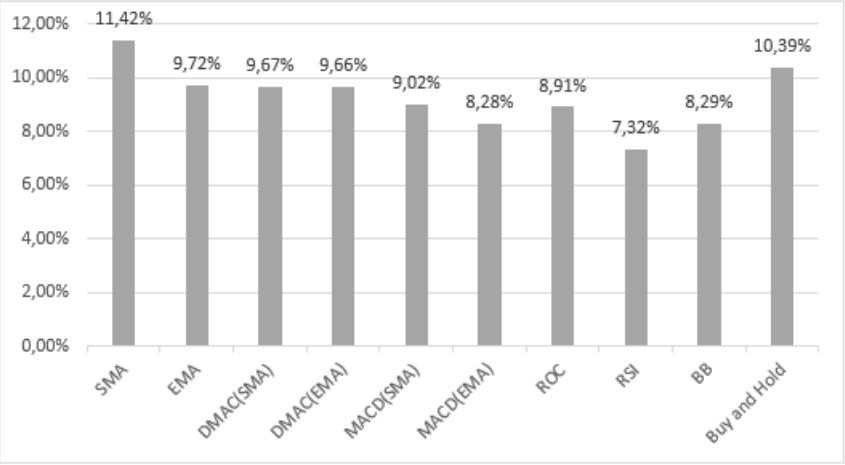


Figure 4.34: JSE Top 40 and S&P 500 - Average returns on the twenty-year data for no transaction fees (Varying Exchange Rate)

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy. In the next section, the results for the JSE Top 40, S&P 500 and NIFTY 50 combination are discussed.

Figure 4.35: JSE Top 40 and S&P 500 - Average returns on the twenty-year data for all transaction fees (Varying Exchange Rate)

4.4.2 JSE Top 40, S&P 500 and NIFTY 50 combination

In this section, the results for the JSE Top 40, S&P 500 and NIFTY 50 combination are discussed. For the constant exchange rate scenario, the returns on the five-year periods and ten-year periods are similar and the results for the three-year and twenty-year periods are similar. Therefore, only the returns for the ten-year and twenty-year periods are shown in this chapter. The returns for the three-, five- and ten-year periods are the same for the varying exchange rate scenario. Therefore, only the returns for the twenty-year periods are shown in this chapter. The results excluded from this chapter are presented in Appendix A section A.2.2.

4.4.2.1 Ten Year Periods

Constant Exchange Rate

Table 4.14 summarises the returns for each of the three periods for $b = 100\%$.

For period A: EMA, SMA, MACD(SMA) and BB outperformed the buy and hold strategy when there are no transaction costs. When we consider transaction costs, the buy and hold strategy is unbeaten.

For period B: only the SMA indicator and EMA indicator outperformed the buy and hold strategy when there are no transaction costs. Once again the buy and hold strategy is unbeaten when considering transaction costs.

Table 4.14: JSE Top 40, S&P 500 and NIFTY 50 - Summary of period A, B & C returns for ten years (Constant Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,31%	-0,43%	2,79%	6,12%
EMA	11,59%	-2,06%	1,66%	5,52%
DMAC(SMA)	8,04%	6,94%	7,25%	7,56%
DMAC(EMA)	9,60%	8,73%	8,98%	9,23%
MACD(SMA)	11,31%	2,89%	5,23%	7,62%
MACD(EMA)	6,03%	-3,23%	-0,67%	1,96%
ROC	6,17%	-25,58%	-17,63%	-8,83%
RSI	8,47%	7,38%	7,69%	8,00%
BB	10,76%	8,26%	8,97%	9,68%
Buy and Hold	10,68%	10,60%	10,63%	10,65%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,94%	-0,22%	3,11%	6,56%
EMA	11,72%	-2,13%	1,64%	5,56%
DMAC(SMA)	7,28%	6,21%	6,51%	6,82%
DMAC(EMA)	8,87%	8,04%	8,28%	8,51%
MACD(SMA)	9,83%	1,48%	3,80%	6,17%
MACD(EMA)	4,35%	-4,84%	-2,30%	0,31%
ROC	5,18%	-26,33%	-18,44%	-9,71%
RSI	9,51%	8,42%	8,73%	9,04%
BB	8,90%	6,40%	7,11%	7,83%
Buy and Hold	10,99%	10,92%	10,94%	10,96%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,13%	-0,91%	2,39%	5,80%
EMA	11,49%	-2,24%	1,50%	5,38%
DMAC(SMA)	7,33%	6,23%	6,54%	6,86%
DMAC(EMA)	9,28%	8,35%	8,62%	8,88%
MACD(SMA)	7,27%	-0,83%	1,42%	3,72%
MACD(EMA)	3,41%	-5,52%	-3,05%	-0,52%
ROC	5,24%	-26,24%	-18,35%	-9,63%
RSI	8,67%	7,59%	7,90%	8,21%
BB	9,89%	7,35%	8,07%	8,79%
Buy and Hold	9,11%	9,04%	9,06%	9,08%

Summary of Average Returns for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,46%	-0,52%	2,77%	6,16%
EMA	11,60%	-2,14%	1,60%	5,49%
DMAC(SMA)	7,55%	6,46%	6,77%	7,08%
DMAC(EMA)	9,25%	8,37%	8,62%	8,87%
MACD(SMA)	9,47%	1,18%	3,48%	5,84%
MACD(EMA)	4,60%	-4,53%	-2,00%	0,58%
ROC	5,53%	-26,05%	-18,14%	-9,39%
RSI	8,88%	7,80%	8,11%	8,42%
BB	9,85%	7,34%	8,05%	8,77%
Buy and Hold	10,26%	10,19%	10,21%	10,23%

For period C: EMA, SMA, BB and DMAC(EMA) outperformed the buy and hold strategy. Once again the buy and hold strategy is unbeaten when considering transaction costs.

For the average returns of period A, B and C: EMA and SMA outperformed the buy and hold strategy in the absence of transaction costs. When transaction costs are taken into account, the buy and hold strategy is unbeaten.

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

Varying Exchange Rate

Table 4.15 summarises the returns for each of the three periods for $b = 100\%$.

For period A: the MACD(SMA) indicator outperformed the buy and hold strategy in the absence of transaction costs. When considering transaction costs, the buy and hold strategy is unbeaten.

For period B: the buy and hold strategy is unbeaten with and without transaction costs.

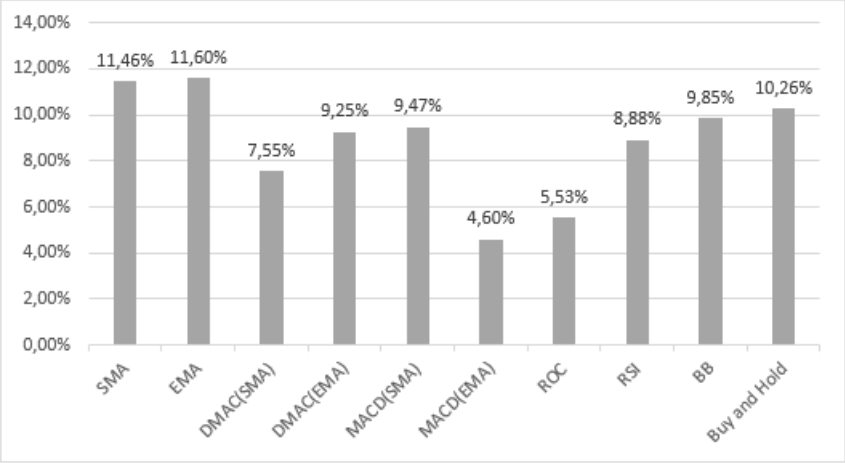


Figure 4.36: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the ten-year data for no transaction fees (Constant Exchange Rate)

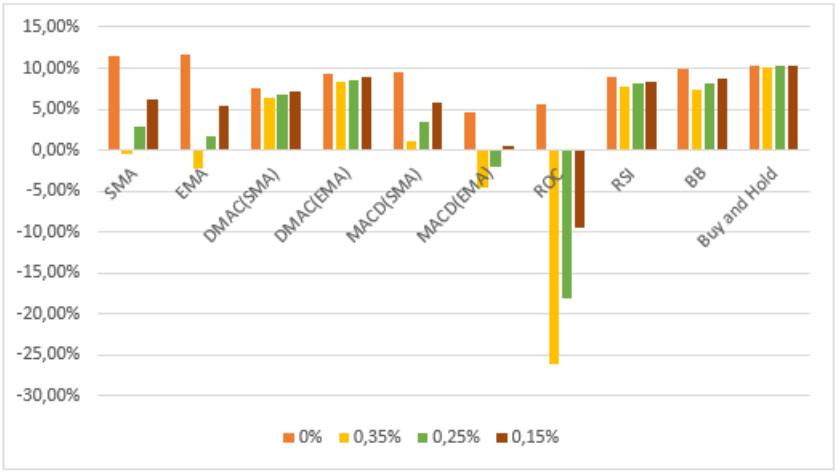


Figure 4.37: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the ten-year data for all transaction fees (Constant Exchange Rate)

For period C: the EMA indicator outperformed the buy and hold strategy in the absence of transaction costs. When considering transaction costs, the buy and hold strategy is unbeaten.

For the average returns of period A, B and C: the buy and hold strategy is unbeaten with and without transaction costs.

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

Table 4.15: JSE Top 40, S&P 500 and NIFTY 50 - Summary of period A, B & C returns for ten years (Varying Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,13%	-1,49%	1,70%	4,99%
EMA	11,96%	-1,73%	2,00%	5,87%
DMAC(SMA)	10,30%	9,18%	9,50%	9,82%
DMAC(EMA)	10,55%	9,67%	9,92%	10,17%
MACD(SMA)	14,43%	5,77%	8,17%	10,63%
MACD(EMA)	11,26%	1,54%	4,23%	6,98%
ROC	10,74%	-22,39%	-14,09%	-4,91%
RSI	9,22%	8,12%	8,43%	8,75%
BB	10,78%	8,47%	9,12%	9,78%
Buy and Hold	13,31%	13,23%	13,25%	13,27%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,29%	-0,80%	2,52%	5,94%
EMA	11,96%	-1,91%	1,87%	5,79%
DMAC(SMA)	7,63%	6,56%	6,87%	7,17%
DMAC(EMA)	8,26%	7,43%	7,66%	7,90%
MACD(SMA)	12,85%	4,28%	6,66%	9,09%
MACD(EMA)	9,04%	-0,56%	2,09%	4,82%
ROC	9,06%	-23,61%	-15,43%	-6,37%
RSI	9,32%	8,27%	8,57%	8,87%
BB	8,24%	5,69%	6,42%	7,14%
Buy and Hold	13,09%	13,01%	13,04%	13,06%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,50%	-1,57%	2,00%	5,70%
EMA	10,96%	-4,39%	-0,23%	4,10%
DMAC(SMA)	5,51%	4,20%	4,57%	4,95%
DMAC(EMA)	6,62%	5,44%	5,77%	6,11%
MACD(SMA)	11,54%	2,97%	5,35%	7,78%
MACD(EMA)	8,28%	-1,83%	0,96%	3,82%
ROC	7,21%	-25,68%	-17,48%	-8,37%
RSI	8,53%	7,47%	7,77%	8,07%
BB	9,84%	7,74%	8,53%	8,67%
Buy and Hold	11,26%	11,00%	11,08%	11,15%

Summary of Average Returns for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,66%	-1,32%	2,48%	5,90%
EMA	11,24%	-4,07%	0,28%	4,40%
DMAC(SMA)	8,59%	7,34%	7,40%	8,05%
DMAC(EMA)	9,24%	8,06%	8,15%	8,73%
MACD(SMA)	11,88%	3,16%	5,08%	8,05%
MACD(EMA)	9,08%	-1,13%	1,07%	4,58%
ROC	7,66%	-25,45%	-17,40%	-8,03%
RSI	8,44%	7,36%	7,63%	7,98%
BB	9,96%	7,46%	8,00%	8,79%
Buy and Hold	11,11%	10,85%	10,92%	11,00%

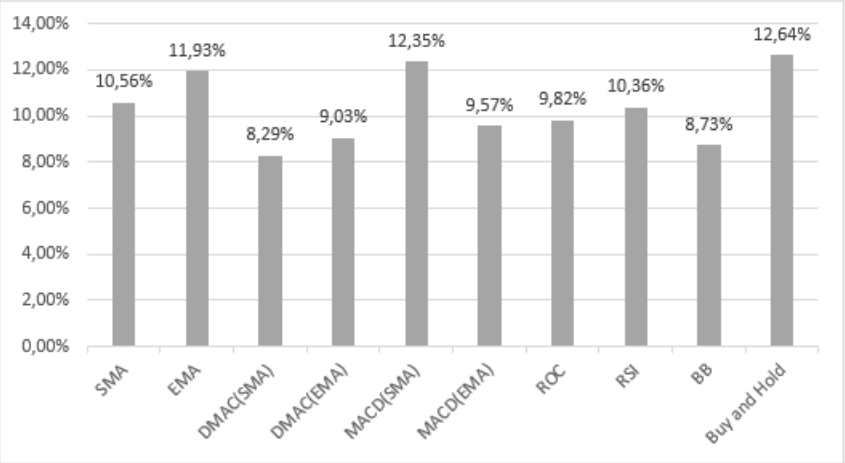


Figure 4.38: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the ten-year data for no transaction fees (Varying Exchange Rate)

4.4.2.2 Twenty-Year Periods

Constant Exchange Rate

Table 4.16 summarises the returns for each of the three periods for $b = 100\%$.

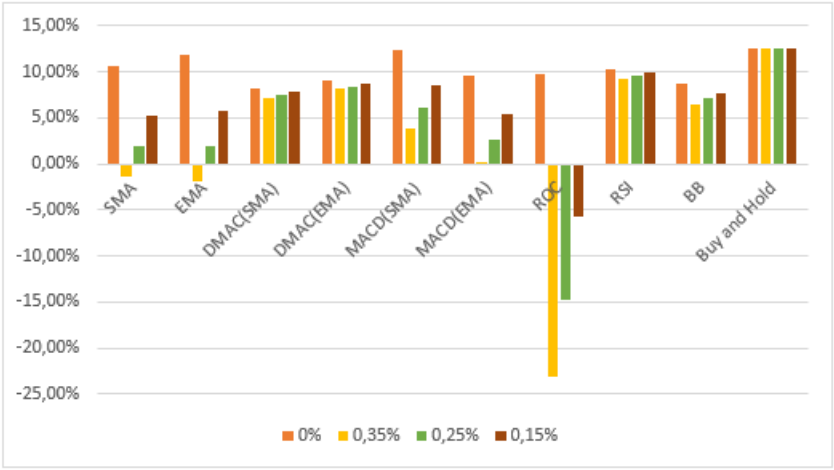


Figure 4.39: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the ten-year data for all transaction fees (Varying Exchange Rate)

Table 4.16: JSE Top 40, S&P 500 and NIFTY 50 - Summary of period A, B & C returns for twenty years (Constant Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,31%	-0,43%	2,79%	6,12%
EMA	11,59%	-2,06%	1,66%	5,52%
DMAC(SMA)	8,04%	6,97%	7,28%	7,58%
DMAC(EMA)	9,73%	8,89%	9,13%	9,37%
MACD(SMA)	11,31%	2,89%	5,23%	7,62%
MACD(EMA)	5,95%	-3,28%	-0,73%	1,89%
ROC	6,12%	-25,61%	-17,66%	-8,86%
RSI	9,05%	7,95%	-17,66%	-8,86%
BB	8,58%	6,47%	8,26%	8,57%
Buy and Hold	10,69%	10,65%	10,66%	10,67%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,94%	-0,22%	3,12%	6,56%
EMA	11,79%	-2,06%	1,71%	5,63%
DMAC(SMA)	7,28%	6,21%	6,51%	6,82%
DMAC(EMA)	8,87%	8,04%	8,28%	8,52%
MACD(SMA)	9,83%	1,52%	3,83%	6,19%
MACD(EMA)	4,36%	-4,80%	-2,27%	0,33%
ROC	5,28%	-26,24%	-18,35%	-9,61%
RSI	9,55%	8,48%	-18,35%	-9,61%
BB	9,32%	6,63%	8,78%	9,09%
Buy and Hold	11,05%	11,01%	11,02%	11,03%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,13%	-0,90%	2,39%	5,80%
EMA	11,49%	-2,24%	1,50%	5,38%
DMAC(SMA)	7,10%	6,02%	6,33%	6,64%
DMAC(EMA)	9,17%	8,31%	8,55%	8,80%
MACD(SMA)	7,34%	-0,75%	1,50%	3,80%
MACD(EMA)	3,37%	-5,56%	-3,09%	-0,56%
ROC	5,24%	-26,23%	-18,35%	-9,63%
RSI	8,30%	7,26%	-18,35%	-9,63%
BB	8,00%	5,47%	7,55%	7,85%
Buy and Hold	8,81%	8,77%	8,78%	8,79%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,46%	-0,52%	2,77%	6,16%
EMA	11,63%	-2,12%	1,62%	5,51%
DMAC(SMA)	7,48%	6,40%	6,71%	7,01%
DMAC(EMA)	9,26%	8,41%	8,65%	8,90%
MACD(SMA)	9,49%	1,22%	3,52%	5,87%
MACD(EMA)	4,56%	-4,55%	-2,03%	0,55%
ROC	5,55%	-26,03%	-18,12%	-9,37%
RSI	8,96%	7,90%	-18,12%	-9,37%
BB	8,63%	6,19%	8,20%	8,50%
Buy and Hold	10,18%	10,14%	10,15%	10,16%

For period A: EMA, SMA and MACD(SMA) outperformed the buy and hold strategy when there are no transaction costs. In the presence of transaction costs the buy and hold strategy is unbeaten.

For period B: SMA and EMA outperformed the buy and hold strategy in the absence of trans-

action costs. The buy and hold strategy is once again unbeaten when transaction costs are considered.

For period C: EMA, SMA and MACD(SMA) outperformed the buy and hold strategy in the absence of transaction costs. The buy and hold strategy is unbeaten for transaction costs of 0.35% and 0.25%. When considering a lower transaction cost of 0.15%, the DMAC(SMA) indicator outperformed the buy and hold strategy.

For the average returns of period A, B and C: only EMA and SMA outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

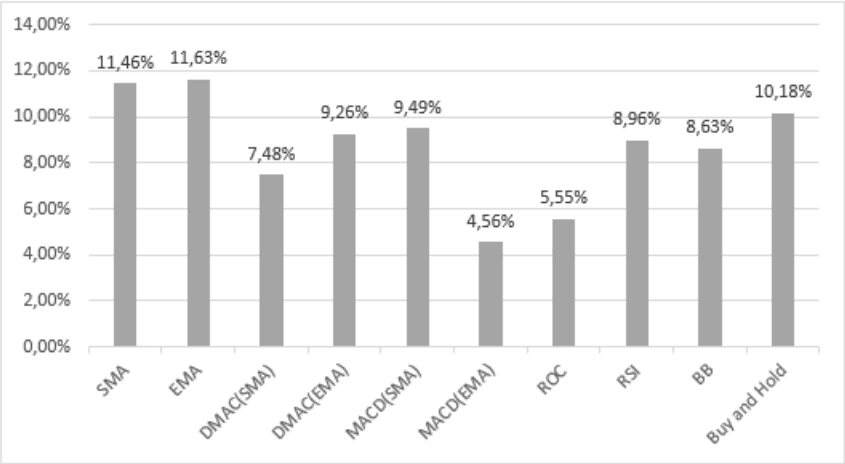


Figure 4.40: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the twenty-year data for no transaction fees (Constant Exchange Rate)

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

Varying Exchange Rate

Table 4.17 summarises the returns for each of the three periods for $b = 100\%$.

For period A and B: the MACD(SMA) indicator outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

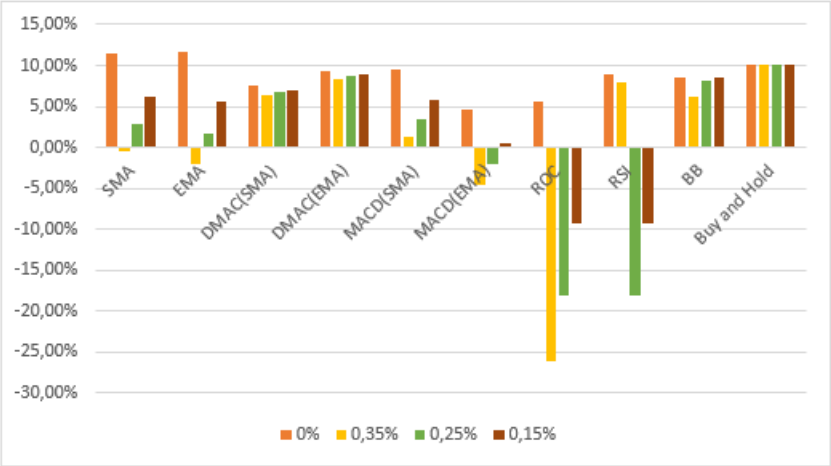


Figure 4.41: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the twenty-year data for all transaction fees (Constant Exchange Rate)

Table 4.17: JSE Top 40, S&P 500 and NIFTY 50 - Summary of period A, B & C returns for twenty years (Varying Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,13%	-1,49%	1,70%	4,99%
EMA	11,96%	-1,73%	2,00%	5,87%
DMAC(SMA)	10,17%	9,08%	9,39%	9,70%
DMAC(EMA)	10,51%	9,67%	9,91%	10,15%
MACD(SMA)	14,43%	5,77%	8,17%	10,63%
MACD(EMA)	11,21%	1,52%	4,20%	6,95%
ROC	10,67%	-22,42%	-14,13%	-4,96%
RSI	10,67%	-22,42%	-14,13%	-4,96%
BB	9,70%	8,66%	8,96%	9,25%
Buy and Hold	12,64%	12,60%	12,61%	12,62%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,29%	-0,80%	2,52%	5,94%
EMA	12,04%	-1,84%	1,94%	5,86%
DMAC(SMA)	7,63%	6,56%	6,87%	7,17%
DMAC(EMA)	8,26%	7,43%	7,66%	7,90%
MACD(SMA)	12,85%	4,31%	6,68%	9,11%
MACD(EMA)	9,04%	-0,53%	2,12%	4,83%
ROC	9,30%	-23,42%	-15,23%	-6,16%
RSI	11,98%	10,92%	11,22%	11,52%
BB	6,55%	4,52%	5,10%	5,68%
Buy and Hold	12,81%	12,77%	12,78%	12,79%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,26%	-1,68%	1,59%	4,97%
EMA	11,88%	-1,89%	1,86%	5,76%
DMAC(SMA)	6,85%	5,76%	6,07%	6,38%
DMAC(EMA)	8,01%	7,16%	7,40%	7,65%
MACD(SMA)	9,82%	1,55%	3,85%	6,20%
MACD(EMA)	8,33%	-1,03%	1,56%	4,21%
ROC	9,65%	-23,15%	-14,94%	-5,84%
RSI	10,32%	9,22%	9,54%	9,85%
BB	6,66%	4,77%	5,31%	5,84%
Buy and Hold	10,49%	10,45%	10,46%	10,47%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,56%	-1,32%	1,93%	5,30%
EMA	11,96%	-1,82%	1,93%	5,83%
DMAC(SMA)	8,22%	7,14%	7,44%	7,75%
DMAC(EMA)	8,93%	8,08%	8,32%	8,57%
MACD(SMA)	12,37%	3,88%	6,23%	8,65%
MACD(EMA)	9,53%	-0,01%	2,62%	5,33%
ROC	9,88%	-23,00%	-14,77%	-5,65%
RSI	10,99%	-0,76%	2,21%	5,47%
BB	7,64%	5,99%	6,45%	6,92%
Buy and Hold	11,98%	11,94%	11,95%	11,96%

For period C: the EMA indicator outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

For the average returns of period A, B and C: the MACD(SMA) indicator outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into

account, the buy and hold strategy is unbeaten.

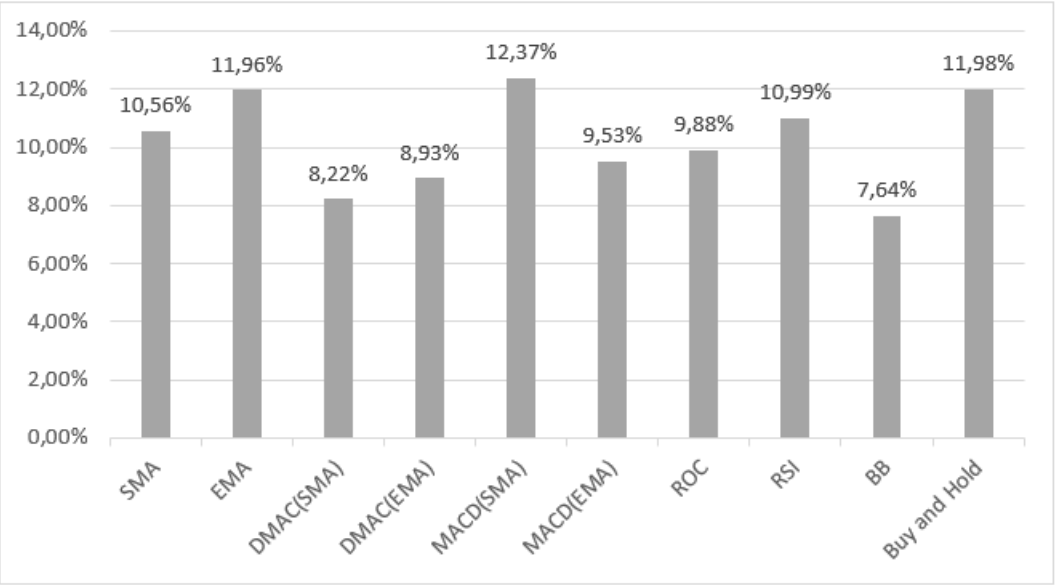


Figure 4.42: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the twenty-year data for no transaction fees (Varying Exchange Rate)

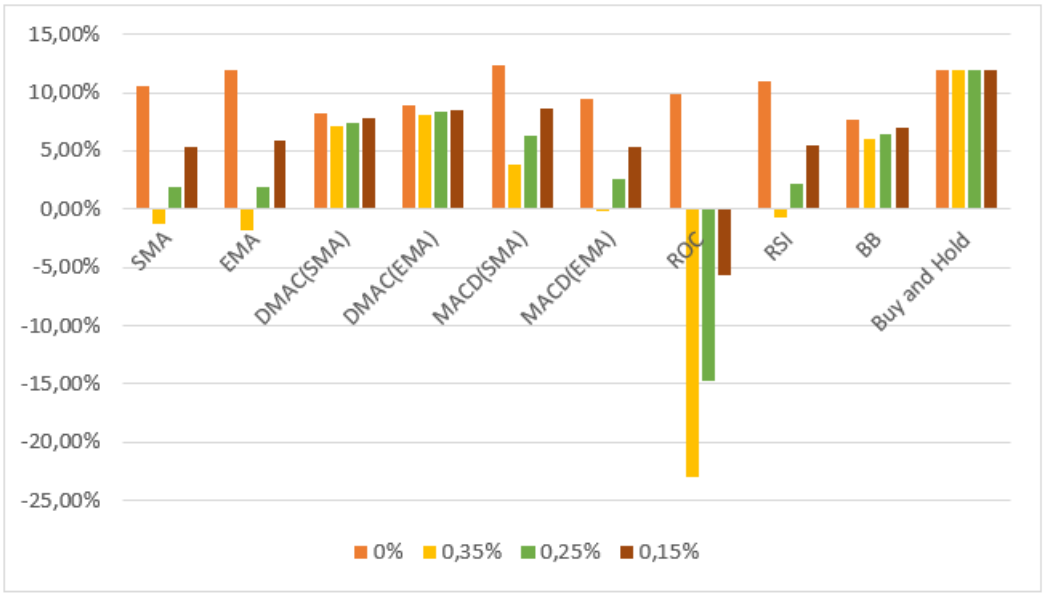


Figure 4.43: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the twenty-year data for all transaction fees (Varying Exchange Rate)

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

4.4.3 JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 combination

In this subsection, the JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 combination is discussed. For the constant exchange rate scenario, the five-, ten- and twenty-year periods produced similar results. Therefore, only the twenty-year periods, along with the three-year periods, are presented in this section and the rest is presented in Appendix A section A.2.3. For the varying exchange rate scenario, the five-year period and twenty-year period produced similar results. Only the three-, ten- and twenty-year periods are presented in this chapter. The results for the five-year periods can be seen in Appendix A section A.2.3.

4.4.3.1 Three-Year Periods

Constant Exchange Rate

Table 4.18 summarises the returns for each of the three periods for $b = 100\%$.

Table 4.18: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Summary of period A, B & C returns for three years (Constant Exchange Rate)

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	13,31%	0,09%	3,70%	7,44%
EMA	11,95%	-3,60%	0,61%	5,00%
DMAC(SMA)	6,79%	5,57%	5,92%	6,26%
DMAC(EMA)	7,51%	6,34%	6,67%	7,01%
MACD(SMA)	8,34%	-0,19%	2,17%	4,60%
MACD(EMA)	5,15%	-4,75%	-2,02%	0,79%
ROC	3,01%	-28,73%	-20,83%	-12,04%
RSI	3,01%	-28,73%	-20,83%	-12,04%
BB	6,01%	5,03%	5,31%	5,59%
Buy and Hold	8,51%	8,26%	8,33%	8,40%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,94%	-0,22%	3,12%	6,56%
EMA	11,79%	-2,06%	1,71%	5,63%
DMAC(SMA)	7,28%	6,21%	6,51%	6,82%
DMAC(EMA)	8,87%	8,04%	8,28%	8,52%
MACD(SMA)	9,83%	1,52%	3,83%	6,19%
MACD(EMA)	4,36%	-4,80%	-2,27%	0,33%
ROC	5,28%	-26,24%	-18,35%	-9,61%
RSI	9,55%	8,48%	-18,35%	-9,61%
BB	9,32%	6,63%	8,78%	9,09%
Buy and Hold	11,05%	11,01%	11,02%	11,03%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,13%	-0,90%	2,39%	5,80%
EMA	11,49%	-2,24%	1,50%	5,38%
DMAC(SMA)	7,10%	6,02%	6,33%	6,64%
DMAC(EMA)	9,17%	8,31%	8,55%	8,80%
MACD(SMA)	7,34%	-0,75%	1,50%	3,80%
MACD(EMA)	3,37%	-5,56%	-3,09%	-0,56%
ROC	5,24%	-26,23%	-18,35%	-9,63%
RSI	8,30%	7,26%	-18,35%	-9,63%
BB	8,00%	5,47%	7,55%	7,85%
Buy and Hold	8,81%	8,77%	8,78%	8,79%

Summary of Average Returns for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,25%	-0,22%	3,19%	6,73%
EMA	11,72%	-2,67%	1,24%	5,31%
DMAC(SMA)	7,37%	6,16%	6,50%	6,85%
DMAC(EMA)	8,72%	7,66%	7,96%	8,26%
MACD(SMA)	9,45%	0,99%	3,34%	5,74%
MACD(EMA)	5,11%	-4,36%	-1,74%	0,94%
ROC	4,91%	-26,76%	-18,84%	-10,07%
RSI	6,80%	-4,53%	-1,68%	1,46%
BB	8,63%	6,50%	7,11%	7,71%
Buy and Hold	8,28%	8,03%	8,10%	8,17%

For period A: SMA and EMA outperformed the buy and hold strategy when there are no transaction costs. In the presence of transaction costs, these returns were eroded. Therefore, the buy and hold strategy is unbeaten when taking transaction costs into account.

For period B: seven of the indicators outperformed the buy and hold strategy when there are no transaction costs. These indicators include (in descending order): MACD(SMA), SMA, BB, EMA, DMAC(EMA), RSI and DMAC(SMA). In presence of transaction costs, four of the indicators still outperformed the buy and hold startegy. These indicators include: DMAC(SMA), DMAC(EMA), RSI and BB.

For period C: SMA, EMA, DMAC(EMA), BB and MACD(SMA) outperformed the buy and hold strategy when there are no transaction costs. For a low transaction cost of 0.15%, the DMAC(EMA) indicator outperformed the buy and hold strategy. For higher transaction costs of 0.25% and 0.35%, the buy and hold strategy is unbeaten.

For the average returns of period A, B and C: SMA, EMA, MACD(SMA), DMAC(EMA) and BB outperformed the buy and hold strategy. For a low transaction cost of 0.15%, the DMAC(EMA) indicator outperformed the buy and hold strategy. For higher transaction costs of 0.25% and 0.35%, the buy and hold strategy is unbeaten.

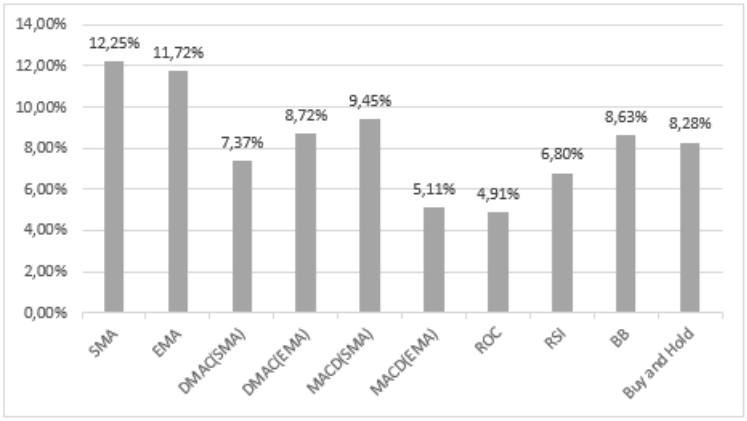


Figure 4.44: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the three-year data for no transaction fees (Constant Exchange Rate)

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

Varying Exchange Rate

Table 4.19 summarises the returns for each of the three periods for $b = 100\%$.

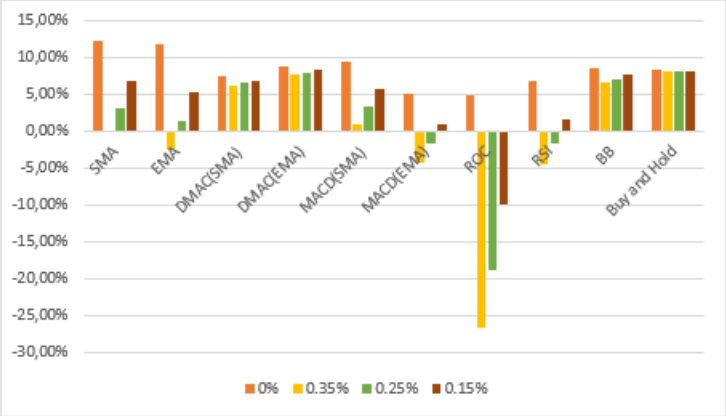


Figure 4.45: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the three-year data for all transaction fees (Constant Exchange Rate)

Table 4.19: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Summary of period A, B & C returns for three years (Varying Exchange Rate)

Summary Period A				
YEARS				
	0%	0.35%	0.25%	0.15%
SMA	13,13%	-0,07%	3,54%	7,27%
EMA	12,50%	-3,11%	1,11%	5,52%
DMAC(SMA)	8,96%	7,72%	8,07%	8,43%
DMAC(EMA)	8,89%	7,70%	8,04%	8,37%
MACD(SMA)	12,30%	3,46%	5,91%	8,42%
MACD(EMA)	9,60%	-0,72%	2,13%	5,05%
ROC	7,19%	-25,85%	-17,62%	-8,47%
RSI	8,08%	7,04%	7,34%	7,63%
BB	10,19%	7,59%	8,33%	9,07%
Buy and Hold	11,25%	10,99%	11,07%	11,14%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,33%	-2,33%	1,13%	4,72%
EMA	10,25%	-4,71%	-0,66%	3,57%
DMAC(SMA)	11,29%	10,11%	10,45%	10,78%
DMAC(EMA)	12,21%	11,04%	11,37%	11,70%
MACD(SMA)	11,80%	3,04%	5,47%	7,96%
MACD(EMA)	9,37%	-0,85%	1,97%	4,86%
ROC	8,58%	-24,84%	-16,51%	-7,26%
RSI	8,72%	7,58%	7,90%	8,23%
BB	9,84%	7,06%	7,85%	8,64%
Buy and Hold	10,81%	10,56%	10,63%	10,70%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,50%	-1,57%	2,94%	5,70%
EMA	10,96%	-4,39%	0,25%	4,10%
DMAC(SMA)	5,51%	4,20%	3,89%	4,95%
DMAC(EMA)	6,62%	5,44%	5,17%	6,11%
MACD(SMA)	11,54%	2,97%	1,05%	7,78%
MACD(EMA)	8,28%	-1,83%	-3,26%	3,82%
ROC	7,21%	-25,68%	-20,54%	-8,37%
RSI	8,53%	7,47%	5,86%	8,07%
BB	10,52%	7,74%	4,34%	9,32%
Buy and Hold	11,26%	11,00%	11,08%	11,15%

Summary of Average Return for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,66%	-1,32%	2,22%	5,90%
EMA	11,24%	-4,07%	0,07%	4,40%
DMAC(SMA)	8,59%	7,34%	7,70%	8,05%
DMAC(EMA)	9,24%	8,06%	8,39%	8,73%
MACD(SMA)	11,88%	3,16%	5,58%	8,05%
MACD(EMA)	9,08%	-1,13%	1,68%	4,58%
ROC	7,66%	-25,45%	-17,20%	-8,03%
RSI	8,44%	7,36%	7,67%	7,98%
BB	9,96%	7,46%	8,23%	8,79%
Buy and Hold	11,11%	10,85%	10,92%	11,00%

For period A: SMA, EMA and MACD(SMA) outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

For period B: DMAC(EMA), MACD(SMA) and DMAC(SMA) outperforms the buy and hold strategy in the absence of transaction costs. The DMAC(EMA) outperformed the buy and

hold strategy for all transaction costs. The DMAC(SMA) also outperformed the buy and hold strategy for a transaction cost of 0.15%.

For period C: MACD(SMA) and SMA outperformed the buy and hold strategy in the absence of transaction costs. The buy and hold strategy is unbeaten in the presence of transaction costs.

For the average returns of period A, B and C: DMAC(SMA), SMA and EMA outperformed the buy and hold strategy when there are no transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

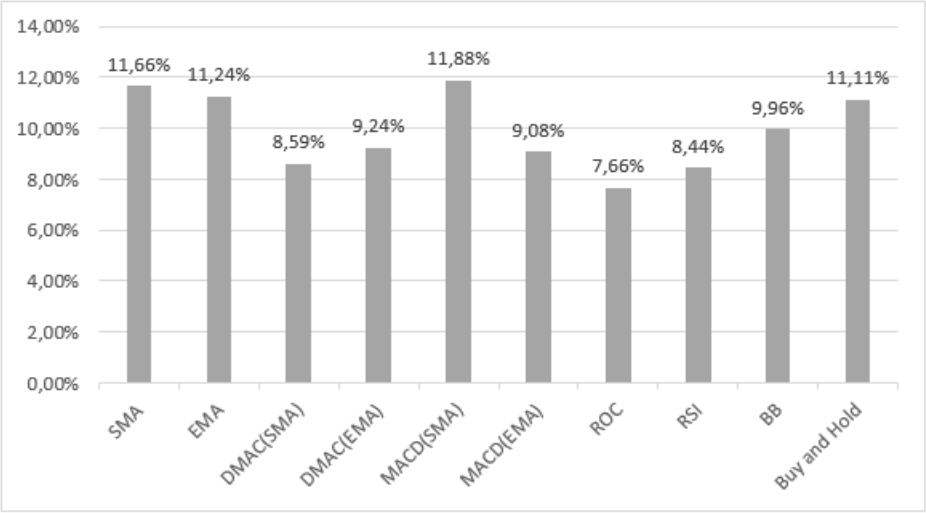


Figure 4.46: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the three-year data for no transaction fees (Varying Exchange Rate)

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

4.4.3.2 Five-Year Periods

Varying Exchange Rate

Table 4.20 summarises the returns for each of the three periods for $b = 100\%$.

For period A: SMA outperformed the buy and hold strategy when there are no transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

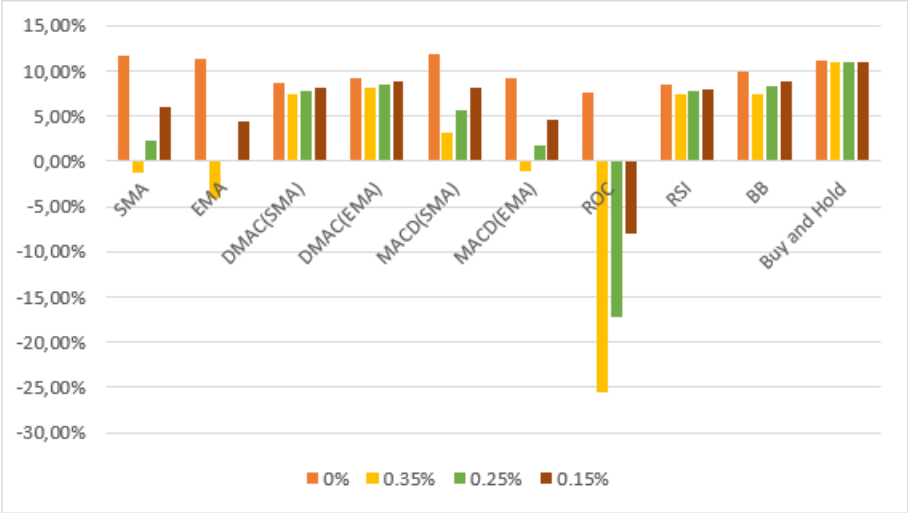


Figure 4.47: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the three-year data for all transaction fees (Varying Exchange Rate)

Table 4.20: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Summary of period A, B & C returns for five years (Varying Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,92%	-0,85%	1,71%	5,29%
EMA	10,83%	-4,27%	0,38%	4,67%
DMAC(SMA)	7,94%	6,80%	9,43%	9,76%
DMAC(EMA)	9,20%	8,16%	10,64%	10,94%
MACD(SMA)	7,97%	-0,42%	5,80%	8,27%
MACD(EMA)	4,98%	-4,87%	1,96%	4,87%
ROC	3,26%	-28,57%	-17,08%	-7,87%
RSI	7,09%	6,08%	8,22%	8,51%
BB	9,43%	6,86%	9,32%	10,12%
Buy and Hold	12,83%	12,68%	12,72%	12,77%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,90%	-2,01%	1,52%	5,17%
EMA	10,32%	-4,76%	-0,68%	3,58%
DMAC(SMA)	7,74%	6,60%	6,92%	7,25%
DMAC(EMA)	9,17%	8,17%	8,45%	8,74%
MACD(SMA)	11,81%	3,19%	5,58%	8,03%
MACD(EMA)	8,17%	-1,88%	0,89%	3,74%
ROC	6,80%	-26,09%	-17,89%	-8,79%
RSI	5,95%	5,00%	5,27%	5,54%
BB	9,02%	6,39%	7,13%	7,89%
Buy and Hold	11,51%	11,35%	11,40%	11,44%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,18%	-2,50%	0,97%	4,55%
EMA	9,63%	-5,39%	-1,32%	2,92%
DMAC(SMA)	4,17%	2,97%	3,31%	3,65%
DMAC(EMA)	4,48%	3,24%	3,59%	3,95%
MACD(SMA)	9,99%	1,54%	3,89%	6,29%
MACD(EMA)	8,16%	-1,70%	1,02%	3,82%
ROC	6,61%	-26,05%	-17,90%	-8,86%
RSI	7,20%	6,21%	6,49%	6,77%
BB	8,37%	5,78%	6,51%	7,25%
Buy and Hold	10,50%	10,35%	10,39%	10,44%

Summary of Average Returns for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,00%	-1,79%	1,40%	5,01%
EMA	10,26%	-4,81%	-0,54%	3,73%
DMAC(SMA)	6,62%	5,46%	6,55%	6,89%
DMAC(EMA)	7,61%	6,52%	7,56%	7,87%
MACD(SMA)	9,93%	1,44%	5,09%	7,53%
MACD(EMA)	7,10%	-2,82%	1,29%	4,14%
ROC	5,56%	-26,90%	-17,62%	-8,51%
RSI	6,74%	5,76%	6,66%	6,94%
BB	8,94%	6,34%	7,66%	8,42%
Buy and Hold	11,62%	11,46%	11,50%	11,55%

For period B: MACD(SMA) and SMA outperforms the buy and hold strategy when there are no transaction costs. In the presence of transaction costs, the buy and hold strategy is unbeaten.

For period C: SMA, MACD(SMA) and EMA outperforms the buy and hold strategy when there

are no transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

For the average returns of period A, B and C: only the SMA indicator outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

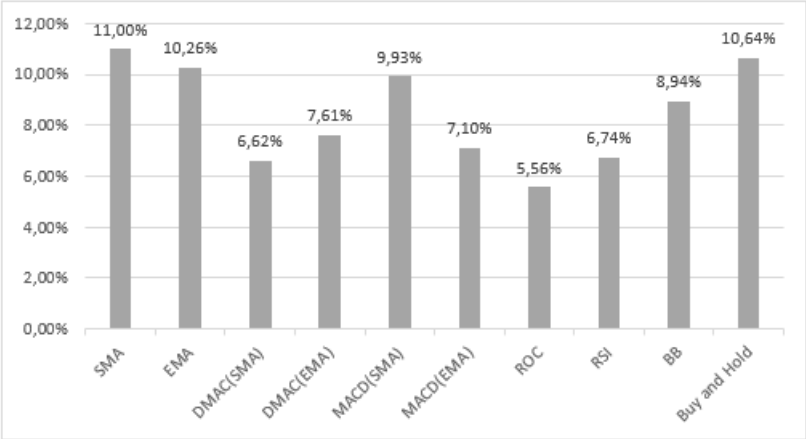


Figure 4.48: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the five-year data for no transaction fees (Varying Exchange Rate)

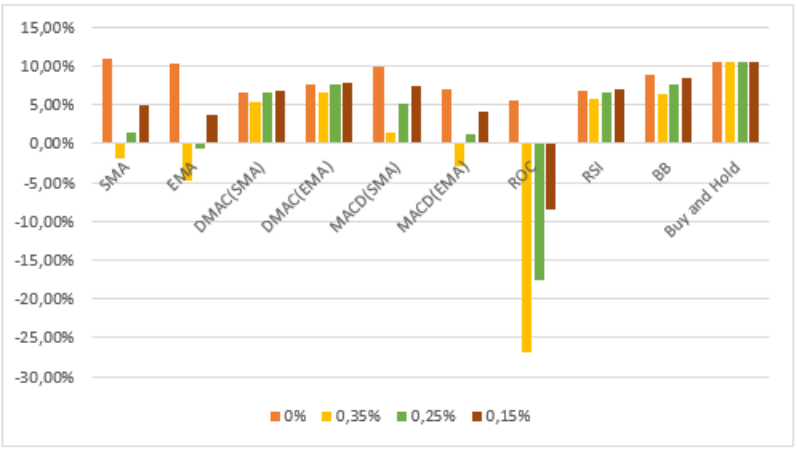


Figure 4.49: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the five-year data for all transaction fees (Varying Exchange Rate)

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

4.4.3.3 Ten-Year Periods

Varying Exchange Rate

Table 4.21 summarises the returns for each of the three periods for $b = 100\%$.

Table 4.21: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Summary of period A, B & C returns for ten years (Varying Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,07%	-1,55%	1,90%	5,47%
EMA	11,61%	-3,53%	0,57%	4,85%
DMAC(SMA)	9,33%	8,21%	8,53%	8,85%
DMAC(EMA)	10,35%	9,35%	9,63%	9,92%
MACD(SMA)	12,37%	3,67%	6,08%	8,55%
MACD(EMA)	9,43%	-0,78%	2,03%	4,93%
ROC	7,92%	-25,33%	-17,04%	-7,84%
RSI	8,93%	7,94%	8,22%	8,50%
BB	13,29%	10,59%	11,36%	12,13%
Buy and Hold	11,84%	11,76%	11,78%	11,80%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,90%	-2,01%	1,52%	5,17%
EMA	10,32%	-4,76%	-0,67%	3,59%
DMAC(SMA)	7,71%	6,65%	6,95%	7,26%
DMAC(EMA)	8,63%	7,67%	7,94%	8,22%
MACD(SMA)	12,08%	3,48%	5,87%	8,31%
MACD(EMA)	8,85%	-1,20%	1,57%	4,42%
ROC	6,78%	-26,06%	-17,88%	-8,78%
RSI	5,96%	5,06%	5,31%	5,57%
BB	9,03%	6,39%	7,14%	7,89%
Buy and Hold	11,43%	11,35%	11,38%	11,40%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	9,91%	-2,72%	0,74%	4,31%
EMA	9,96%	-5,10%	-1,02%	3,23%
DMAC(SMA)	6,42%	5,31%	5,63%	5,94%
DMAC(EMA)	6,93%	5,84%	6,15%	6,46%
MACD(SMA)	9,92%	1,53%	3,86%	6,24%
MACD(EMA)	8,12%	-1,67%	1,03%	3,81%
ROC	6,57%	-26,07%	-17,93%	-8,89%
RSI	6,94%	5,99%	6,26%	6,54%
BB	7,22%	5,15%	5,74%	6,33%
Buy and Hold	10,01%	9,93%	9,96%	9,98%

Summary of Average Return for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,63%	-2,09%	1,38%	4,99%
EMA	10,63%	-4,46%	-0,37%	3,89%
DMAC(SMA)	7,82%	6,72%	7,04%	7,35%
DMAC(EMA)	8,63%	7,62%	7,91%	8,20%
MACD(SMA)	11,46%	2,90%	5,27%	7,70%
MACD(EMA)	8,80%	-1,22%	1,55%	4,39%
ROC	7,09%	-25,82%	-17,62%	-8,51%
RSI	7,28%	6,33%	6,60%	6,87%
BB	9,85%	7,38%	8,08%	8,78%
Buy and Hold	11,09%	11,02%	11,04%	11,06%

For period A: BB and MACD(SMA) outperformed the buy and hold strategy when there are no transaction costs. When considering high transaction costs of 0.35% and 0.25%, the buy and hold strategy is unbeaten. When lowering the transaction costs, the BB indicator outperformed the buy and hold strategy.

For period B: MACD(SMA) outperformed the buy and hold strategy when there are no transaction costs. When considering transaction costs, the buy and hold strategy is unbeaten.

For period C: the buy and hold strategy is unbeaten for all possible transaction costs and when there are no transaction costs.

For the average returns of period A, B and C: the MACD(SMA) indicator is the only indicator

to outperform the buy and hold strategy when there are no transaction costs. In the presence of transaction costs, the buy and hold strategy is unbeaten.

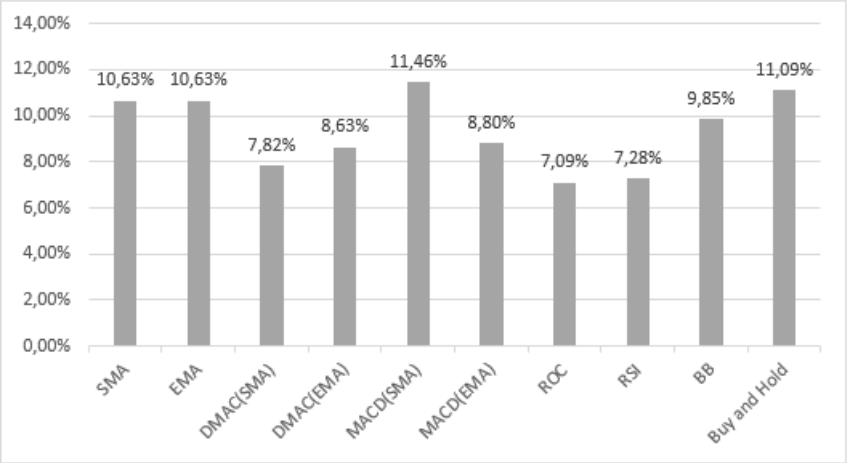


Figure 4.50: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the ten-year data for no transaction fees (Varying Exchange Rate)

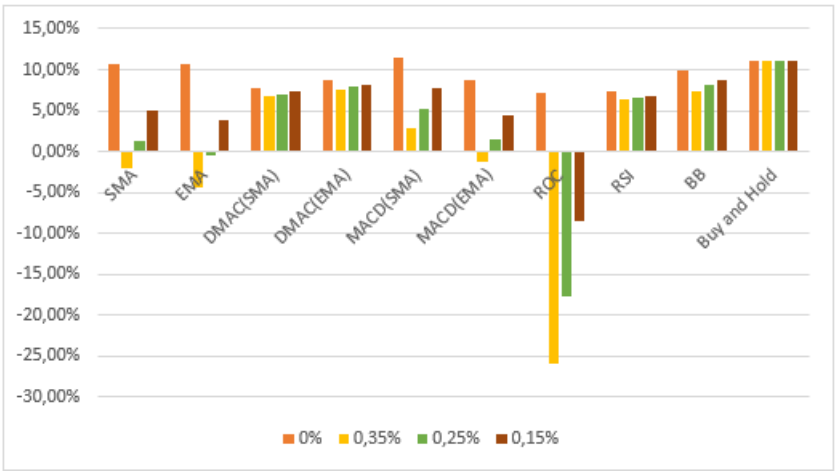


Figure 4.51: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the ten-year data for all transaction fees (Varying Exchange Rate)

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

4.4.3.4 Twenty-Year Periods

Constant Exchange Rate

Table 4.22 summarises the returns for each of the three periods for $b = 100\%$.

Table 4.22: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Summary of period A, B & C returns for twenty years (Constant Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,97%	-0,76%	2,72%	6,33%
EMA	10,95%	-4,10%	-0,02%	4,23%
DMAC(SMA)	7,60%	6,53%	6,84%	7,14%
DMAC(EMA)	9,17%	8,22%	8,49%	8,77%
MACD(SMA)	8,11%	-0,25%	2,07%	4,45%
MACD(EMA)	4,95%	-4,83%	-2,13%	0,64%
ROC	3,25%	-28,54%	-20,62%	-11,82%
RSI	6,51%	5,58%	5,84%	6,11%
BB	9,84%	7,18%	7,93%	8,69%
Buy and Hold	9,45%	9,41%	9,42%	9,43%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,81%	-1,21%	2,34%	6,03%
EMA	10,64%	-4,49%	-0,39%	3,88%
DMAC(SMA)	7,52%	6,46%	6,76%	7,07%
DMAC(EMA)	8,75%	7,79%	8,07%	8,34%
MACD(SMA)	7,60%	-0,61%	1,67%	4,00%
MACD(EMA)	4,49%	-5,12%	-2,47%	0,26%
ROC	3,00%	-28,66%	-20,77%	-12,00%
RSI	4,78%	3,92%	4,16%	4,41%
BB	8,78%	6,44%	7,10%	7,77%
Buy and Hold	9,72%	9,68%	9,69%	9,70%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,65%	-2,07%	1,41%	5,01%
EMA	10,13%	-4,96%	-0,88%	3,39%
DMAC(SMA)	6,70%	5,59%	5,91%	6,23%
DMAC(EMA)	7,34%	6,30%	6,59%	6,89%
MACD(SMA)	5,44%	-2,57%	-0,35%	1,93%
MACD(EMA)	3,06%	-6,28%	-3,70%	-1,05%
ROC	2,40%	-28,95%	-21,13%	-12,45%
RSI	6,39%	5,44%	5,71%	5,98%
BB	5,49%	3,38%	3,98%	4,58%
Buy and Hold	7,60%	7,56%	7,58%	7,59%

Summary of Average Return for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,48%	-1,35%	2,16%	5,79%
EMA	10,57%	-4,52%	-0,43%	3,84%
DMAC(SMA)	7,27%	6,20%	6,50%	6,81%
DMAC(EMA)	8,42%	7,44%	7,72%	8,00%
MACD(SMA)	7,05%	-1,15%	1,13%	3,46%
MACD(EMA)	4,17%	-5,41%	-2,77%	-0,05%
ROC	2,88%	-28,72%	-20,84%	-12,09%
RSI	5,89%	4,98%	5,24%	5,50%
BB	8,04%	5,67%	6,34%	7,02%
Buy and Hold	8,92%	8,88%	8,90%	8,91%

For period A: SMA, EMA and BB outperformed the buy and hold strategy when ignoring transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

For period B, C and the average returns of the three periods: SMA and EMA outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeaten.

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

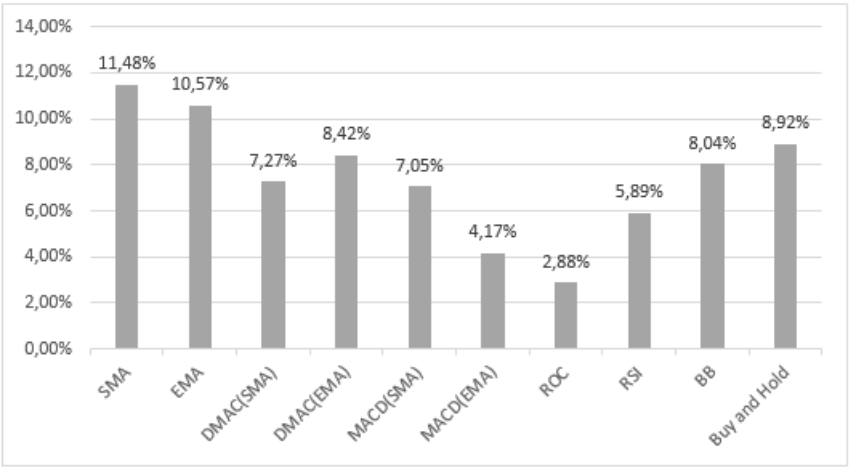


Figure 4.52: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the twenty-year data for no transaction fees (Constant Exchange Rate)

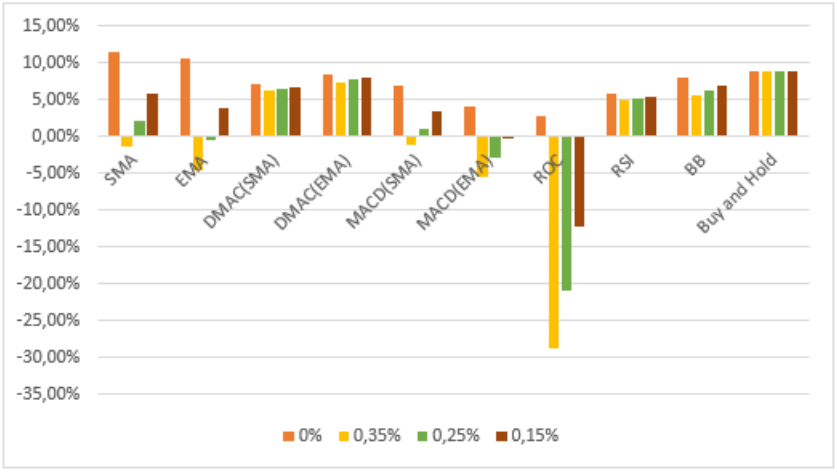


Figure 4.53: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the twenty-year data for all transaction fees (Constant Exchange Rate)

Varying Exchange Rate

Table 4.23 summarises the returns for each of the three periods for $b = 100\%$.

For period A: MACD(SMA) and EMA outperformed the buy and hold strategy when there are no transaction costs. In the presence of transaction costs, the buy and hold strategy is unbeaten.

For period B: only the MACD(SMA) indicator outperformed the buy and hold strategy. When considering transaction costs, the buy and hold strategy is once again unbeaten.

For period C: MACD(SMA), EMA and SMA outperformed the buy and hold strategy when

Table 4.23: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Summary of period A, B & C returns for twenty years (Varying Exchange Rate)

Summary Period A				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,07%	-1,55%	1,90%	5,47%
EMA	11,59%	-3,54%	0,56%	4,83%
DMAC(SMA)	9,29%	8,21%	8,52%	8,82%
DMAC(EMA)	10,30%	9,34%	9,62%	9,89%
MACD(SMA)	12,37%	3,67%	6,08%	8,55%
MACD(EMA)	9,38%	-0,80%	2,00%	4,89%
ROC	7,87%	-25,35%	-17,07%	-7,87%
RSI	8,19%	7,25%	7,52%	7,79%
BB	11,16%	8,56%	9,29%	10,03%
Buy and Hold	11,53%	11,49%	11,51%	11,52%

Summary Period B				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,91%	-2,01%	1,52%	5,17%
EMA	10,40%	-4,69%	-0,60%	3,66%
DMAC(SMA)	7,71%	6,65%	6,95%	7,26%
DMAC(EMA)	8,63%	7,67%	7,94%	8,22%
MACD(SMA)	12,08%	3,52%	5,90%	8,33%
MACD(EMA)	8,89%	-1,13%	1,64%	4,48%
ROC	6,96%	-25,92%	-17,73%	-8,62%
RSI	4,82%	3,98%	4,22%	4,46%
BB	10,26%	7,90%	8,57%	9,24%
Buy and Hold	11,55%	11,51%	11,52%	11,53%

Summary Period C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	9,92%	-2,71%	0,74%	4,31%
EMA	9,96%	-5,10%	-1,02%	3,23%
DMAC(SMA)	6,39%	5,29%	5,60%	5,92%
DMAC(EMA)	6,96%	5,92%	6,22%	6,51%
MACD(SMA)	9,98%	1,61%	3,93%	6,31%
MACD(EMA)	8,05%	-1,75%	0,95%	3,73%
ROC	6,57%	-26,06%	-17,92%	-8,89%
RSI	6,96%	6,04%	6,30%	6,56%
BB	6,53%	4,53%	5,10%	5,67%
Buy and Hold	9,39%	9,35%	9,36%	9,38%

Summary of Average Return for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,63%	-2,09%	1,39%	4,99%
EMA	10,65%	-4,45%	-0,36%	3,91%
DMAC(SMA)	7,80%	6,72%	7,02%	7,33%
DMAC(EMA)	8,63%	7,65%	7,93%	8,21%
MACD(SMA)	11,48%	2,93%	5,31%	7,73%
MACD(EMA)	8,77%	-1,23%	1,53%	4,37%
ROC	7,13%	-25,78%	-17,57%	-8,46%
RSI	6,66%	5,76%	6,01%	6,27%
BB	9,31%	7,00%	7,65%	8,31%
Buy and Hold	10,82%	10,79%	10,80%	10,81%

there are no transaction costs. When considering transaction costs, the buy and hold strategy is unbeaten.

For the average returns of period A, B and C: only the MACD(SMA) indicator outperformed the buy and hold strategy in the absence of transaction costs. The buy and hold strategy is unbeaten in the presence of transaction costs.

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

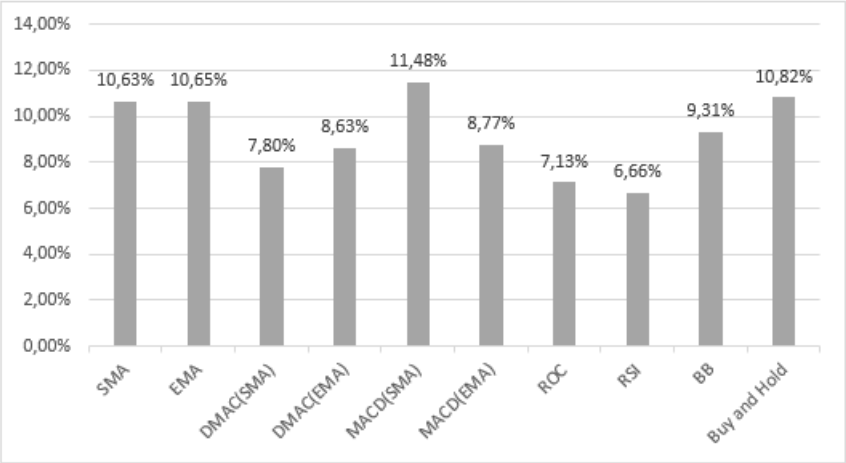


Figure 4.54: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the twenty-year data for no transaction fees (Varying Exchange Rate)

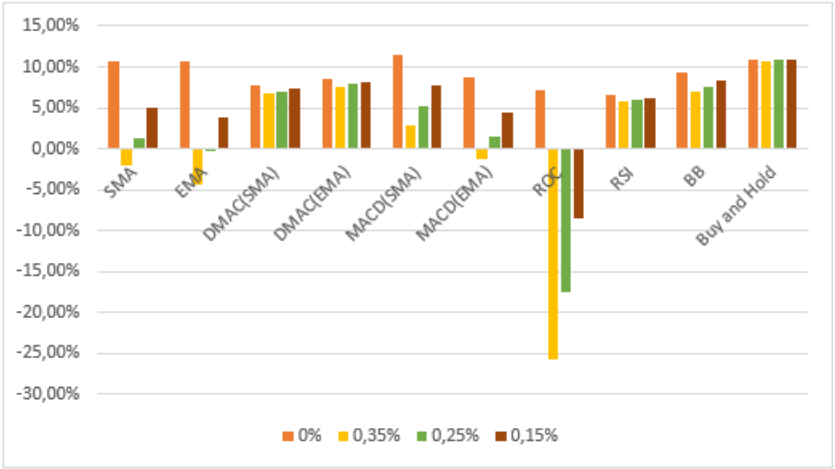


Figure 4.55: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the twenty-year data for all transaction fees (Varying Exchange Rate)

4.5 Alternative Approaches

4.5.1 Multiple Technical Indicators Approach

Period A is the only period that showed more profitable returns than the buy and hold strategy for decision rule 1 and decision rule 2. These returns are still lower than the returns produced by the MACD(SMA) indicator. For the rest of the periods and the average returns of the periods, the buy and hold strategy is unbeaten.

Table 4.24: Returns produced for the multiple indicator alternative approach

Summary Scenario A				
20 Years				
	0%	0.35%	0.25%	0.15%
Decision Rule 1	8,17%	1,48%	3,35%	5,25%
Decision Rule 2	12,21%	7,73%	8,99%	10,27%
Decision Rule 3	11,63%	10,91%	11,12%	11,32%
Buy and Hold	11,53%	11,49%	11,51%	11,52%

Summary Scenario B				
20 Years				
	0%	0.35%	0.25%	0.15%
Decision Rule 1	6,54%	-0,11%	1,74%	3,64%
Decision Rule 2	9,02%	4,61%	5,85%	7,11%
Decision Rule 3	9,74%	9,03%	9,23%	9,44%
Buy and Hold	11,55%	11,51%	11,52%	11,53%

Summary Scenario C				
20 Years				
	0%	0.35%	0.25%	0.15%
Decision Rule 1	5,97%	-0,62%	1,22%	3,09%
Decision Rule 2	7,59%	3,36%	4,55%	5,76%
Decision Rule 3	7,39%	6,69%	6,89%	7,09%
Buy and Hold	9,39%	9,35%	9,36%	9,38%

Summary of Average Returns for Period A, B and C				
20 Years				
	0%	0.35%	0.25%	0.15%
Decision Rule 1	6,89%	0,25%	2,10%	3,99%
Decision Rule 2	9,61%	5,24%	6,47%	7,71%
Decision Rule 3	9,59%	8,88%	9,08%	9,28%
Buy and Hold	10,82%	10,79%	10,80%	10,81%

4.5.2 Overdraft Facility Approach

For the second alternative approach, the investors buys one share when a buy signal occurs. The investor has access to an overdraft facility. We will now look at the results produced by the S&P500. We started by considering a three-year period. We specifically looked at Period C dates with 0.35% transaction costs and a constant exchange rate.

Table 4.25: S&P500 - Summary of the overdraft facility approach for the three-year period C

Overdraft Facility Approach - Summary		
	Constant Exchange Rate	
	0%	0.35%
SMA	7,424%	-1,372%
EMA	7,031%	-2,310%
DMAC(SMA)	4,164%	3,001%
DMAC(EMA)	5,723%	4,929%
MACD(SMA)	5,592%	-1,003%
MACD(EMA)	2,231%	-6,774%
ROC	0,592%	-100,000%
RSI	6,396%	5,747%
BB	5,808%	4,044%

The indices performed well when considering no transaction costs. When considering the 0.35% transaction costs, the indices performed poorly, especially the ROC indicator. The bank account ended in debt. When the bank account ended with a negative amount, we capped the loss at 0 and our return was -100%. When considering the ten-year period, the same thing happened. When considering different periods and time frames and indices, the same problem occurred with other indicators as well. We decided not to further investigate this approach as the indicators performed poorly when considering transaction costs.

Table 4.26: S&P500 - Summary of overdraft facility approach for the ten-year period C

Overdraft Facility Approach - Summary		
	Constant Exchange Rate	
	0%	0.35%
SMA	6,959%	-3,332%
EMA	6,556%	-5,525%
DMAC(SMA)	4,408%	3,359%
DMAC(EMA)	5,749%	5,159%
MACD(SMA)	5,295%	-3,005%
MACD(EMA)	2,983%	-14,631%
ROC	1,593%	-100,000%
RSI	6,288%	5,738%
BB	5,751%	4,075%

4.6 Discussion of Results

4.6.1 JSE Top 40

For the three-year periods, the buy and hold strategy was close to unbeatable. The JSE Top 40 is an emerging market, and it would be expected that the technical indicators would prove profitable in the South African market because emerging markets are not as efficient as emerged markets. This does not mean that technical indicators cannot perform well for three-year periods when trading the JSE Top 40 index. When considering the individual three-year subperiods in table 4.27 it is clear that the technical indicators outperformed the buy and hold strategy for almost all individual subperiods, except for subperiod 2004 - 2006 for period B. Even when the market performs well and produces returns of 30%, some of the indicators still outperform the market in the absence of transaction costs. The annual average return of the seven subperiods, calculated using the formula provided in the methodology, shows that buy and hold strategy is unbeaten for most indicators in period A, B and C. This is because there is not a specific indicator that outperforms all the individual subperiods consistently. This is consistent with the adaptive market hypothesis study discussed in the literature review chapter. The studies showed that indicator performance is temporary [47], [92].

Table 4.28 shows the detailed returns of the three-year subperiods with a transaction cost of 0.35%. For a lot of the subperiods, the technical indicators still outperformed the buy and hold strategy when considering transaction costs, except for periods where the buy and hold produced returns above 16.40%. It is clear that when the market performs well, the buy and hold strategy is unbeaten when taking transaction costs into account. The results are similar for the other investment lengths as well, however, these results are not presented in the study.

The expectation was that technical indicators would perform well on the JSE Top 40 index

Table 4.27: JSE Top 40: Detailed results for three-year period A, B and C without transaction costs

3 Years - No Transaction Costs								
Period A								
	1997 - 1999	**2000 - 2002**	**2003 - 2005**	**2006 - 2008**	**2009 - 2011**	**2012 -2014**	**2015 -2017**	**Average**
Buy and Hold	11,44%	2,95%	23,76%	5,22%	13,09%	14,54%	6,33%	10,86%
SMA	-9,11%	0,56%	13,05%	10,00%	27,23%	15,31%	15,54%	9,82%
EMA	-9,67%	1,63%	10,64%	10,63%	20,85%	14,70%	9,33%	7,90%
DMAC(SMA)	15,57%	5,40%	22,90%	8,51%	14%	9,65%	-0,90%	10,46%
DMAC(EMA)	15,95%	-2,72%	23,99%	13,19%	5,79%	13,01%	-0,84%	9,41%
MACD(SMA)	12,30%	-2,71%	14,34%	-5,96%	5,00%	12,54%	4,45%	5,45%
MACD(EMA)	19,72%	11,31%	18,22%	-3,39%	3,30%	13,71%	4,55%	9,35%
ROC	12,62%	6,19%	13,20%	-5,73%	4,17%	3,84%	-2,61%	4,32%
RSI	1,22%	5,34%	7,41%	2,58%	20,98%	6,90%	6,94%	7,18%
BB	1,88%	3,42%	10,64%	6,64%	30,67%	11,26%	6,18%	9,76%
Period B								
	1998 - 2000	**2001 - 2003**	**2004 - 2006**	**2007 - 2009**	**2010 - 2012**	**2013 -2015**	**2016 -2018**	**Average**
Buy and Hold	16,53%	5,86%	32,95%	3,03%	11,42%	8,81%	1,50%	11,03%
SMA	-0,56%	-2,46%	18,20%	13,98%	23,66%	13,56%	12,74%	10,95%
EMA	-4,51%	-1,01%	23,56%	6,04%	20,78%	11,59%	8,14%	8,80%
DMAC(SMA)	16,22%	13,34%	27,23%	8,92%	7,86%	-0,65%	0,59%	10,15%
DMAC(EMA)	9,40%	10,10%	28,89%	10,51%	3,29%	4,17%	-2,33%	8,79%
MACD(SMA)	12,86%	2,56%	16,13%	-5,51%	9,31%	9,88%	-3,33%	5,71%
MACD(EMA)	24,00%	12,25%	19,53%	-7,90%	8,30%	11,40%	0,76%	9,29%
ROC	14,04%	2,97%	23,38%	-10,31%	2,62%	2,99%	-4,00%	4,03%
RSI	12,92%	-0,24%	13,97%	2,31%	10,04%	8,16%	3,13%	7,06%
BB	10,99%	2,85%	14,37%	13,27%	16,09%	12,19%	3,83%	10,41%
Period C								
	1999 - 2001	**2002 - 2004**	**2005 - 2007**	**2008 - 2010**	**2011 - 2013**	**2014 -2016**	**2017 -2019**	**Average**
Buy and Hold	30,41%	3,41%	31,53%	2,53%	12,89%	1,66%	4,71%	11,82%
SMA	5,29%	6,62%	19,86%	9,10%	26,23%	16,55%	7,53%	12,79%
EMA	6,54%	4,75%	24,54%	2,16%	24,58%	10,86%	5,76%	10,98%
DMAC(SMA)	23,70%	8,97%	27,52%	9,87%	8%	-2,49%	-0,23%	10,28%
DMAC(EMA)	12,26%	9,98%	31,53%	6,93%	7,63%	-2,69%	-2,45%	8,53%
MACD(SMA)	13,35%	-1,13%	10,40%	-2,70%	11,37%	-1,78%	5,76%	4,85%
MACD(EMA)	33,13%	1,02%	14,54%	-4,33%	12,32%	-1,68%	9,73%	8,64%
ROC	20,39%	-3,79%	23,44%	-9,38%	3,48%	-7,21%	7,09%	4,18%
RSI	14,00%	-3,61%	12,38%	11,75%	7,44%	5,00%	9,94%	7,98%
BB	14,61%	1,01%	20,51%	17,00%	13,79%	5,26%	8,19%	11,30%

Table 4.28: JSE Top 40: Detailed results for three-year period A, B and C with a transaction cost of 0.35%

3 Years - Transaction Costs (0,35%)								
Period A								
	1997 - 1999	2000 - 2002	2003 - 2005	2006 - 2008	2009 - 2011	2012 -2014	2015 -2017	Average
Buy and Hold	11,31%	2,83%	23,62%	5,10%	12,96%	14,40%	6,21%	10,73%
SMA	-13,25%	-6,02%	4,18%	1,37%	17,80%	6,02%	4,51%	1,68%
EMA	-15,97%	-7,21%	2,68%	1,01%	10,33%	4,73%	-1,80%	-1,22%
DMAC(SMA)	14,77%	4,42%	22,33%	7,75%	12,86%	8,38%	-2,05%	9,54%
DMAC(EMA)	15,14%	-3,63%	23,41%	12,66%	5%	12,48%	-2,44%	8,50%
MACD(SMA)	5,20%	-9,29%	7,36%	-12,12%	-0,72%	5,92%	-2,39%	-1,12%
MACD(EMA)	12,15%	4,76%	10,22%	-10,75%	-3,46%	5,53%	-2,29%	2,02%
ROC	-13,88%	-20,30%	-14,05%	-29,09%	-23,62%	-23,87%	-27,42%	-21,94%
RSI	0,28%	4,36%	6,66%	1,87%	19,86%	6,40%	6,19%	6,36%
BB	-0,24%	1,51%	8,85%	4,91%	27,06%	8,94%	3,97%	7,55%
Period B								
	1998 - 2000	2001 - 2003	2004 - 2006	2007 - 2009	2010 - 2012	2013 -2015	2016 -2018	Average
Buy and Hold	16,40%	5,74%	32,80%	2,91%	11,29%	8,68%	1,38%	10,90%
SMA	-6,19%	-7,99%	8,42%	5,78%	13,17%	4,17%	2,70%	2,62%
EMA	-11,17%	-8,13%	13,34%	-2,96%	10,02%	1,41%	-3,09%	-0,43%
DMAC(SMA)	15,41%	12,28%	26,64%	7,91%	6,61%	-1,80%	-0,34%	9,17%
DMAC(EMA)	8,64%	9,08%	28,29%	9,74%	1,86%	3,44%	-4,13%	7,74%
MACD(SMA)	5,97%	-4,15%	8,79%	-11,28%	3,12%	2,93%	-9,66%	-0,88%
MACD(EMA)	16,16%	4,66%	11,19%	-14,52%	0,98%	4,11%	-6,71%	1,80%
ROC	-10,74%	-23,08%	-6,75%	-32,53%	-26,33%	-23,42%	-28,28%	-22,05%
RSI	11,61%	-0,93%	13,17%	1,84%	9,27%	7,41%	2,41%	6,28%
BB	8,68%	0,95%	13,04%	10,91%	13,94%	9,35%	2,39%	8,37%
Period C								
	1999 - 2001	2002 - 2004	2005 - 2007	2008 - 2010	2011 - 2013	2014 -2016	2017 -2019	Average
Buy and Hold	30,26%	3,29%	31,37%	2,41%	12,76%	1,54%	4,59%	11,69%
SMA	-0,44%	-1,74%	10,46%	2,68%	15,25%	4,94%	-0,90%	4,16%
EMA	-0,89%	-3,91%	13,44%	-4,30%	12,16%	-0,42%	-4,56%	1,40%
DMAC(SMA)	22,55%	8,21%	26,92%	8,86%	7%	-3,40%	-1,39%	9,26%
DMAC(EMA)	11,22%	9,21%	31,22%	5,69%	6,63%	-3,82%	-4,48%	7,42%
MACD(SMA)	6,43%	-7,17%	2,69%	-8,00%	4,82%	-8,21%	-0,46%	-1,59%
MACD(EMA)	25,29%	-6,68%	6,30%	-10,80%	4,97%	-9,39%	2,79%	1,16%
ROC	-7,73%	-27,45%	-6,92%	-32,93%	-25,18%	-30,68%	-20,00%	-22,15%
RSI	12,94%	-4,06%	11,59%	10,72%	6,94%	4,27%	8,92%	7,19%
BB	12,49%	-0,39%	18,56%	14,04%	11,68%	3,31%	5,94%	9,20%

because South Africa is an emerging market. However, the opposite is true when considering the annual returns. The JSE Top 40 consists of the top 40 shares on the JSE Stock Exchange. These companies are large and some are even international. Therefore these companies are influenced by the global market because of overseas investments, overseas branches and exports, just to name a few. A study shows that the JSE Stock Exchange is highly influenced by the global stock market [93]. This could be a possible reason for the contradictory results.

4.6.2 S&P 500

For the S&P 500 index, there are two possible scenarios: constant exchange rate and varying exchange rate. The results for these two scenarios are quite different. For the constant exchange rate scenario, the technical indicators outperformed the buy and hold strategy for all

periods up to transaction costs of 0.35%. For the varying exchange rate, the technical indicators outperformed the buy and hold strategy for some of the periods and even in the presence of transaction costs. The results for the individual subperiods are similar to the results for the JSE Top 40. These subperiod returns are, however, not included in the study. The overall results prove that technical indicators can perform well even in a developed economy like the USA which is consistent with a previous study on the S&P 500 [15].

4.6.3 NIFTY 50

For the constant exchange rate scenario for the NIFTY 50, some of the technical indicators outperformed the buy and hold strategy for some of the possible investment lengths and periods. The buy and hold strategy is unbeaten for almost all possible investment lengths and periods when taking transaction costs into account.

For the varying exchange rate scenario, the buy and hold strategy is beatable for all periods and investment lengths in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is beatable for some periods up to 0.35% transaction costs. The results are similar to the other emerging market tested, the JSE Top 40 index. Once again the counter intuitive results are produced. Because India is an emerging market, it would be expected that technical indicators would show profitability over the buy and hold strategy even for transaction costs, but the opposite results are obtained. However, the NIFTY 50 index consists of the top 50 shares on the Indian stock exchange. These companies are most likely international and therefore heavily influenced by the global market. Even though India is an emerging market, the NIFTY 50 index could possibly consist of efficient shares.

4.6.4 FTSE 100

For both the constant exchange rate scenario and varying exchange rate scenario, the buy and hold strategy is beatable without transaction costs and for all periods up to 0.35% transaction costs for some of the indicators. When there are no transaction costs, almost all the indicators outperformed the buy and hold strategy.

The returns produced for the buy and hold strategy are much lower than the returns produced for any of the other indices. As seen in figure 4.56, the data shows a sideways pattern. The other indices showed upward trends for the period studied.

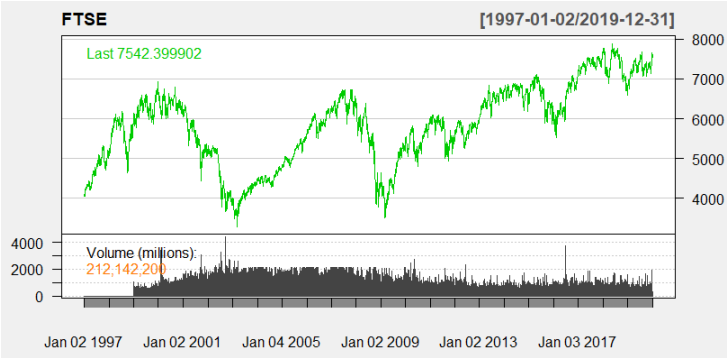


Figure 4.56: Closing Price of FTSE 100 from 1997 to 2019

For the single indices, two emerging markets and two developed markets are studied. For both the developed markets, technical analysis produced good returns for almost all the indicators tested in the absence of transaction costs. A few indicators outperformed the buy and hold strategy even in the presence of high transaction costs of 0.35%. The technical indicators performed worse in the emerging markets than in the developed markets. For the two emerging markets, the technical indicators outperformed the buy and hold strategy for almost all periods when there are no transaction costs and for periods when the transaction costs are low. Also, the same indicators performed well and poorly throughout all the investment period lengths (three, five, ten and twenty years) for the single indices.

4.6.5 JSE Top 40 and S&P 500 combination

For the constant exchange rate scenario, at least two indicators outperformed the buy and hold strategy in the absence of transaction costs for every possible investment period and length. When considering transaction costs, only four periods outperformed the buy and hold strategy. These periods are: three years (period B), five years (period A and period C), twenty years (period C). When considering the average returns of period A, B and C, the buy and hold strategy is unbeaten in the presence of transaction costs. The SMA and EMA indicators performed well for all investment lengths and periods. There are also other indicators that outperformed the buy and hold strategy for certain periods. These include: DMAC(SMA), DMAC(EMA), RSI and BB.

For the varying exchange rate scenario, at least one indicator outperformed the buy and hold strategy in the absence of transaction costs. There is no period for which the buy and hold strategy is unbeaten when there are no transaction costs. When taking transaction costs into account, there are four periods that outperformed the buy and hold strategy. These periods are:

three years (period A and period B), five years (period A) and twenty years (period A). When considering the average returns of period A, B and C, the buy and hold strategy is unbeaten in the presence of transaction costs. There are no indicators that consistently performed well. The SMA outperformed the buy and hold strategy for the average returns of period A, B and C for all in the investment lengths in the absence of transaction costs.

The returns of the varying exchange rate scenarios are generally higher than the constant exchange rate scenarios.

4.6.6 JSE Top 40, S&P 500 and NIFTY 50 combination

The technical indicators outperformed the buy and hold strategy for all possible investment lengths and periods for the constant exchange rate scenario. There are no periods where the buy and hold strategy is unbeaten. There are three periods for which the buy and hold strategy got beaten in the presence of transaction costs: three years (period A and period B) and twenty years (period C). The returns for the JSE Top 40, S&P 500 and NIFTY 50 combination are generally higher than for the combination without the NIFTY 50. The SMA and EMA indicators outperformed the buy and hold strategy for all possible investment periods and investment lengths in the absence of transaction costs. Other indicators that also performed well for at least one period include: DMAC(EMA), MACD(SMA) and BB.

For the varying exchange rate scenario, the returns produced by the buy and hold strategy is high. Therefore, there are quite a lot of periods for which the buy and hold strategy proved unbeaten. There are a few periods for which the buy and hold strategy got beaten in the absence of transaction costs and only one period for which the buy and hold strategy got beaten in the presence of transaction costs of 0.15%. For the 20-year periods, the buy and hold strategy got beaten for each period by only one indicator in the absence of transaction costs. For the three-, five- and ten-year, there is at least one period for which the buy and hold strategy got beaten when not taking transaction costs into account.

The returns produced for varying exchange rate scenario is much higher than the returns produced by the constant exchange rate scenario.

4.6.7 JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 combination

For the constant rate scenario, at least one indicator outperformed the buy and hold strategy for each period in the absence of transaction costs. When taking transaction costs into account, there are only two periods that outperformed the buy and hold strategy. These periods are period B and period C for three years, as well as the average returns for period A, B and C of the three-year periods. For longer investment period lengths, the buy and hold strategy is unbeaten. The returns for the JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 combination are generally lower than the returns without the FTSE 100 index. This could be due to the low returns produced by the FTSE 100 index when considered on its own. The SMA indicator produced higher returns than the buy and hold strategy for all the possible periods studied. The EMA indicator produced higher returns in almost all periods except for a few exceptions. Other indicators that performed well include: DMAC(SMA), DMAC(EMA), MACD(SMA), RSI and BB.

For the varying exchange rate scenario, at least one indicator outperformed the buy and hold strategy for almost all periods, except for the ten-year period C. There are two periods for which the buy and hold strategy got beaten even in the presence of transaction costs. These periods are three years (period B) and ten years (period A). There are no indicators that performed well for all periods. The indicators that outperformed the buy and hold strategy for at least one scenario include: SMA, EMA, DMAC(SMA), DMAC(EMA), MACD(SMA) and BB.

The varying exchange rate scenario produced higher returns than the constant exchange rate scenario for most periods.

4.7 Summary of Results

The technical indicators showed profitable returns over and above the returns produced by the buy and hold strategy for both the single indices and multiple indices even when taking transaction costs into account. However, most of the returns were eroded by the inclusion of transaction costs. The lowering of transaction costs to 0.15% enabled more indicators to outperform the buy and hold strategy.

Table 4.29 provides a rough overview of the performance of technical indicators versus a buy and hold strategy. The table shows the number of times that at least one technical indicator

outperformed the buy and hold strategy for the relevant period as a percentage of the total periods. The periods accounted for include: Period A, B, C and the average returns of the three periods. For example if we consider the single indices for the constant exchange rate scenarios and no transaction costs, there are 64 periods in total considered and for 58 of the periods, the buy and hold strategy was beaten by at least one indicator. Therefore the percentage is 91% (as shown in the table).

Table 4.29: Percentage of times that at least one indicator produced a higher return than the buy and hold strategy for the different scenarios

	Constant Exchange Rate		**Varying Exchange Rates**	
	Single Indices	**Multiple Indices**	**Single Indices**	**Multiple Indices**
No transaction costs	91%	100%	94%	83%
Transaction costs (0,15%-0,35%)	56%	21%	75%	23%

From table 4.29 it is clear that TA performed well in comparison to the buy and hold strategy for most of the periods when there are no transaction costs. When considering only the single indices, the performance of TA is still very good in the presence of transaction costs. However, when taking transaction costs into account, the buy and hold strategy is difficult to beat for the multiple indices periods. The table is, however, a very rough overview of the results and it is preferable to rather consider the performance of each index and combination of indices individually. Table 4.30 and table 4.31 show whether TA can outperform the buy and hold strategy by showing a 'Y' (yes) or an 'N' (no) at the relevant period in the table for the constant exchange rate scenario and varying exchange rate scenario respectively. If TA outperformed the buy and hold strategy, the highest percentage of transaction costs for which TA outperforms the buy and hold strategy is presented in brackets. A transaction cost of 0% is equivalent to no transaction costs. There has to be at least one indicator that outperforms the buy and hold strategy before a 'Y' is shown in the table. In the table combination 1 refers to the JSE Top 40 and S&P 500 combination. Combination 2 refers to combination 1 plus the NIFTY 50 index. Lastly, combination 3 refers to combination 2 plus the FTSE 100 index.

The constant exchange rate scenario is studied first. For the single indices, the technical indicators proved to outperform the buy and hold strategy for most of the periods when there are no transaction costs. The only indicator that performed poorly is the JSE Top 40. However, there are still periods for which the technical indicators outperformed the buy and hold strategy when there are no transaction costs. When taking transaction costs into account, at least one technical indicator outperformed the buy and hold strategy for S&P 500 and FTSE 100 at the highest possible transaction costs of 0.35%. The technical indicators performed poorly in the presence of transaction costs for the two emerging markets, JSE Top 40 and NIFTY 50. For the

Table 4.30: Outcome of whether technical analysis can outperform a buy and hold strategy for each indicator and combinations of indicators for the constant exchange rate scenario

Constant Exchange Rate							
	JSE Top 40	**S&P 500**	**NIFTY 50**	**FTSE 100**	**Combination 1**	**Combination 2**	**Combination 3**
3 Years							
A	N	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)
B	N	Y (0,35%)	Y (0,15%)	Y (0,35%)	Y (0,15%)	Y (0,15%)	Y (0,35%)
C	Y (0%)	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0,15%)
Average	N	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0,15%)
5 Years							
A	N	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0,35%)	Y (0%)	Y (0%)
B	Y (0%)	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0%)
C	Y (0,15%)	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0,15%)	Y (0%)	Y (0%)
Average	Y (0%)	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0%)
10 Years							
A	N	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0%)
B	Y (0%)	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0%)
C	Y (0,15%)	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0%)
Average	Y (0%)	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0%)
20 Years							
A	N	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0%)
B	Y (0%)	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0%)
C	Y (0,15%)	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0,25%)	Y (0,15%)	Y (0%)
Average	Y (0%)	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0%)

majority of the periods, the buy and hold strategy is unbeatable in the presence of transaction costs. There are, however, a few periods for which the buy and hold strategy was beaten, but this only occurs at low transaction costs of 0.15%. For the multiple indices combinations, the technical indicators outperformed the buy and hold strategy for all the periods studied when the transaction costs are 0%. The buy and hold strategy is difficult to beat when taking transaction costs into account for most of the periods. The percentages for which the buy and hold is beaten is a combination from 0.15% to 0.35% for the different periods.

The varying exchange rate scenario does not include the JSE Top 40 because no exchange rate needs to be applied to the data. When applying a varying exchange rate approach to the data, there are more periods for which the buy and hold strategy is unbeatable for both the single indices and multiple indices. For the FTSE 100, the technical indicators outperformed the buy and hold strategy for all periods and all possible transaction costs. The technical indicators performed well on the S&P 500 index as well, except for period A for the five-, ten- and twenty-year scenarios when not taking transaction costs into account. For the NIFTY 50 index, the buy and hold strategy was beaten in the absence of transaction costs. However, when taking transaction costs into account the technical indicator profitability is varying for the different periods and percentages for the S&P 500 and NIFTY 50. For the multiple index combinations, technical indicators produced superior returns over the buy and hold strategy for combination 1 and for

Table 4.31: Outcome of whether technical analysis can outperform a buy and hold strategy for each indicator and combinations of indicators for the varying exchange rate scenario

Varying Exchange Rate						
	S&P 500	**NIFTY 50**	**FTSE 100**	**Combination 1**	**Combination 2**	**Combination 3**
3 Years						
A	Y (0,15%)	Y (0,35%)	Y (0,35%)	Y (0,35%)	Y (0%)	Y (0%)
B	Y (0,15%)	Y (0,35%)	Y (0,35%)	Y (0,35%)	Y (0,15%)	Y (0,35%)
C	Y (0,35%)	Y (0,35%)	Y (0,35%)	Y (0%)	N	Y (0%)
Average	Y (0%)	Y (0,15%)	Y (0,35%)	Y (0%)	N	Y (0%)
5 Years						
A	N	Y (0,35%)	Y (0,35%)	Y (0,35%)	Y (0%)	Y (0%)
B	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	N	Y (0%)
C	Y (0,25%)	Y (0%)	Y (0,35%)	Y (0%)	N	Y (0%)
Average	Y (0,15%)	Y (0%)	Y (0,35%)	Y (0%)	N	Y (0%)
10 Years						
A	N	Y (0,35%)	Y (0,35%)	Y (0%)	Y (0%)	Y (0,15%)
B	Y (0,35%)	Y (0%)	Y (0,35%)	Y (0%)	N	Y (0%)
C	Y (0,25%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0%)	N
Average	Y (0,15%)	Y (0,15%)	Y (0,35%)	Y (0%)	N	Y (0%)
20 Years						
A	N	Y (0,35%)	Y (0,35%)	Y (0,25%)	Y (0,15%)	Y (0%)
B	Y (0,15%)	Y (0,35%)	Y (0,35%)	Y (0%)	Y (0,15%)	Y (0%)
C	Y (0,25%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0,15%)	Y (0%)
Average	Y (0%)	Y (0%)	Y (0,35%)	Y (0%)	Y (0,15%)	Y (0%)

some periods of combination 2 and combination 3. When taking transaction costs into account, the multiple indicator performance is poor in comparison to the buy and hold strategy with a few exceptions.

The varying exchange approach produced higher returns than the constant exchange rate approach for most of the periods. This is mainly due to the weakening of the ZAR in comparison to the other currencies. It is important to consider both approaches because the constant exchange rate approach provides the performance of the technical indicators versus the buy and hold strategy without the interfering effect of exchange rates. However, the varying exchange rate scenario is also tested because in practice, exchange rates will influence returns and cannot be ignored.

The results differ quite substantially for the different transaction cost percentages for some of the indicators due to the number of transactions for each method. When the number of transactions are high, such as for ROC, SMA and EMA, the effect of transaction costs is significant. These methods performed poorly in the presence of transaction costs, even for a transaction cost as low as 0.15%. The effect of transaction costs on other methods that had a low number of transactions, such as DMAC(SMA), DMAC(EMA), RSI and BB, was relatively low. Even in some scenarios, these methods struggled to outperform the buy and hold strategy when taking

transaction costs into account due to the fact that the buy and hold strategy only produces one buy signal and one sell signal.

Two alternative methods are considered for the study in not much detail. For both the approaches the returns produced are not better than the returns produced in the main approach. There is, however, a possibility for future study for both these methods.

From this study, it is evident that the technical indicators outperform the buy and hold strategy for almost all the periods for the single indices and multiple indices. Therefore, technical indicators are profitable in the absence of transaction costs. For the single indices, the profitability remains even in the presence of transaction costs. However, for the multiple indices, the profitable returns were eroded in the presence of transaction costs. Not a single indicator performed well for all markets and all periods. The SMA indicators showed promising results in the absence of transaction costs for most markets. For a single index or a single combination, there is usually one indicator that performs well for most of the periods. The indicators that perform well for one market do not necessarily perform well in another market.

It is important to note that the results obtained rely heavily on the methodology. The next section includes a few suggestions for future work.

Chapter 5

Conclusion

There is a big debate about whether active investment strategies can outperform passive investment strategies. The EMH states that it is impossible to outperform a buy and hold strategy because markets are efficient. If the market is efficient, investors cannot use active investment strategies, such as technical analysis and fundamental analysis, to outperform the market. The EMH also assumes that investors are rational. However, a lot of research done on behavioural finance proves the contrary. These studies show that investors behave differently in real life, than assumed in finance models. From studies on behaviours finance, the AMH was born. The AMH states that behavioural finance and the EMH are both correct. The AMH also states that market efficiency is not an "all-or-nothing" situation, but rather a changing situation. Therefore, markets can be efficient for one period, and not efficient for another period.

Although the EMH is a well-known theory in finance, many investors and researchers believe that markets are not efficient. These investors and investment managers use active strategies with the aim of outperforming the market. The two active strategies, as mentioned earlier, are fundamental analysis and technical analysis.

This study employs technical analysis techniques to generate returns for an active investment strategy to compare to a passive buy and hold strategy. In past research, the question of whether technical analysis techniques can produce superior returns above a simple buy and hold strategy has remained unsolved. Therefore, the aim of this study is to develop a method to compare the returns produced by technical analysis to the returns produced by the buy and hold strategy.

5.1 Results

The study only focuses on four single indices, as well as combinations of these indices. The two emerging markets studied are the JSE Top 40 index and the NIFTY 50 index. The two developed markets studied are the S&P 500 index and the FTSE 100 index. The daily share prices from 01/01/1997 to 31/12/2019 are used for all the indices. The data is split up into three-, five-, ten- and twenty-year periods. Different starting points are used to ensure that the results do not rely on the chosen starting date and ending date. These different starting point periods are referred to as period A, B and C.

For the single index scenarios, the results are similar across the three-, five-, ten- and twenty-year investment horizons. Therefore, similar technical indicators performed well over all investment horizons. However, the results differed across the different indices. For the JSE Top 40 index, the SMA indicator performed well in the absence of transaction costs. However, the buy and hold strategy is difficult to beat when considering transaction costs. For the S&P 500 index, almost all the indicators outperformed the buy and hold strategy in the absence of transaction costs when considering the constant exchange rate approach, except for two indicators: MACD(EMA) and ROC. The DMAC(EMA) is the only indicator that outperformed the buy and hold strategy for all possible transaction costs, the rest of the indicator's returns got eroded in the presence of transaction costs for most scenarios. For the varying exchange rate approach, the DMAC(EMA) indicator performed well in the absence of transaction costs and for lower transaction costs of 0.15% and 0.25%. For the NIFTY 50 index, only the MACD(SMA) and RSI indicators outperformed the buy and hold strategy when there are no transaction costs for the constant exchange rate scenario. Unfortunately, none of the indicators outperformed the buy and hold strategy when considering transaction costs. For the varying exchange rate scenario, MACD(SMA), DMAC(SMA) and DMAC(EMA) performed well in the absence of transaction costs, but performed poorly in the presence of transaction costs for most periods. For the FTSE 100 index, almost all the indicators performed well in the absence of transaction costs for the constant exchange rate scenario. BB, RSI and DMAC(SMA) outperformed the buy and hold strategy even in the presence of transaction costs. For the varying exchange rate scenario, BB, SMA, DMAC(SMA), DMAC(EMA) and EMA outperformed the buy and hold strategy when transaction costs are 0%. However, only BB outperformed the buy and hold strategy for all possible transaction costs and DMAC(SMA) for lower transaction costs of 0.25% and 0.15%. It is therefore evident that the performance of the different indicators altered with the different indices and that some indicators performed well when lowering the transaction costs.

For the multiple index scenarios, the results differed across most of the different investment horizons. The SMA and EMA indicators performed well across all possible combinations of indices without transaction costs. However, because these methods have a lot transactions per year, the returns got eroded in the presence of transaction costs for all scenarios. The other indicators also performed well for different scenarios, but not one indicator performed well throughout.

The use of different initial starting points, altered the results slightly. In a few cases, the indicator performance differed across the different starting points. However, for the majority of scenarios, the initial starting point has a small influence on the overall results. It is still beneficial to consider different initial starting points, because the investment market is very volatile and easily influenced by a financial crisis or and event like COVID 19.

For the main approach used in the study, different investment percentages of available funds are considered. For the single index scenarios, it is best to invest 100% of available funds in the share when the market is performing well, and 0% of the available funds when the market is performing poorly. Therefore, alternative investment percentages are not beneficial when investing in a single index. However, when considering multiple index combinations, other investment percentages such as 80% provided better returns than investing 100% of the available funds. Unfortunately, in all these scenarios, the higher returns is still not enough to outperform the buy and hold strategy.

The study also considered two alternative approaches. For both of these approaches the buy and hold strategy is difficult to beat. For the overdraft facility approach, the technical indicators performed extremely poorly in the presence of transaction costs.

The overall results of the study is mixed and relies heavily on the investment market index studied and the indicators used. Whether the markets studied are efficient is not clear, especially since technical analysis only test weak form efficiency. The results are therefore consistent with the AMH which states that market efficiency is not a black or white situation, but rather a mix of the two. The next section includes a few suggestions for future work and how to improve the methodology provided in the study.

5.2 Future Study and Limitations

Even though this study tried to remove the effect of the start point and end point on the returns, they do still heavily affect the results. It could therefore be beneficial to include more start points and end points in future studies. This would increase the number of periods studied. The start points could be in months or days.

Stock markets are very volatile and it could be more beneficial to study shorter periods such as a year or even less.

The study is limited to only four indices: it could be beneficial to add more indices to obtain a well-diversified portfolio. Future researches could also study company stocks, instead of indices.

There are hundreds of indicators available to be used on stocks markets. This study only includes nine possible indicators. It could be beneficial to study the returns of other indicators on the data used in this study or other possible studies.

The study trades fully on the buy and sell signals provided by the indicators and ignores any human element. In reality investors are human and will sometimes incorporate judgement when trading. It could be beneficial to incorporate a human element through fundamental analysis in future studies.

The use of machine learning in all fields has been growing at a rapid pace over the past couple of years. The study looked at multiple indices on a very high level. The use of machine learning could possibly increase the returns produced by the multiple indices methods.

Finally, the study excluded any statistical analysis. Different statistical methods, such as hypothesis testing, can be introduced to test whether technical analysis indicators outperform a buy and hold strategy.

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Appendix A

Extra Results from the Results Chapter

In this appendix, the results now shown in Chapter 4 will be presented here. The appendix will follow exactly the same format of presenting the results as in Chapter 4. The appendix will start with the results for single indices and present the results for the multiple indices.

A.1 Single Indices

A.1.1 JSE Top 40

A.1.1.1 Three-Year Periods

Table A.1 summarises the return for each indicator for each period.

For period A and B: the buy and hold achieved the highest return for all possible transaction cost percentages.

For period C: the SMA indicator achieved the highest return when considering transaction costs of 0%. Buy and hold and the BB indicator achieved the second and third highest returns respectively. When considering transaction costs, the SMA indicator performed poorly and the buy and hold strategy achieved the highest return.

For the average returns of period A, B and C: the buy and hold strategy is unbeatable for all possible transaction costs.

Table A.1: JSE Top 40: Summary of period A, B & C returns for three years

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	9,82%	1,68%	3,94%	6,26%
EMA	7,90%	-1,22%	1,30%	3,89%
DMAC(SMA)	10,46%	9,54%	9,80%	10,07%
DMAC(EMA)	9,41%	8,50%	8,76%	9,02%
MACD(SMA)	5,45%	-1,12%	0,71%	2,58%
MACD(EMA)	9,35%	2,02%	4,06%	6,14%
ROC	4,32%	-21,94%	-15,20%	-7,87%
RSI	7,18%	6,36%	6,59%	6,83%
BB	9,76%	7,55%	8,18%	8,81%
Buy and Hold	10,86%	10,73%	10,77%	10,80%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,95%	2,62%	4,93%	7,30%
EMA	8,80%	-0,43%	2,13%	4,75%
DMAC(SMA)	10,15%	9,17%	9,45%	9,73%
DMAC(EMA)	8,79%	7,74%	8,04%	8,34%
MACD(SMA)	5,71%	-0,88%	0,96%	2,83%
MACD(EMA)	9,29%	1,80%	3,89%	6,02%
ROC	4,03%	-22,05%	-15,35%	-8,08%
RSI	7,06%	6,28%	6,50%	6,73%
BB	10,41%	8,37%	8,94%	9,53%
Buy and Hold	11,03%	10,90%	10,93%	10,97%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,79%	4,16%	6,55%	9,01%
EMA	10,98%	1,40%	4,05%	6,77%
DMAC(SMA)	10,29%	9,26%	9,55%	9,85%
DMAC(EMA)	8,53%	7,42%	7,74%	8,05%
MACD(SMA)	4,85%	-1,59%	0,21%	2,04%
MACD(EMA)	8,64%	1,16%	3,24%	5,37%
ROC	4,18%	-22,15%	-15,39%	-8,05%
RSI	7,98%	7,19%	7,42%	7,64%
BB	11,30%	9,20%	9,80%	10,39%
Buy and Hold	11,84%	11,69%	11,72%	11,76%

Summary of Average Returns for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,19%	2,82%	5,14%	7,52%
EMA	9,23%	-0,08%	2,49%	5,14%
DMAC(SMA)	10,30%	9,32%	9,60%	9,88%
DMAC(EMA)	8,91%	7,89%	8,18%	8,47%
MACD(SMA)	5,33%	-1,20%	0,63%	2,48%
MACD(EMA)	9,09%	1,66%	3,73%	5,84%
ROC	4,18%	-22,05%	-15,31%	-8,00%
RSI	7,41%	6,61%	6,84%	7,07%
BB	10,49%	8,37%	8,97%	9,58%
Buy and Hold	11,23%	11,10%	11,14%	11,18%

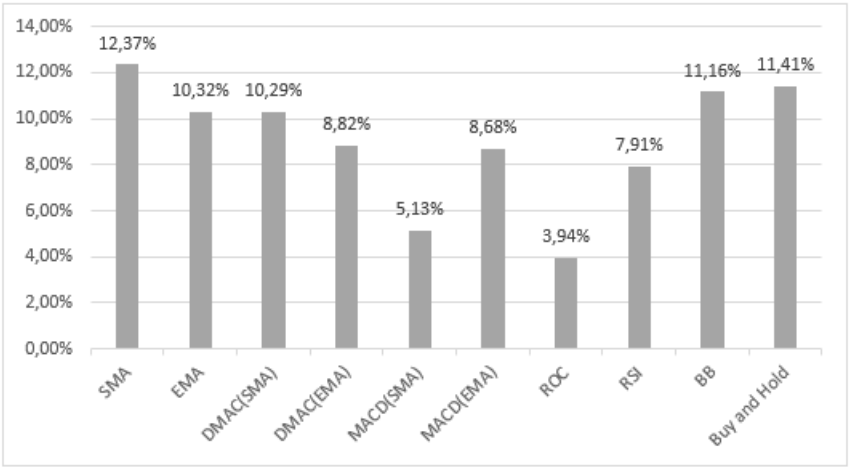

Figure A.1: JSE Top 40 - Average returns on the three-year data for no transaction fees

A.1.1.2 Five-Year Periods

Table A.2 summarises the return for each indicator for each period.

For period A: the buy and hold achieved the highest return for all possible transaction cost percentages.

For period B: the SMA indicator outperformed the buy and hold strategy when there are no

Figure A.2: JSE Top 40 - Average returns on the three-year data for all transaction fees

Table A.2: JSE Top 40: Summary of period A, B & C returns for five years

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,13%	2,82%	5,13%	7,49%
EMA	8,98%	-0,12%	2,40%	4,98%
DMAC(SMA)	11,23%	10,34%	10,59%	10,85%
DMAC(EMA)	9,98%	9,10%	9,35%	9,61%
MACD(SMA)	6,72%	0,21%	2,03%	3,88%
MACD(EMA)	10,03%	2,63%	4,69%	6,80%
ROC	4,39%	-21,73%	-15,02%	-7,73%
RSI	9,00%	8,13%	8,37%	8,62%
BB	11,68%	9,48%	10,10%	10,73%
Buy and Hold	12.22%	12.14%	12.16%	12.18%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	13,03%	4,40%	6,80%	9,25%
EMA	11,19%	1,59%	4,24%	6,97%
DMAC(SMA)	11,11%	10,21%	10,47%	10,72%
DMAC(EMA)	9,47%	8,52%	8,79%	9,06%
MACD(SMA)	4,79%	-1,64%	0,15%	1,98%
MACD(EMA)	8,40%	0,97%	3,04%	5,15%
ROC	4,08%	-22,24%	-15,49%	-8,15%
RSI	7,57%	6,81%	7,03%	7,24%
BB	11,26%	9,22%	9,80%	10,38%
Buy and Hold	12.15%	12.07%	12.09%	12.12%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,93%	4,05%	6,51%	9,04%
EMA	10,80%	1,06%	3,75%	6,52%
DMAC(SMA)	8,27%	7,33%	7,60%	7,87%
DMAC(EMA)	6,73%	5,69%	5,99%	6,28%
MACD(SMA)	3,66%	-2,70%	-0,93%	0,88%
MACD(EMA)	7,37%	0,14%	2,16%	4,21%
ROC	3,12%	-23,06%	-16,35%	-9,04%
RSI	7,20%	6,45%	6,66%	6,87%
BB	10,64%	8,57%	9,15%	9,75%
Buy and Hold	9.64%	9.57%	9.59%	9.61%

Summary of Average Returns for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,36%	3,76%	6,15%	8,59%
EMA	10,32%	0,84%	3,46%	6,15%
DMAC(SMA)	10,20%	9,29%	9,55%	9,81%
DMAC(EMA)	8,73%	7,77%	8,04%	8,32%
MACD(SMA)	5,06%	-1,38%	0,42%	2,25%
MACD(EMA)	8,60%	1,25%	3,30%	5,39%
ROC	3,86%	-22,35%	-15,62%	-8,31%
RSI	7,92%	7,13%	7,35%	7,58%
BB	11,20%	9,09%	9,69%	10,29%
Buy and Hold	11.34%	11.26%	11.28%	11.30%

transaction costs (0%). In the presence of transaction costs, the buy and hold strategy is unbeatable.

For period C: SMA, EMA and BB outperform the buy and hold strategy (in descending order) when there are no transaction costs. The buy and hold strategy is unbeatable for transaction costs of 0.35% and 0.25%. When lowering the transaction costs to 0.15%, BB outperformed the buy and hold strategy.

For the average returns of period A, B and C: the SMA indicator outperformed the buy and hold strategy when there are no transaction costs (0%). In the presence of transaction costs, the buy and hold strategy is unbeatable.

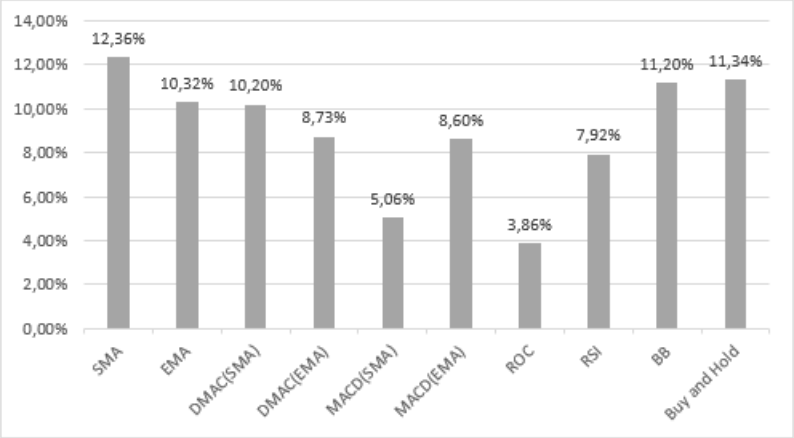

Figure A.3: JSE Top 40 - Average returns on the five-year data for no transaction fees

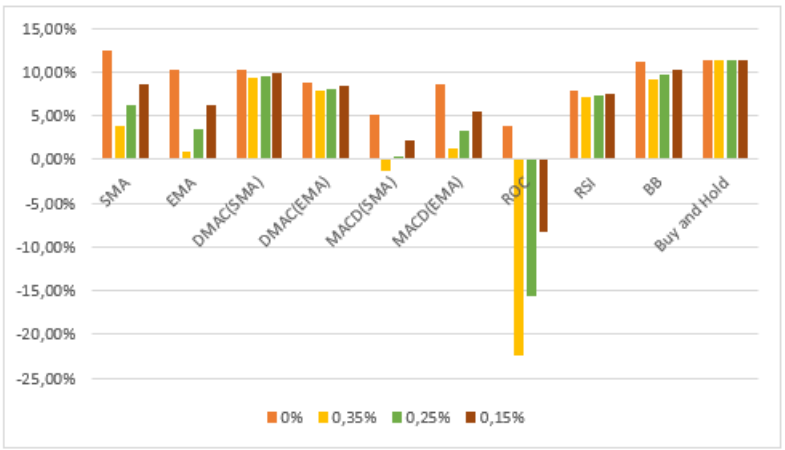

Figure A.4: JSE Top 40 - Average returns on the five-year data for all transaction fees

A.1.1.3 Ten-Year Periods

Table A.3 summarises the return for each indicator for each period.

For period A: the buy and hold achieved the highest return for all possible transaction cost percentages.

For period B: the SMA indicator outperformed the buy and hold strategy when there are no transaction costs (0%). In the presence of transaction costs, the buy and hold strategy is un-

Table A.3: JSE Top 40: Summary of period A, B & C returns for ten years

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11.2%	2.85%	5.15%	7.50%
EMA	8,97%	-0,09%	2,42%	4,99%
DMAC(SMA)	11,34%	10,49%	10,73%	10,97%
DMAC(EMA)	10,09%	9,25%	9,49%	9,73%
MACD(SMA)	6,82%	0,37%	2,17%	4,01%
MACD(EMA)	10,14%	2,80%	4,84%	6,93%
ROC	4,50%	-21,63%	-14,91%	-7,62%
RSI	8,66%	7,83%	8,07%	8,31%
BB	11,49%	9,33%	9,94%	10,56%
Buy and Hold	12,32%	12,28%	12,29%	12,31%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	13,04%	4,40%	6,80%	9,25%
EMA	11,19%	1,59%	4,24%	6,97%
DMAC(SMA)	11,22%	10,40%	10,64%	10,87%
DMAC(EMA)	9,58%	8,70%	8,95%	9,20%
MACD(SMA)	4,90%	-1,47%	0,31%	2,12%
MACD(EMA)	8,51%	1,14%	3,19%	5,29%
ROC	4,18%	-22,11%	-15,36%	-8,03%
RSI	7,57%	6,82%	7,03%	7,25%
BB	11,27%	9,22%	9,80%	10,39%
Buy and Hold	12,26%	12,22%	12,24%	12,25%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,93%	4,05%	6,52%	9,04%
EMA	10,81%	1,06%	3,76%	6,52%
DMAC(SMA)	8,33%	7,42%	7,68%	7,94%
DMAC(EMA)	6,78%	5,78%	6,06%	6,35%
MACD(SMA)	3,68%	-2,62%	-0,86%	0,93%
MACD(EMA)	7,38%	0,23%	2,22%	4,26%
ROC	3,14%	-23,03%	-16,31%	-9,02%
RSI	7,51%	6,76%	6,98%	7,19%
BB	10,73%	8,65%	9,24%	9,83%
Buy and Hold	9,66%	9,62%	9,63%	9,64%

Summary of Average Returns for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,37%	3,77%	6,16%	8,60%
EMA	10,32%	0,85%	3,47%	6,16%
DMAC(SMA)	10,29%	9,44%	9,68%	9,93%
DMAC(EMA)	8,82%	7,91%	8,17%	8,43%
MACD(SMA)	5,13%	-1,24%	0,54%	2,35%
MACD(EMA)	8,68%	1,39%	3,42%	5,49%
ROC	3,94%	-22,25%	-15,53%	-8,22%
RSI	7,91%	7,14%	7,36%	7,58%
BB	11,16%	9,07%	9,66%	10,26%
Buy and Hold	11,41%	11,38%	11,39%	11,40%

beatable.

For period C: SMA, EMA and BB outperform the buy and hold strategy (in descending order) when there are no transaction costs. The buy and hold strategy is unbeatable for transaction costs of 0.35% and 0.25%. When lowering the transaction costs to 0.15%, BB outperformed the buy and hold strategy.

For the average returns of period A, B and C: the SMA indicator outperformed the buy and hold strategy when there are no transaction costs (0%). In the presence of transaction costs, the buy and hold strategy is unbeatable.

A.1.2 S&P 500

A.1.2.1 Three-Year Periods

Constant Exchange Rate

Table A.4 summarises the returns for each of the three periods.

For period A: there are quite a few techniques that outperformed the buy and hold strategy

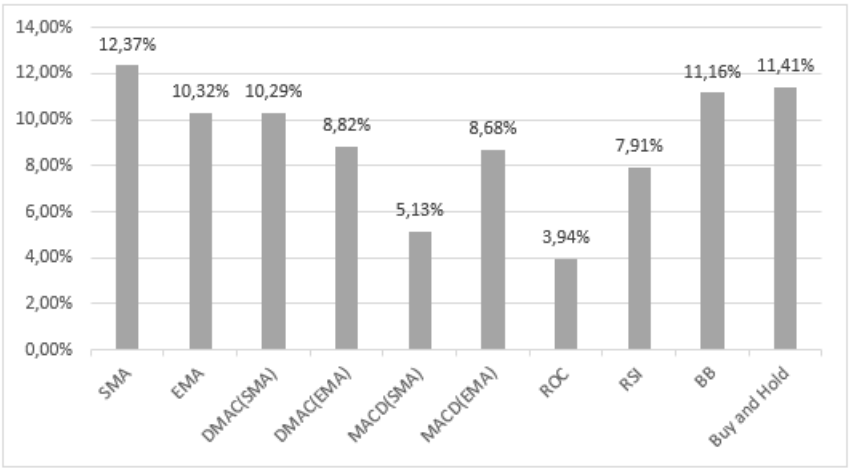

Figure A.5: JSE Top 40 - Average returns on the ten-year data for no transaction fees

Figure A.6: JSE Top 40 - Average returns on the ten-year data for all transaction fees

when considering no transaction costs. They are given in descending order of returns: SMA, DMAC(EMA), EMA and RSI. The DMAC(EMA) outperformed the buy and hold strategy even in the presence of transaction costs. For transaction costs of 0.25% and 0.15%, the RSI indicator also outperformed the buy and hold strategy.

For period B: there are five indicators that outperformed the buy and hold strategy when considering no transaction costs. They are given in descending order of returns: SMA, EMA, DMAC(EMA), RSI and BB. For all transaction costs, the DMAC(EMA) indicator and RSI indicator outperform the buy and hold strategy.

For period C: SMA, EMA, RSI, DMAC(EMA), BB and MACD(SMA) outperformed the buy and hold strategy (in descending order) for no transaction costs. Once again the DMAC(EMA)

Table A.4: S&P 500: Summary of period A, B & C returns for three years (Constant Exchange Rate)

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,96%	-1,17%	1,36%	3,95%
EMA	7,54%	-2,14%	0,53%	3,28%
DMAC(SMA)	5,71%	4,62%	4,93%	5,24%
DMAC(EMA)	7,57%	6,75%	6,98%	7,22%
MACD(SMA)	5,68%	-0,84%	0,98%	2,84%
MACD(EMA)	2,06%	-5,35%	-3,29%	-1,18%
ROC	1,40%	-24,91%	-18,18%	-10,85%
RSI	6,27%	5,60%	5,79%	5,98%
BB	5,54%	3,69%	4,21%	4,74%
Buy and Hold	5,86%	5,74%	5,77%	5,81%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,70%	-1,38%	1,14%	3,71%
EMA	7,11%	-2,43%	0,20%	2,91%
DMAC(SMA)	4,56%	3,48%	3,79%	4,10%
DMAC(EMA)	6,10%	5,25%	5,49%	5,74%
MACD(SMA)	4,28%	-2,18%	-0,38%	1,46%
MACD(EMA)	1,71%	-5,64%	-3,60%	-1,51%
ROC	1,86%	-24,52%	-17,77%	-10,42%
RSI	5,43%	4,73%	4,93%	5,13%
BB	5,28%	3,40%	3,93%	4,47%
Buy and Hold	4,60%	4,47%	4,51%	4,54%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,28%	-1,50%	0,93%	3,42%
EMA	6,88%	-2,32%	0,22%	2,83%
DMAC(SMA)	4,76%	3,64%	3,96%	4,28%
DMAC(EMA)	6,27%	5,45%	5,68%	5,92%
MACD(SMA)	5,21%	-1,18%	0,60%	2,42%
MACD(EMA)	2,22%	-5,20%	-3,14%	-1,03%
ROC	1,86%	-24,52%	-17,77%	-10,42%
RSI	6,44%	5,74%	5,94%	6,14%
BB	5,51%	3,66%	4,18%	4,71%
Buy and Hold	4,81%	4,69%	4,72%	4,76%

Summary of Average Returns for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,64%	-1,35%	1,14%	3,69%
EMA	7,18%	-2,30%	0,32%	3,01%
DMAC(SMA)	5,01%	3,92%	4,23%	4,54%
DMAC(EMA)	6,65%	5,82%	6,05%	6,29%
MACD(SMA)	5,06%	-1,40%	0,40%	2,24%
MACD(EMA)	1,99%	-5,40%	-3,34%	-1,24%
ROC	1,70%	-24,65%	-17,91%	-10,56%
RSI	6,05%	5,36%	5,55%	5,75%
BB	5,44%	3,58%	4,11%	4,64%
Buy and Hold	5,09%	4,97%	5,00%	5,04%

indicator and RSI indicator outperform the buy and hold strategy for all transaction costs.

For the average returns of period A, B and C: SMA, EMA, DMAC(EMA), RSI, and BB produced higher returns than the buy and hold strategy when considering no transaction costs. When taking transaction costs into account, only the DMAC(EMA) indicator and RSI indicator produced higher returns than the buy and hold strategy.

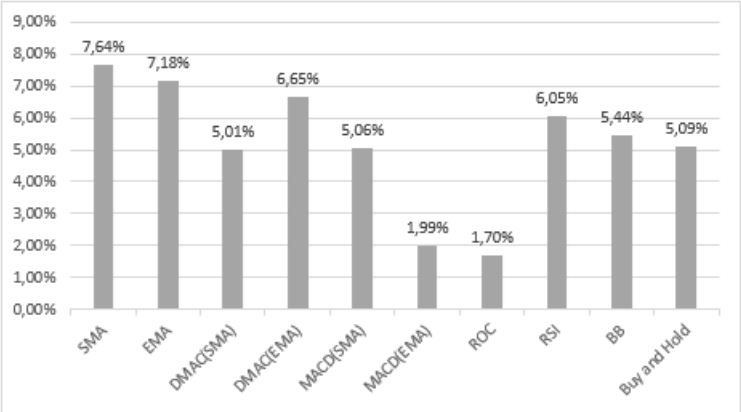

Figure A.7: S&P 500 - Average returns on the three-year data for no transaction fees

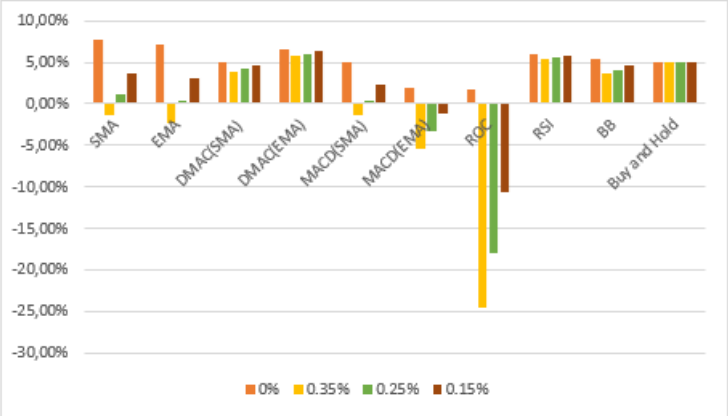

Figure A.8: S&P 500 - Average returns on the three-year data for all transaction fees

Varying Exchange Rate

Table A.5 summarises the returns for each of the three periods.

Table A.5: S&P 500: Summary of period A, B & C returns for three years (Varying Exchange Rate)

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	8,42%	-0,75%	1,79%	4,39%
EMA	7,65%	-2,05%	0,63%	3,38%
DMAC(SMA)	9,77%	8,64%	8,96%	9,28%
DMAC(EMA)	11,21%	10,37%	10,61%	10,85%
MACD(SMA)	9,13%	2,40%	4,28%	6,19%
MACD(EMA)	7,43%	-0,37%	1,80%	4,02%
ROC	8,03%	-19,99%	-12,83%	-5,01%
RSI	7,81%	7,13%	7,33%	7,52%
BB	7,66%	5,78%	6,31%	6,85%
Buy and Hold	10,85%	10,72%	10,75%	10,79%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,36%	-1,69%	0,82%	3,38%
EMA	6,37%	-3,11%	-0,49%	2,20%
DMAC(SMA)	8,66%	7,54%	7,86%	8,18%
DMAC(EMA)	10,68%	9,80%	10,05%	10,31%
MACD(SMA)	8,19%	1,48%	3,36%	5,26%
MACD(EMA)	8,66%	0,81%	2,99%	5,22%
ROC	9,39%	-18,96%	-11,71%	-3,81%
RSI	6,94%	6,23%	6,43%	6,64%
BB	6,74%	4,84%	5,38%	5,92%
Buy and Hold	10,20%	10,07%	10,10%	10,14%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,04%	-1,72%	0,71%	3,19%
EMA	6,54%	-2,63%	-0,09%	2,51%
DMAC(SMA)	6,69%	5,56%	5,88%	6,21%
DMAC(EMA)	8,61%	7,78%	8,01%	8,25%
MACD(SMA)	7,90%	1,34%	3,17%	5,04%
MACD(EMA)	7,07%	-0,70%	1,46%	3,67%
ROC	8,16%	-19,85%	-12,68%	-4,88%
RSI	9,60%	8,87%	9,08%	9,29%
BB	7,31%	5,43%	5,97%	6,50%
Buy and Hold	8,95%	8,83%	8,86%	8,90%

Summary of average for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,60%	-1,39%	1,10%	3,65%
EMA	6,85%	-2,60%	0,02%	2,70%
DMAC(SMA)	8,37%	7,25%	7,57%	7,89%
DMAC(EMA)	10,17%	9,31%	9,56%	9,80%
MACD(SMA)	8,41%	1,74%	3,60%	5,50%
MACD(EMA)	7,72%	-0,09%	2,09%	4,30%
ROC	8,53%	-19,60%	-12,41%	-4,57%
RSI	8,12%	7,41%	7,61%	7,82%
BB	7,24%	5,35%	5,88%	6,42%
Buy and Hold	10,00%	9,87%	9,91%	9,94%

For period A and B: only the DMAC(EMA) indicator outperformed the buy and hold strategy in the absence of transaction costs. For high transaction costs of 0.35% and 0.25% the buy and hold strategy is unbeatable. When lowering the transaction costs to 0.15%, the DMAC(EMA)

indicator outperformed the buy and hold strategy.

For period C: the RSI indicator outperformed the buy and hold strategy for all transaction costs and without transaction costs.

For the average returns of period A, B and C: the DMAC(EMA) indicator outperformed the buy and hold strategy when there are no transaction costs. When including transaction costs, the buy and hold strategy is unbeatable.

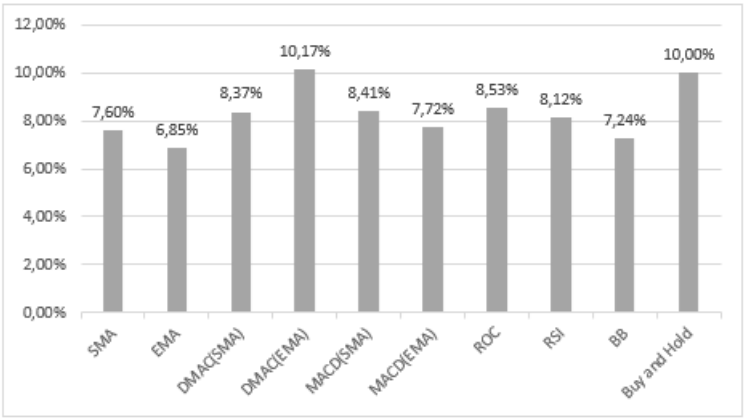

Figure A.9: S&P 500 - Average returns on the three-year data for no transaction fees (Varying Exchange Rate)

Figure A.10: S&P 500 - Average returns on the three-year data for all transaction fees (Varying Exchange Rate

A.1.2.2 Five-Year Periods

Constant Exchange Rate

Table A.6 summarises the returns for each of the five periods.

Table A.6: S&P 500: Summary of period A, B & C returns for five years (Constant Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,63%	-1,46%	1,05%	3,63%
EMA	7,21%	-2,43%	0,23%	2,97%
DMAC(SMA)	4,47%	3,49%	3,77%	4,05%
DMAC(EMA)	6,32%	5,58%	5,79%	6,00%
MACD(SMA)	4,70%	-1,66%	0,12%	1,93%
MACD(EMA)	1,91%	-5,31%	-3,30%	-1,25%
ROC	1,39%	-25,04%	-18,29%	-10,92%
RSI	4,53%	3,94%	4,11%	4,28%
BB	5,33%	3,54%	4,05%	4,56%
Buy and Hold	4,89%	4,82%	4,84%	4,86%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,03%	-2,01%	0,49%	3,06%
EMA	6,64%	-2,80%	-0,19%	2,49%
DMAC(SMA)	4,25%	3,23%	3,52%	3,81%
DMAC(EMA)	6,10%	5,36%	5,57%	5,78%
MACD(SMA)	4,20%	-2,23%	-0,43%	1,40%
MACD(EMA)	0,96%	-6,36%	-4,32%	-2,25%
ROC	0,89%	-25,30%	-18,60%	-11,30%
RSI	5,71%	5,05%	5,24%	5,43%
BB	3,91%	2,15%	2,65%	3,15%
Buy and Hold	3,39%	3,31%	3,33%	3,35%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,28%	-2,29%	0,09%	2,52%
EMA	5,91%	-3,10%	-0,60%	1,95%
DMAC(SMA)	4,54%	3,48%	3,78%	4,08%
DMAC(EMA)	6,28%	5,50%	5,72%	5,95%
MACD(SMA)	4,64%	-1,78%	0,01%	1,84%
MACD(EMA)	2,40%	-4,92%	-2,89%	-0,81%
ROC	2,23%	-24,40%	-17,59%	-10,17%
RSI	5,75%	5,09%	5,28%	5,47%
BB	4,87%	3,05%	3,56%	4,08%
Buy and Hold	4,13%	4,06%	4,08%	4,10%

Summary of Average Returns for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,98%	-1,92%	0,55%	3,07%
EMA	6,59%	-2,78%	-0,19%	2,47%
DMAC(SMA)	4,42%	3,40%	3,69%	3,98%
DMAC(EMA)	6,23%	5,48%	5,69%	5,91%
MACD(SMA)	4,51%	-1,89%	-0,10%	1,72%
MACD(EMA)	1,76%	-5,53%	-3,51%	-1,43%
ROC	1,50%	-24,92%	-18,16%	-10,80%
RSI	5,33%	4,69%	4,87%	5,06%
BB	4,70%	2,91%	3,42%	3,93%
Buy and Hold	4,13%	4,06%	4,08%	4,10%

For period A: SMA, EMA, DMAC(EMA) and BB outperformed the buy and hold strategy in the absence of transaction costs. When we take transaction costs into account, only the DMAC(EMA) indicator outperformed the buy and hold strategy.

For period B: SMA, EMA, DMAC(EMA), RSI, DMAC(SMA), MACD(SMA) and BB outperformed the buy and hold strategy. When taking transaction costs into account DMAC(EMA) and RSI outperformed the buy and hold strategy for all possible transaction costs. For transaction costs of 0.25% and 0.15%, the DMAC(SMA) indicator also outperformed the buy and hold startegy.

For period C: SMA and DMAC(EMA) produced the highest return of 6.29%. EMA, RSI, BB, MACD(SMA) and DMAC(SMA) also outperformed the buy and hold strategy when the trans-

action costs are 0%. Most of the returns were eroded in the presence of transaction costs. The only indicator that still outperforms the buy and hold strategy is the DMAC(EMA) indicator. The RSI indicator produced the closest returns to the buy and hold strategy when considering transaction costs.

For the average returns of period A, B and C: most technical indicators outperformed the buy and hold strategy except for the MACD(EMA) indicator and ROC indicator. Most of the returns are eroded in the presence of transaction costs. DMAC(SMA) and RSI once again outperformed the buy and hold strategy even in the presence of transaction costs.

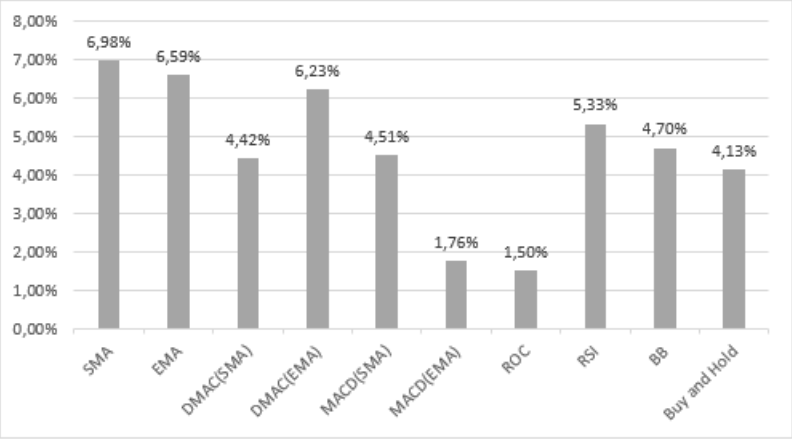

Figure A.11: S&P 500 - Average returns on the five-year data for no transaction fees

Figure A.12: S&P 500 - Average returns on the five-year data for all transaction fees

Varying Exchange Rate

Table A.7 summarises the returns for each of the three periods.

Table A.7: S&P 500: Summary of period A, B & C returns for five years (Varying Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,80%	-1,30%	1,22%	3,80%
EMA	7,12%	-2,51%	0,15%	2,88%
DMAC(SMA)	8,45%	7,43%	7,72%	8,02%
DMAC(EMA)	9,87%	9,10%	9,32%	9,54%
MACD(SMA)	8,17%	1,60%	3,43%	5,30%
MACD(EMA)	7,52%	-0,10%	2,02%	4,19%
ROC	8,31%	-19,93%	-12,71%	-4,84%
RSI	5,96%	5,37%	5,54%	5,71%
BB	7,42%	5,59%	6,11%	6,63%
Buy and Hold	9,88%	9,80%	9,82%	9,84%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,06%	-1,98%	0,52%	3,09%
EMA	6,30%	-3,12%	-0,51%	2,16%
DMAC(SMA)	6,53%	5,49%	5,78%	6,08%
DMAC(EMA)	8,82%	8,06%	8,28%	8,50%
MACD(SMA)	7,71%	1,06%	2,92%	4,81%
MACD(EMA)	6,98%	-0,78%	1,38%	3,58%
ROC	7,17%	-20,66%	-13,54%	-5,79%
RSI	8,15%	7,47%	7,66%	7,86%
BB	5,75%	3,96%	4,47%	4,98%
Buy and Hold	7,98%	7,91%	7,93%	7,95%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,02%	-2,52%	-0,15%	2,27%
EMA	5,66%	-3,32%	-0,84%	1,71%
DMAC(SMA)	6,64%	5,56%	5,87%	6,18%
DMAC(EMA)	9,03%	8,23%	8,46%	8,69%
MACD(SMA)	7,11%	0,53%	2,37%	4,24%
MACD(EMA)	7,42%	-0,27%	1,87%	4,05%
ROC	8,56%	-19,72%	-12,49%	-4,61%
RSI	8,36%	7,68%	7,88%	8,07%
BB	6,41%	4,56%	5,09%	5,61%
Buy and Hold	8,50%	8,42%	8,44%	8,47%

Summary of Average Returns for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,96%	-1,93%	0,53%	3,05%
EMA	6,36%	-2,98%	-0,40%	2,25%
DMAC(SMA)	7,21%	6,16%	6,46%	6,76%
DMAC(EMA)	9,24%	8,47%	8,69%	8,91%
MACD(SMA)	7,66%	1,06%	2,91%	4,78%
MACD(EMA)	7,31%	-0,38%	1,76%	3,94%
ROC	8,01%	-20,10%	-12,91%	-5,08%
RSI	7,49%	6,84%	7,03%	7,21%
BB	6,53%	4,70%	5,22%	5,74%
Buy and Hold	8,79%	8,71%	8,73%	8,75%

For period A: the buy and hold strategy is unbeatable for all possible transaction costs.

For period B: RSI and DMAC(EMA) outperformed the buy and hold strategy when there are no transaction costs. The DMAC(SMA) indicator outperformed the buy and hold strategy for all possible transaction cost percentages.

For period C: RSI and DMAC(EMA) outperformed the buy and hold strategy when there are no transaction costs. The DMAC(SMA) indicator outperformed the buy and hold strategy for transaction cost percentages of 0.25% and 0.15%.

For the average returns of period A, B and C: only the DMAC(EMA) indicator outperformed the buy and hold strategy for no transaction costs and transaction costs of 0.15%.

A.1.2.3 Ten-Year Periods

Constant Exchange Rate

Table A.8 summarises the returns for each of the ten periods.

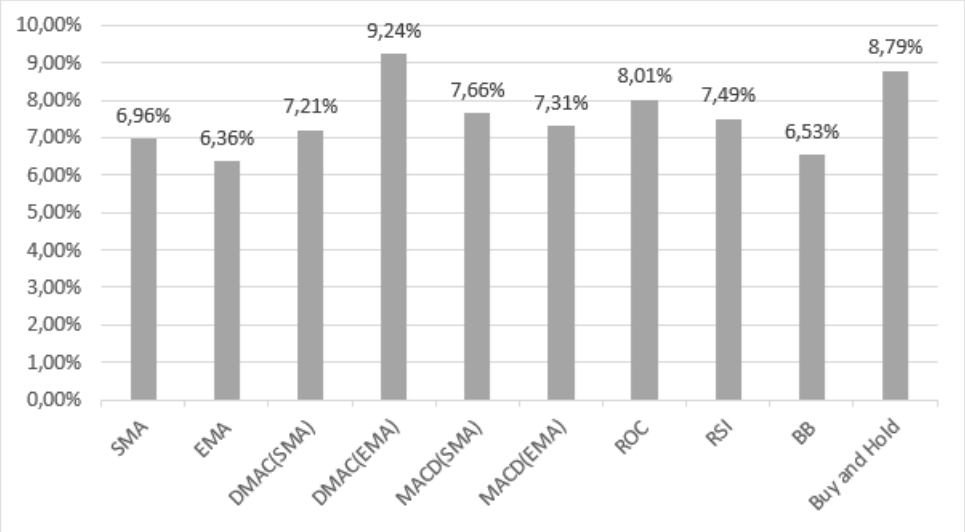

Figure A.13: S&P 500 - Average returns on the five-year data for no transaction fees (Varying Exchange Rate)

Figure A.14: S&P 500 - Average returns on the five-year data for all transaction fees (Varying Exchange Rate

For period A: the SMA indicator produced the highest return for no transaction costs. Other indicators that also outperformed the buy and hold strategy are EMA, DMAC(EMA), RSI and BB. Only the DMAC(EMA) indicator outperformed the buy and hold strategy in the presence of transaction costs.

For period B: all the indicators except for two, MACD(EMA) and ROC, outperformed the buy and hold strategy in the absence of transaction costs. When considering transaction costs, only the DMAC(EMA) and RSI indicators outperformed the buy and hold strategy for all transaction

Table A.8: S&P 500: Summary of period A, B & C returns for five years (Constant Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,94%	-1,17%	1,35%	3,94%
EMA	7,61%	-2,03%	0,64%	3,37%
DMAC(SMA)	4,78%	3,83%	4,10%	4,37%
DMAC(EMA)	6,54%	5,84%	6,04%	6,24%
MACD(SMA)	4,71%	-1,65%	0,12%	1,93%
MACD(EMA)	1,91%	-5,31%	-3,30%	-1,25%
ROC	1,39%	-25,04%	-18,29%	-10,92%
RSI	5,39%	4,80%	4,97%	5,14%
BB	5,33%	3,54%	4,05%	4,56%
Buy and Hold	5,29%	5,25%	5,26%	5,27%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,03%	-2,00%	0,50%	3,06%
EMA	6,65%	-2,80%	-0,19%	2,49%
DMAC(SMA)	4,22%	3,27%	3,54%	3,81%
DMAC(EMA)	6,06%	5,40%	5,59%	5,78%
MACD(SMA)	4,17%	-2,19%	-0,41%	1,40%
MACD(EMA)	0,93%	-6,32%	-4,31%	-2,25%
ROC	0,91%	-25,27%	-18,57%	-11,28%
RSI	5,71%	5,05%	5,24%	5,43%
BB	3,92%	2,15%	2,65%	3,16%
Buy and Hold	3,35%	3,32%	3,33%	3,34%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,28%	-2,28%	0,09%	2,52%
EMA	5,92%	-3,09%	-0,60%	1,96%
DMAC(SMA)	4,43%	3,45%	3,73%	4,01%
DMAC(EMA)	6,17%	5,47%	5,67%	5,87%
MACD(SMA)	4,53%	-1,81%	-0,04%	1,76%
MACD(EMA)	2,35%	-4,94%	-2,91%	-0,84%
ROC	2,13%	-24,47%	-17,67%	-10,26%
RSI	5,75%	5,09%	5,28%	5,47%
BB	4,73%	2,95%	3,46%	3,96%
Buy and Hold	4,02%	3,99%	4,00%	4,01%

Summary of Average Returns for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,08%	-1,82%	0,65%	3,17%
EMA	6,72%	-2,64%	-0,05%	2,61%
DMAC(SMA)	4,48%	3,52%	3,79%	4,06%
DMAC(EMA)	6,26%	5,57%	5,76%	5,96%
MACD(SMA)	4,47%	-1,89%	-0,11%	1,70%
MACD(EMA)	1,73%	-5,52%	-3,51%	-1,45%
ROC	1,48%	-24,93%	-18,18%	-10,82%
RSI	5,62%	4,98%	5,16%	5,35%
BB	4,66%	2,88%	3,39%	3,89%
Buy and Hold	4,22%	4,18%	4,20%	4,21%

costs. For transaction costs of 0.25% and 0.15%, the DMAC(SMA) also outperformed the buy and hold strategy.

For period C: all the indicators except for two, MACD(EMA) and ROC, outperformed the buy and hold strategy in the absence of transaction costs. When considering transaction costs, only the DMAC(EMA) and RSI indicators outperformed the buy and hold strategy for all transaction costs. For transaction cost of 0.15%, the DMAC(SMA) also outperformed the buy and hold strategy.

For the average returns of period A, B and C: all the indicators except for two, MACD(EMA) and ROC, outperformed the buy and hold strategy in the absence of transaction costs. When considering transaction costs, only the DMAC(EMA) and RSI indicators outperformed the buy and hold strategy for all transaction costs.

Varying Exchange Rate

Table A.9 summarises the returns for each of the three periods.

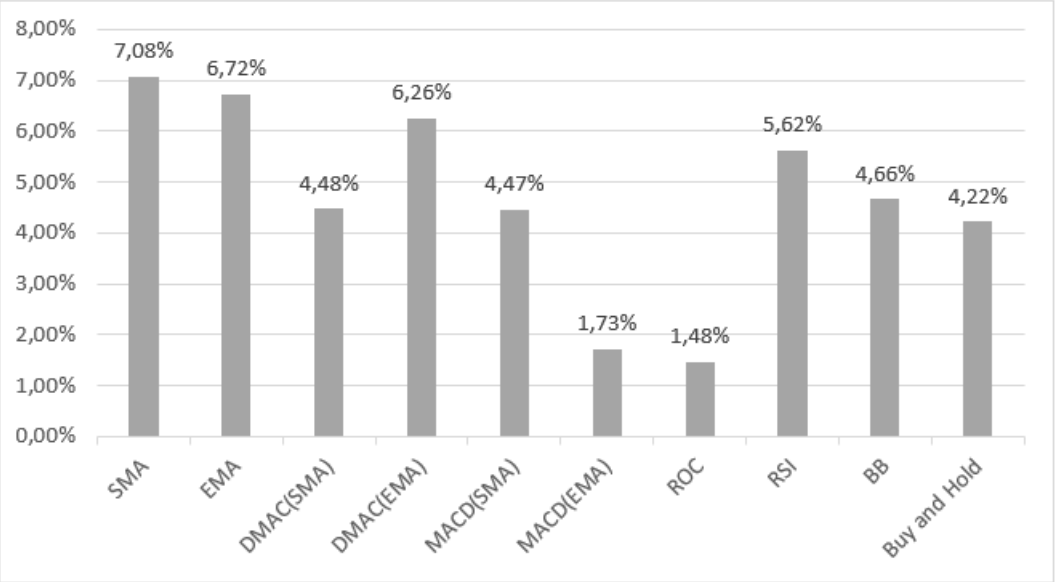

Figure A.15: S&P 500 - Average returns on the ten-year data for no transaction fees

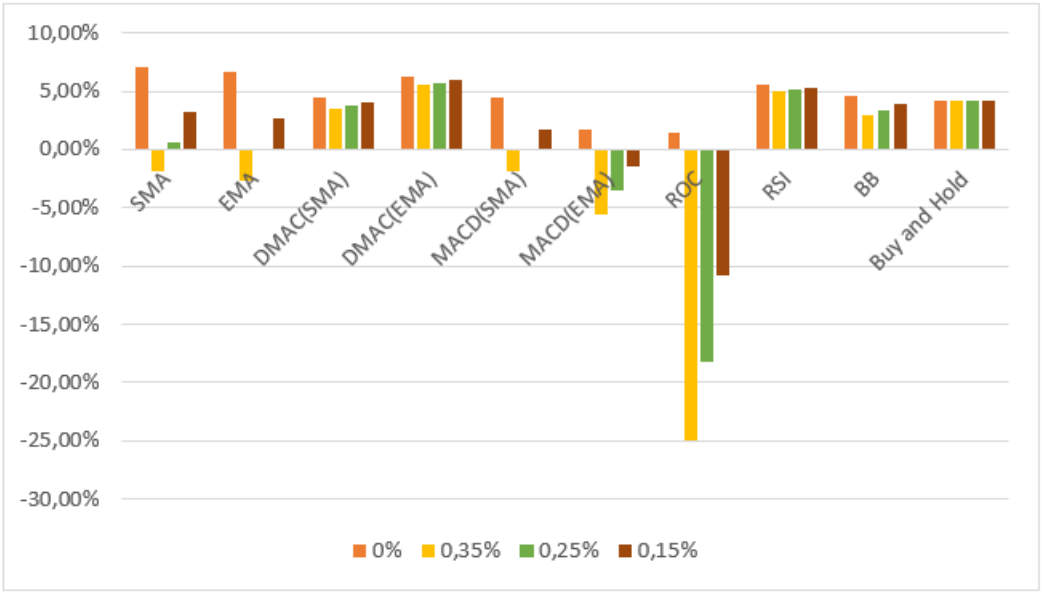

Figure A.16: S&P 500 - Average returns on the ten-year data for all transaction fees

For period A: the buy and hold strategy is unbeatable with and without transaction costs.

For period B: DMAC(EMA) and RSI outperformed the buy and hold strategy in the absence of transaction costs. When including transaction costs, only the DMAC(EMA) indicator outperformed the buy and hold strategy.

For period C: DMAC(EMA) and ROC outperformed the buy and hold strategy when transaction costs are not taken into account. For a transaction cost of 0.35%, the buy and hold strategy

Table A.9: S&P 500: Summary of period A, B & C returns for ten years (Varying Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	8,04%	-1,08%	1,44%	4,03%
EMA	7,44%	-2,18%	0,48%	3,21%
DMAC(SMA)	8,69%	7,71%	7,99%	8,27%
DMAC(EMA)	10,07%	9,34%	9,55%	9,76%
MACD(SMA)	8,17%	1,60%	3,43%	5,30%
MACD(EMA)	7,53%	-0,09%	2,03%	4,19%
ROC	8,31%	-19,93%	-12,71%	-4,84%
RSI	6,82%	6,23%	6,40%	6,57%
BB	7,42%	5,59%	6,11%	6,63%
Buy and Hold	10,21%	10,17%	10,18%	10,19%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,06%	-1,98%	0,52%	3,09%
EMA	6,30%	-3,11%	-0,51%	2,16%
DMAC(SMA)	6,54%	5,57%	5,85%	6,13%
DMAC(EMA)	8,79%	8,10%	8,30%	8,49%
MACD(SMA)	7,72%	1,14%	2,98%	4,85%
MACD(EMA)	6,99%	-0,69%	1,45%	3,63%
ROC	7,17%	-20,63%	-13,52%	-5,78%
RSI	8,15%	7,47%	7,67%	7,86%
BB	5,76%	3,96%	4,47%	4,98%
Buy and Hold	8,00%	7,96%	7,97%	7,98%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,03%	-2,52%	-0,15%	2,28%
EMA	5,67%	-3,32%	-0,83%	1,72%
DMAC(SMA)	6,57%	5,57%	5,85%	6,14%
DMAC(EMA)	8,96%	8,24%	8,44%	8,65%
MACD(SMA)	7,03%	0,53%	2,35%	4,20%
MACD(EMA)	7,38%	-0,26%	1,86%	4,04%
ROC	8,46%	-19,79%	-12,56%	-4,69%
RSI	8,37%	7,68%	7,88%	8,07%
BB	6,58%	4,77%	5,28%	5,80%
Buy and Hold	8,43%	8,39%	8,40%	8,41%

Summary of Average Return for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,04%	-1,86%	0,61%	3,13%
EMA	6,47%	-2,87%	-0,29%	2,36%
DMAC(SMA)	7,27%	6,28%	6,56%	6,84%
DMAC(EMA)	9,27%	8,56%	8,77%	8,97%
MACD(SMA)	7,64%	1,09%	2,92%	4,78%
MACD(EMA)	7,30%	-0,35%	1,78%	3,95%
ROC	7,98%	-20,11%	-12,93%	-5,10%
RSI	7,78%	7,13%	7,31%	7,50%
BB	6,59%	4,77%	5,29%	5,81%
Buy and Hold	8,88%	8,84%	8,85%	8,86%

is unbeatable. For lower transaction costs of 0.25% and 0.15%, DMAC(EMA) outperformed the buy and hold strategy.

For the average returns of period A, B and C: only DMAC(EMA) outperformed the buy and hold strategy in the absence of transaction costs. For transaction costs of 0.35% and 0.25%, the buy and hold strategy is unbeatable. When lowering the transaction costs to 0.15%, the DMAC(EMA) outperformed the buy and hold strategy.

A.1.3 NIFTY 50

A.1.3.1 Three-Year Periods

Constant Exchange Rate

Table A.10 summarises the returns for each of the three periods.

For period A: the MACD(SMA) indicator produced the highest returns in the absence of transaction costs. The buy and hold strategy produced the second highest returns with DMAC(SMA) and DMAC(EMA) producing returns close to the buy and hold strategy. In the presence of trans-

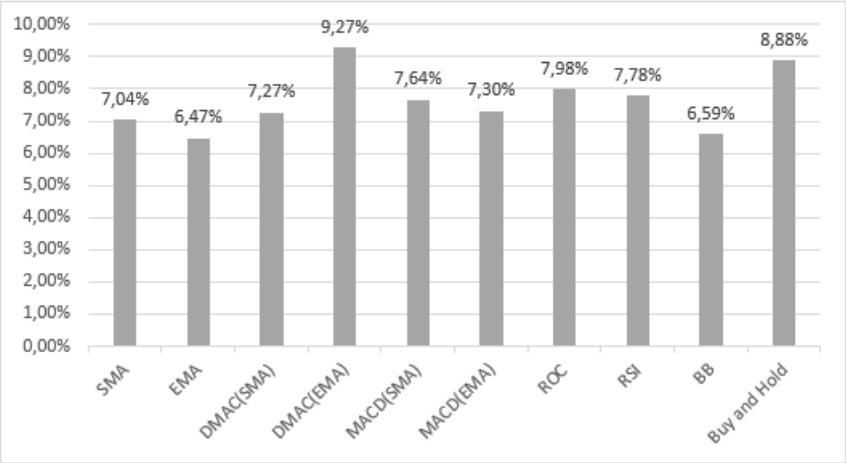

Figure A.17: S&P 500 - Average returns on the ten-year data for no transaction fees (Varying Exchange Rate)

Figure A.18: S&P 500 - Average returns on the ten-year data for all transaction fees (Varying Exchange Rate

action costs, the buy and hold strategy is unbeatable. For lower transaction costs of 0.15%, the MACD(SMA) indicator produced returns very close to the buy and hold strategy.

For period B: MACD(SMA) produced the best returns once again with the buy and hold strategy producing the second highest return. The buy and hold strategy is unbeatable for transaction costs of 0.25% and 0.35%. For transaction costs of 0.15%, the MACD(SMA) indicator and buy and hold strategy produced the same return.

For period C: the MACD(SMA) indicator outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is

Table A.10: NIFTY 50: Summary of period A, B & C returns for three years (Constant Exchange Rate)

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,53%	-3,02%	-1,19%	0,67%
EMA	2,88%	-4,94%	-2,77%	-0,55%
DMAC(SMA)	10,93%	9,90%	10,19%	10,49%
DMAC(EMA)	10,77%	9,85%	10,11%	10,38%
MACD(SMA)	14,29%	7,67%	9,52%	11,40%
MACD(EMA)	9,60%	2,43%	4,43%	6,47%
ROC	10,22%	-16,39%	-9,53%	-2,09%
RSI	4,89%	4,71%	4,76%	4,81%
BB	5,00%	4,20%	4,42%	4,65%
Buy and Hold	11,63%	11,50%	11,54%	11,57%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,04%	-3,47%	-1,66%	0,20%
EMA	2,22%	-5,67%	-3,48%	-1,24%
DMAC(SMA)	9,89%	8,87%	9,16%	9,45%
DMAC(EMA)	10,40%	9,48%	9,74%	10,00%
MACD(SMA)	14,30%	7,58%	9,46%	11,37%
MACD(EMA)	10,53%	3,29%	5,31%	7,37%
ROC	10,12%	-16,55%	-9,67%	-2,22%
RSI	10,62%	10,40%	10,46%	10,53%
BB	8,25%	7,32%	7,58%	7,85%
Buy and Hold	11,42%	11,29%	11,33%	11,37%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	4,12%	-2,63%	-0,74%	1,18%
EMA	3,55%	-4,48%	-2,25%	0,03%
DMAC(SMA)	10,95%	9,85%	10,16%	10,47%
DMAC(EMA)	11,24%	10,24%	10,52%	10,81%
MACD(SMA)	13,94%	7,16%	9,06%	10,99%
MACD(EMA)	10,46%	3,10%	5,15%	7,24%
ROC	10,35%	-16,37%	-9,48%	-2,01%
RSI	12,35%	12,13%	12,19%	12,26%
BB	7,38%	6,56%	6,80%	7,03%
Buy and Hold	13,17%	13,04%	13,08%	13,11%

Summary of Average Returns for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,57%	-3,04%	-1,20%	0,68%
EMA	2,88%	-5,03%	-2,83%	-0,59%
DMAC(SMA)	10,59%	9,54%	9,84%	10,14%
DMAC(EMA)	10,80%	9,86%	10,13%	10,40%
MACD(SMA)	14,18%	7,47%	9,34%	11,25%
MACD(EMA)	10,20%	2,94%	4,96%	7,03%
ROC	10,23%	-16,44%	-9,56%	-2,11%
RSI	9,29%	9,08%	9,14%	9,20%
BB	6,88%	6,03%	6,27%	6,51%
Buy and Hold	12,07%	11,94%	11,98%	12,02%

unbeatable.

For the average returns of period A, B and C: the MACD(SMA) indicator outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeatable.

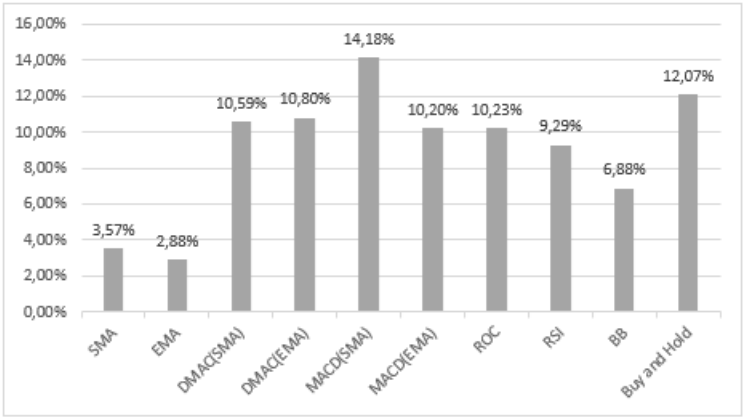

Figure A.19: NIFTY 50 - Average returns on the three-year data for no transaction fees (Constant Exchange Rate)

Figure A.20: NIFTY 50 - Average returns on the three-year data for all transaction fees (Constant Exchange Rate)

Varying Exchange Rate

Table A.11 summarises the returns for each of the three periods.

Table A.11: NIFTY 50: Summary of period A, B & C returns for three years (Varying Exchange Rate)

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	4,29%	-2,31%	-0,47%	1,41%
EMA	2,90%	-4,91%	-2,74%	-0,52%
DMAC(SMA)	10,61%	9,58%	9,88%	10,17%
DMAC(EMA)	10,22%	9,31%	9,57%	9,83%
MACD(SMA)	12,41%	5,90%	7,72%	9,57%
MACD(EMA)	5,71%	-1,20%	0,73%	2,69%
ROC	7,64%	-18,35%	-11,64%	-4,38%
RSI	2,63%	2,46%	2,51%	2,56%
BB	2,30%	1,52%	1,74%	1,96%
Buy and Hold	9,59%	9,46%	9,50%	9,54%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,88%	-2,69%	-0,85%	1,02%
EMA	2,57%	-5,35%	-3,15%	-0,91%
DMAC(SMA)	9,68%	8,66%	8,96%	9,25%
DMAC(EMA)	10,04%	9,13%	9,39%	9,65%
MACD(SMA)	12,00%	5,40%	7,25%	9,12%
MACD(EMA)	5,99%	-0,95%	0,99%	2,96%
ROC	7,10%	-18,84%	-12,14%	-4,90%
RSI	8,01%	7,79%	7,85%	7,91%
BB	5,44%	4,53%	4,79%	5,05%
Buy and Hold	8,75%	8,63%	8,66%	8,70%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	5,71%	-1,14%	0,77%	2,71%
EMA	4,52%	-3,58%	-1,33%	0,97%
DMAC(SMA)	10,79%	9,68%	10,00%	10,31%
DMAC(EMA)	10,53%	9,54%	9,82%	10,10%
MACD(SMA)	11,50%	4,87%	6,72%	8,61%
MACD(EMA)	5,07%	-1,94%	0,02%	2,01%
ROC	7,87%	-18,25%	-11,51%	-4,22%
RSI	11,39%	11,17%	11,23%	11,29%
BB	4,70%	3,90%	4,13%	4,36%
Buy and Hold	11,29%	11,16%	11,20%	11,23%

Summary of Average Returns for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	4,63%	-2,05%	-0,18%	1,71%
EMA	3,33%	-4,61%	-2,41%	-0,15%
DMAC(SMA)	10,36%	9,31%	9,61%	9,91%
DMAC(EMA)	10,26%	9,33%	9,59%	9,86%
MACD(SMA)	11,97%	5,39%	7,23%	9,10%
MACD(EMA)	5,59%	-1,36%	0,58%	2,55%
ROC	7,54%	-18,48%	-11,77%	-4,50%
RSI	7,34%	7,14%	7,20%	7,26%
BB	4,14%	3,31%	3,55%	3,79%
Buy and Hold	9,88%	9,75%	9,79%	9,82%

For period A: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. The DMAC(SMA) indicator

outperformed the buy and hold strategy for all possible transaction costs. When lowering the transaction costs to 0.25% and 0.15%, the DMAC(EMA) also outperformed the buy and hold strategy. For a transaction cost of 0.15%, the MACD(SMA) also outperformed the buy and hold strategy.

For period B: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy again (in descending order) when there are no transaction costs. For all possible transaction costs, DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy. When lowering the transaction costs to 0.15%, the MACD(SMA) indicator also outperformed the buy and hold strategy.

For period C: the MACD(SMA) and RSI indicators outperformed the buy and hold strategy in the absence of transaction costs and the RSI indicator outperformed the buy and hold strategy even in the presence of transaction costs.

For the average returns of period A, B and C: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. Only for a transaction cost of 0.15% is the buy and hold strategy beatable by DMAC(SMA) and DMAC(EMA).

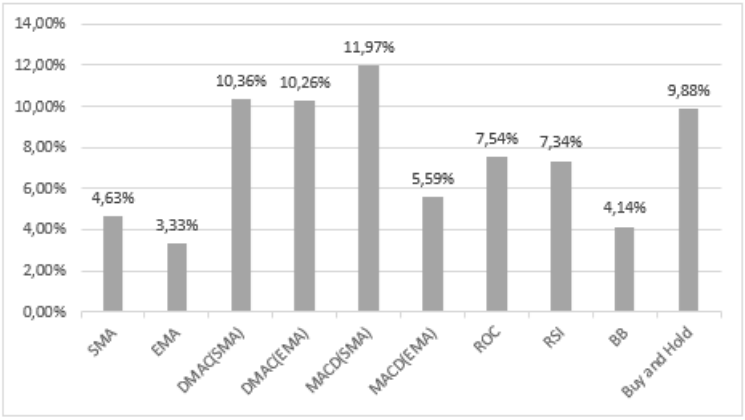

Figure A.21: NIFTY 50 - Average returns on the three-year data for no transaction fees (Varying Exchange Rate)

Figure A.22: NIFTY 50 - Average returns on the three-year data for all transaction fees (Varying Exchange Rate)

A.1.3.2 Five-Year Periods

Constant Exchange Rate

Table A.12 summarises the returns for each of the three periods.

Table A.12: NIFTY 50: Summary of period A, B & C returns for five years (Constant Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,06%	-3,40%	-1,59%	0,24%
EMA	2,32%	-5,46%	-3,30%	-1,09%
DMAC(SMA)	10,96%	9,96%	10,24%	10,53%
DMAC(EMA)	11,27%	10,38%	10,63%	10,89%
MACD(SMA)	14,76%	8,05%	9,93%	11,83%
MACD(EMA)	10,85%	3,65%	5,66%	7,70%
ROC	10,07%	-16,61%	-9,72%	-2,27%
RSI	3,69%	3,58%	3,61%	3,64%
BB	7,51%	6,65%	6,90%	7,14%
Buy and Hold	11,97%	11,89%	11,92%	11,94%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,60%	-2,97%	-1,14%	0,73%
EMA	2,90%	-5,06%	-2,85%	-0,59%
DMAC(SMA)	11,19%	10,22%	10,50%	10,78%
DMAC(EMA)	11,53%	10,67%	10,92%	11,16%
MACD(SMA)	14,39%	7,63%	9,52%	11,44%
MACD(EMA)	10,56%	3,23%	5,27%	7,36%
ROC	10,76%	-16,20%	-9,25%	-1,72%
RSI	11,06%	10,94%	10,97%	11,01%
BB	7,10%	6,28%	6,52%	6,75%
Buy and Hold	13,08%	13,01%	13,03%	13,05%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	2,94%	-3,68%	-1,83%	0,05%
EMA	2,97%	-5,03%	-2,81%	-0,54%
DMAC(SMA)	8,73%	7,67%	7,97%	8,28%
DMAC(EMA)	9,01%	8,06%	8,33%	8,60%
MACD(SMA)	11,81%	5,20%	7,05%	8,93%
MACD(EMA)	9,76%	2,56%	4,57%	6,61%
ROC	8,49%	-17,63%	-10,89%	-3,59%
RSI	10,58%	10,42%	10,47%	10,51%
BB	7,01%	6,15%	6,40%	6,64%
Buy and Hold	10,58%	10,50%	10,52%	10,55%

Summary of Average Returns for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,20%	-3,35%	-1,52%	0,34%
EMA	2,73%	-5,18%	-2,99%	-0,74%
DMAC(SMA)	10,30%	9,28%	9,57%	9,86%
DMAC(EMA)	10,60%	9,70%	9,96%	10,22%
MACD(SMA)	13,65%	6,96%	8,83%	10,73%
MACD(EMA)	10,39%	3,14%	5,16%	7,22%
ROC	9,77%	-16,81%	-9,95%	-2,53%
RSI	8,44%	8,32%	8,35%	8,39%
BB	7,21%	6,36%	6,60%	6,85%
Buy and Hold	11,88%	11,80%	11,82%	11,84%

For period A: the MACD(SMA) indicator outperformed the buy and hold strategy when there

are no transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeatable.

For period B and C: the MACD(SMA) indicator outperformed the buy and hold strategy when there are no transaction costs. The RSI indicator produced the same returns as the buy and hold strategy when there are no transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeatable.

For the average returns of period A, B and C: the MACD(SMA) indicator outperformed the buy and hold strategy when there are no transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeatable.

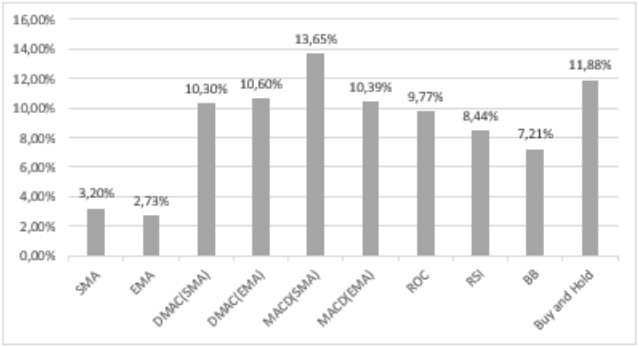

Figure A.23: NIFTY 50 - Average returns on the five-year data for no transaction fees (Constant Exchange Rate)

Figure A.24: NIFTY 50 - Average returns on the five-year data for all transaction fees (Constant Exchange Rate)

Varying Exchange Rate

Table A.13 summarises the returns for each of the three periods.

Table A.13: NIFTY 50: Summary of period A, B & C returns for five years (Varying Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,51%	-2,98%	-1,17%	0,67%
EMA	2,08%	-5,68%	-3,52%	-1,32%
DMAC(SMA)	10,70%	9,70%	9,98%	10,27%
DMAC(EMA)	10,86%	9,97%	10,22%	10,47%
MACD(SMA)	12,84%	6,25%	8,09%	9,97%
MACD(EMA)	7,00%	0,04%	1,98%	3,96%
ROC	7,35%	-18,67%	-11,96%	-4,69%
RSI	1,21%	1,10%	1,13%	1,16%
BB	4,33%	3,49%	3,73%	3,97%
Buy and Hold	9,54%	9,47%	9,49%	9,51%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	5,21%	-1,46%	0,40%	2,30%
EMA	3,76%	-4,27%	-2,04%	0,24%
DMAC(SMA)	11,02%	10,05%	10,33%	10,60%
DMAC(EMA)	10,98%	10,13%	10,38%	10,62%
MACD(SMA)	11,19%	4,62%	6,46%	8,33%
MACD(EMA)	5,49%	-1,50%	0,45%	2,44%
ROC	8,52%	-17,89%	-11,08%	-3,70%
RSI	9,93%	9,81%	9,84%	9,88%
BB	4,30%	3,50%	3,73%	3,96%
Buy and Hold	10,83%	10,75%	10,77%	10,79%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	4,56%	-2,17%	-0,29%	1,62%
EMA	3,91%	-4,16%	-1,92%	0,37%
DMAC(SMA)	8,62%	7,56%	7,86%	8,17%
DMAC(EMA)	8,17%	7,23%	7,50%	7,77%
MACD(SMA)	9,77%	3,29%	5,10%	6,94%
MACD(EMA)	4,57%	-2,29%	-0,38%	1,57%
ROC	6,18%	-19,38%	-12,78%	-5,64%
RSI	8,80%	8,65%	8,69%	8,73%
BB	4,34%	3,50%	3,74%	3,98%
Buy and Hold	8,80%	8,72%	8,75%	8,77%

Summary of Average Returns for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	4,42%	-2,20%	-0,35%	1,53%
EMA	3,25%	-4,70%	-2,49%	-0,24%
DMAC(SMA)	10,11%	9,10%	9,39%	9,68%
DMAC(EMA)	10,00%	9,11%	9,37%	9,62%
MACD(SMA)	11,27%	4,72%	6,55%	8,41%
MACD(EMA)	5,69%	-1,25%	0,68%	2,66%
ROC	7,35%	-18,65%	-11,94%	-4,68%
RSI	6,64%	6,52%	6,55%	6,59%
BB	4,32%	3,50%	3,73%	3,97%
Buy and Hold	9,72%	9,65%	9,67%	9,69%

For period A: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. For all possible transaction costs, DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy. When lowering the transaction costs to 0.15%, the MACD(SMA) indicator also outperformed the buy and hold strategy.

For period B: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy again (in descending order) when there are no transaction costs. In the presence of transaction costs, none of the indicators outperformed the buy and hold strategy. The DMAC(EMA) and DMAC(SMA) indicators produced the closest returns to the buy and hold strategy for all possible transaction costs.

For period C: the MACD(SMA) indicator outperformed the buy and hold strategy in the absence of transaction costs and the RSI indicator produced the same returns as the buy and hold

strategy. The buy and hold strategy is unbeatable in the presence of transaction costs.

For the average returns of period A, B and C: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. The buy and hold strategy is unbeatable in the presence of transaction costs.

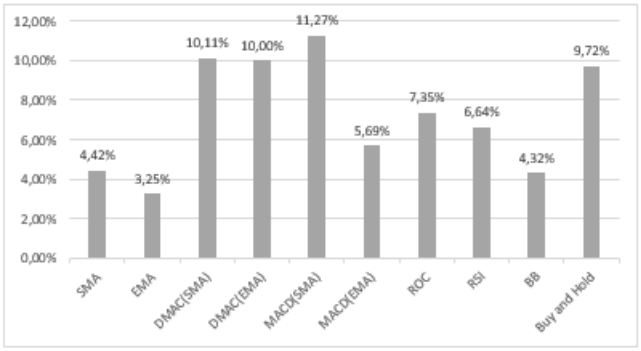

Figure A.25: NIFTY 50 - Average returns on the five-year data for no transaction fees (Varying Exchange Rate)

Figure A.26: NIFTY 50 - Average returns on the five-year data for all transaction fees (Varying Exchange Rate)

A.1.3.3 Ten-Year Periods

Constant Exchange Rate

Table A.14 summarises the returns for each of the three periods.

For period A, B and C and the average returns of the three periods: the MACD(SMA) produced the highest returns in the absence of transaction costs, with the buy and hold strategy and the RSI indicator producing the second highest returns combined. When considering transaction costs, the buy and hold strategy produced the highest returns with RSI producing results close

Table A.14: NIFTY 50: Summary of period A, B & C returns for ten years (Constant Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,06%	-3,40%	-1,59%	0,24%
EMA	2,32%	-5,46%	-3,30%	-1,09%
DMAC(SMA)	11,04%	10,11%	10,37%	10,64%
DMAC(EMA)	11,35%	10,53%	10,76%	11,00%
MACD(SMA)	14,76%	8,05%	9,93%	11,84%
MACD(EMA)	10,85%	3,65%	5,66%	7,70%
ROC	10,11%	-16,54%	-9,67%	-2,22%
RSI	12,05%	11,97%	11,99%	12,02%
BB	7,52%	6,65%	6,90%	7,15%
Buy and Hold	12,05%	12,01%	12,02%	12,03%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,60%	-2,97%	-1,13%	0,73%
EMA	2,90%	-5,06%	-2,85%	-0,59%
DMAC(SMA)	11,29%	10,39%	10,65%	10,90%
DMAC(EMA)	11,62%	10,84%	11,07%	11,29%
MACD(SMA)	14,49%	7,76%	9,64%	11,55%
MACD(EMA)	10,65%	3,39%	5,41%	7,48%
ROC	10,85%	-16,10%	-9,15%	-1,62%
RSI	13,18%	13,10%	13,12%	13,15%
BB	7,26%	6,44%	6,68%	6,91%
Buy and Hold	13,18%	13,14%	13,15%	13,16%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	2,95%	-3,64%	-1,81%	0,07%
EMA	2,97%	-5,03%	-2,81%	-0,54%
DMAC(SMA)	8,82%	7,84%	8,12%	8,40%
DMAC(EMA)	9,10%	8,22%	8,47%	8,72%
MACD(SMA)	11,81%	5,20%	7,05%	8,93%
MACD(EMA)	9,76%	2,56%	4,57%	6,62%
ROC	8,49%	-17,60%	-10,86%	-3,57%
RSI	10,67%	10,59%	10,62%	10,64%
BB	7,30%	6,44%	6,69%	6,93%
Buy and Hold	10,67%	10,63%	10,64%	10,65%

Summary of Average Returns for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,20%	-3,34%	-1,51%	0,35%
EMA	2,73%	-5,18%	-2,99%	-0,74%
DMAC(SMA)	10,38%	9,45%	9,71%	9,98%
DMAC(EMA)	10,69%	9,87%	10,10%	10,34%
MACD(SMA)	13,68%	7,01%	8,87%	10,77%
MACD(EMA)	10,42%	3,20%	5,21%	7,27%
ROC	9,82%	-16,75%	-9,89%	-2,47%
RSI	11,97%	11,89%	11,91%	11,93%
BB	7,36%	6,51%	6,75%	7,00%
Buy and Hold	11,97%	11,93%	11,94%	11,95%

to the buy and hold strategy.

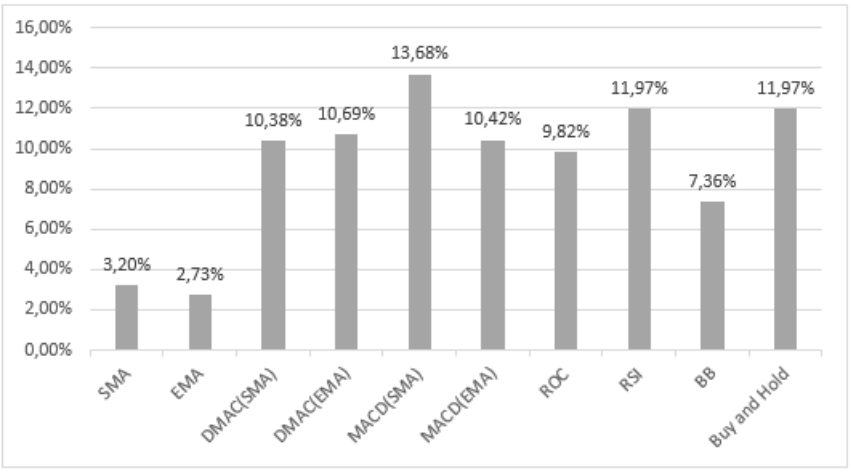

Figure A.27: NIFTY 50 - Average returns on the ten-year data for no transaction fees (Constant Exchange Rate)

Varying Exchange Rate

Table A.15 summarises the returns for each of the three periods.

Figure A.28: NIFTY 50 - Average returns on the ten-year data for all transaction fees (Constant Exchange Rate)

Table A.15: NIFTY 50: Summary of period A, B & C returns for ten years (Varying Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	3,51%	-2,98%	-1,17%	0,67%
EMA	2,08%	-5,68%	-3,52%	-1,32%
DMAC(SMA)	10,70%	9,70%	9,98%	10,27%
DMAC(EMA)	10,86%	9,97%	10,22%	10,47%
MACD(SMA)	12,84%	6,25%	8,09%	9,97%
MACD(EMA)	7,00%	0,04%	1,98%	3,96%
ROC	7,35%	-18,67%	-11,96%	-4,69%
RSI	1,21%	1,10%	1,13%	1,16%
BB	4,33%	3,49%	3,73%	3,97%
Buy and Hold	9,54%	9,47%	9,49%	9,51%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	5,21%	-1,46%	0,40%	2,30%
EMA	3,76%	-4,27%	-2,04%	0,24%
DMAC(SMA)	11,02%	10,05%	10,33%	10,60%
DMAC(EMA)	10,98%	10,13%	10,38%	10,62%
MACD(SMA)	11,19%	4,62%	6,46%	8,33%
MACD(EMA)	5,49%	-1,50%	0,45%	2,44%
ROC	8,52%	-17,89%	-11,08%	-3,70%
RSI	9,93%	9,81%	9,84%	9,88%
BB	4,30%	3,50%	3,73%	3,96%
Buy and Hold	10,83%	10,75%	10,77%	10,79%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	4,56%	-2,17%	-0,29%	1,62%
EMA	3,91%	-4,16%	-1,92%	0,37%
DMAC(SMA)	8,62%	7,56%	7,86%	8,17%
DMAC(EMA)	8,17%	7,23%	7,50%	7,77%
MACD(SMA)	9,77%	3,29%	5,10%	6,94%
MACD(EMA)	4,57%	-2,29%	-0,38%	1,57%
ROC	6,18%	-19,38%	-12,78%	-5,64%
RSI	8,80%	8,65%	8,69%	8,73%
BB	4,34%	3,50%	3,74%	3,98%
Buy and Hold	8,80%	8,72%	8,75%	8,77%

Summary of Average Returns for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	4,42%	-2,20%	-0,35%	1,53%
EMA	3,25%	-4,70%	-2,49%	-0,24%
DMAC(SMA)	10,11%	9,10%	9,39%	9,68%
DMAC(EMA)	10,00%	9,11%	9,37%	9,62%
MACD(SMA)	11,27%	4,72%	6,55%	8,41%
MACD(EMA)	5,69%	-1,25%	0,68%	2,66%
ROC	7,35%	-18,65%	-11,94%	-4,68%
RSI	6,64%	6,52%	6,55%	6,59%
BB	4,32%	3,50%	3,73%	3,97%
Buy and Hold	9,72%	9,65%	9,67%	9,69%

For period A: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs and the RSI indicator produced the same returns as the buy and hold strategy. For all possible transaction costs, DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy. When lowering the transaction costs to 0.15%, the MACD(SMA) indicator also outperformed the buy and hold

strategy.

For period B: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy again (in descending order) when there are no transaction costs and the RSI indicator produced the same returns as the buy and hold strategy. In the presence of transaction costs, none of the indicators outperformed the buy and hold strategy. The DMAC(EMA) and DMAC(SMA) indicators produced the closest returns to the buy and hold strategy for all possible transaction costs.

For period C: the MACD(SMA) indicator outperformed the buy and hold strategy in the absence of transaction costs and the RSI indicator produced the same returns as the buy and hold strategy. The buy and hold strategy is unbeatable in the presence of transaction costs.

For the average returns of period A, B and C: MACD(SMA), DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs and the RSI indicator produced the same returns as the buy and hold strategy. The buy and hold strategy is unbeatable in the presence of transaction costs of 0.35% and 0.25%. The DMAC(SMA) indicator produced the same results as the buy and hold strategy for a transaction cost of 0.15%.

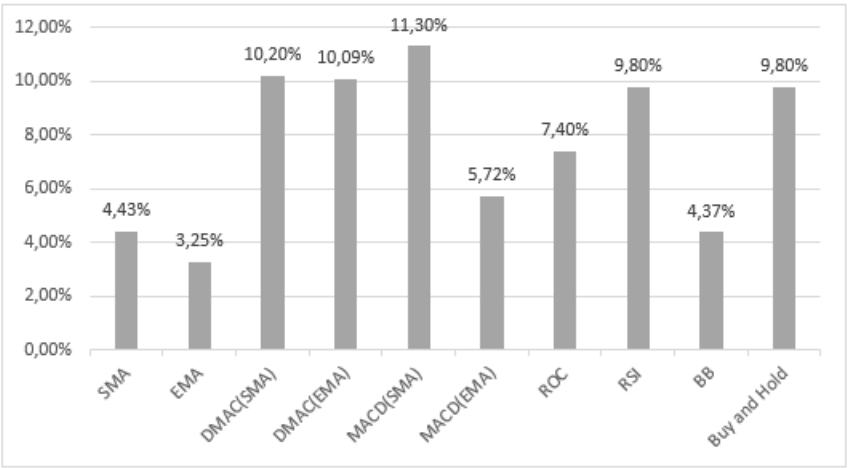

Figure A.29: NIFTY 50 - Average returns on the ten-year data for no transaction fees (Varying Exchange Rate)

Figure A.30: NIFTY 50 - Average returns on the ten-year data for all transaction fees (Varying Exchange Rate)

A.1.4 FTSE 100

A.1.4.1 Three-Year Periods

Constant Exchange Rate

Table A.16 summarises the returns for each of the three periods.

For period A: all the indicators, except for two, outperformed the buy and hold strategy in the absence of transaction costs. The indicators that performed poorly are MACD(SMA) and ROC. When we consider transaction costs of 0.35% and 0.25%, RSI, BB and DMAC(SMA) outperformed the buy and hold strategy. For lower transaction costs of 0.15% BB, DMAC(SMA), RSI, SMA and DMAC(EMA) outperformed the buy and hold strategy.

For period B: the results for no transaction costs and transaction costs of 0.35% and 0.25% are the same as period A. However, for transaction costs of 0.15% only BB, DMAC(SMA), SMA and RSI outperformed the buy and hold strategy.

For period C: there are three indicators that produced lower returns than the buy and hold strategy. These indicators are DAMC(EMA), MACD(EMA) and ROC. The rest of the indicators performed better than the buy and hold strategy. When we consider transaction costs of 0.35% and 0.25%, the following indicators once again outperformed the buy and hold strategy: BB, RSI and DMAC(SMA). For a lower transaction cost of 0.15% BB, DMAC(SMA), SMA and RSI outperformed the buy and hold strategy.

Table A.16: FTSE 100: Summary of period A, B & C returns for three years (Constant Exchange Rate)

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,40%	-1,48%	0,98%	3,50%
EMA	6,64%	-3,99%	-1,06%	1,95%
DMAC(SMA)	4,58%	3,54%	3,84%	4,13%
DMAC(EMA)	3,34%	2,18%	2,51%	2,84%
MACD(SMA)	3,28%	-3,06%	-1,29%	0,51%
MACD(EMA)	-0,19%	-7,71%	-5,62%	-3,48%
ROC	-2,30%	-27,75%	-21,24%	-14,15%
RSI	4,38%	3,76%	3,94%	4,12%
BB	5,41%	3,60%	4,11%	4,63%
Buy and Hold	2,62%	2,50%	2,53%	2,57%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,01%	-2,82%	-0,38%	2,13%
EMA	5,16%	-5,22%	-2,36%	0,58%
DMAC(SMA)	2,93%	1,84%	2,15%	2,46%
DMAC(EMA)	1,65%	0,37%	0,73%	1,10%
MACD(SMA)	2,46%	-3,77%	-2,03%	-0,26%
MACD(EMA)	-0,52%	-7,98%	-5,91%	-3,79%
ROC	-2,47%	-27,97%	-21,45%	-14,35%
RSI	1,67%	1,12%	1,28%	1,43%
BB	5,35%	3,47%	4,01%	4,54%
Buy and Hold	1,21%	1,09%	1,12%	1,16%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,03%	-1,89%	0,58%	3,11%
EMA	6,30%	-4,36%	-1,43%	1,59%
DMAC(SMA)	2,65%	1,49%	1,82%	2,15%
DMAC(EMA)	1,22%	-0,16%	0,23%	0,63%
MACD(SMA)	3,35%	-2,83%	-1,10%	0,66%
MACD(EMA)	0,29%	-7,14%	-5,08%	-2,97%
ROC	-1,92%	-27,56%	-21,01%	-13,87%
RSI	3,78%	3,16%	3,33%	3,51%
BB	5,40%	3,52%	4,05%	4,59%
Buy and Hold	1,24%	1,13%	1,16%	1,19%

Summary of Average Returns for period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,81%	-2,06%	0,40%	2,92%
EMA	6,04%	-4,52%	-1,62%	1,37%
DMAC(SMA)	3,39%	2,29%	2,60%	2,92%
DMAC(EMA)	2,07%	0,80%	1,16%	1,52%
MACD(SMA)	3,03%	-3,22%	-1,47%	0,30%
MACD(EMA)	-0,14%	-7,61%	-5,54%	-3,41%
ROC	-2,23%	-27,76%	-21,23%	-14,12%
RSI	3,28%	2,68%	2,85%	3,02%
BB	5,39%	3,53%	4,06%	4,59%
Buy and Hold	1,69%	1,57%	1,60%	1,64%

For the average returns of period A. B and C: once again all but two indicators outperformed the buy and hold strategy. In the presence of transaction costs, only BB, RSI and DMAC(SMA) outperformed the market for all possible transaction costs. When lowering the transaction costs to 0.15%, SMA also outperformed the buy and hold strategy.

Varying Exchange Rate

Table A.17 summarises the returns for each of the three periods.

For period A: SMA, BB, DMAC(SMA), EMA and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. When considering all possibilities of transaction costs, BB and DMAC(SMA) outperformed the buy and hold strategy. For a lower transaction cost of 0.15%, the DMAC(EMA) also outperformed the buy and hold strategy.

For period B: BB, SMA, DMAC(SMA), DMAC(EMA) and EMA outperformed the buy and hold strategy (in descending order) when there are no transaction costs. When considering all

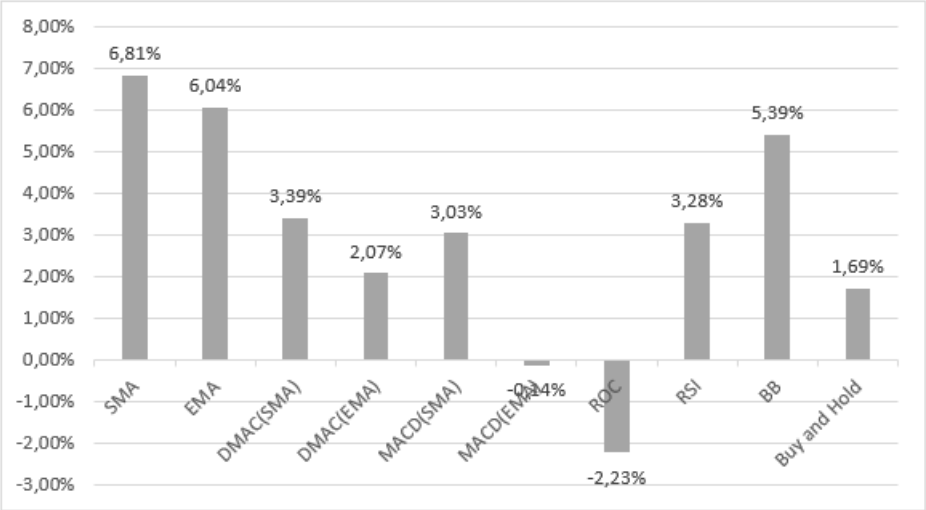

Figure A.31: FTSE 100 - Average returns on the three-year data for no transaction fees (Constant Exchange Rate)

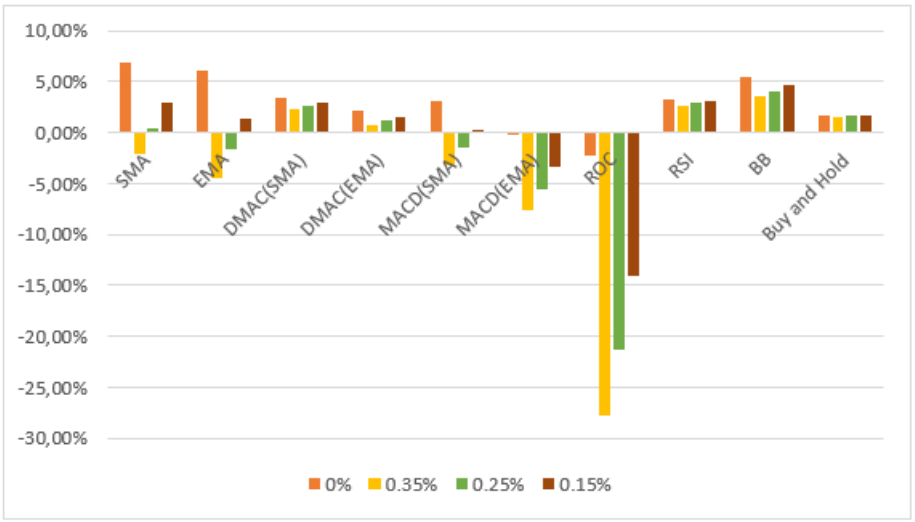

Figure A.32: FTSE 100 - Average returns on the three-year data for all transaction fees (Constant Exchange Rate)

possibilities of transaction costs, BB and DMAC(SMA) outperformed the buy and hold strategy.

For period C: BB, SMA, EMA, RSI and DMAC(SMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. When taking transaction costs into account, only BB and RSI outperformed the buy and hold strategy.

For the average returns of period A, B and C: BB, SMA, DMAC(SMA), EMA and DMAC(EMA) outperformed the buy and hold strategy in the absence of transaction costs. The BB indicator

Table A.17: FTSE 100: Summary of period A, B & C returns for three years (Varying Exchange Rate)

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	8,88%	-0,13%	2,37%	4,92%
EMA	6,99%	-3,67%	-0,74%	2,28%
DMAC(SMA)	7,53%	6,46%	6,77%	7,07%
DMAC(EMA)	6,81%	5,61%	5,95%	6,29%
MACD(SMA)	3,24%	-3,10%	-1,33%	0,47%
MACD(EMA)	-2,38%	-9,73%	-7,69%	-5,60%
ROC	3,77%	-23,26%	-16,35%	-8,82%
RSI	4,33%	3,70%	3,88%	4,06%
BB	8,59%	6,73%	7,26%	7,79%
Buy and Hold	6,15%	6,03%	6,06%	6,10%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,64%	-2,24%	0,22%	2,74%
EMA	4,70%	-5,64%	-2,79%	0,14%
DMAC(SMA)	6,31%	5,18%	5,51%	5,83%
DMAC(EMA)	5,68%	4,35%	4,73%	5,11%
MACD(SMA)	2,36%	-3,86%	-2,12%	-0,35%
MACD(EMA)	-1,79%	-9,16%	-7,11%	-5,02%
ROC	4,20%	-23,04%	-16,08%	-8,49%
RSI	3,96%	3,41%	3,56%	3,72%
BB	8,02%	6,09%	6,64%	7,19%
Buy and Hold	5,23%	5,11%	5,15%	5,18%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,99%	-1,92%	0,55%	3,08%
EMA	5,23%	-5,32%	-2,42%	0,57%
DMAC(SMA)	4,51%	3,33%	3,67%	4,00%
DMAC(EMA)	3,96%	2,54%	2,95%	3,35%
MACD(SMA)	2,46%	-3,67%	-1,96%	-0,22%
MACD(EMA)	-1,91%	-9,18%	-7,16%	-5,09%
ROC	3,42%	-23,61%	-16,71%	-9,17%
RSI	4,92%	4,29%	4,47%	4,65%
BB	7,41%	5,50%	6,04%	6,59%
Buy and Hold	4,37%	4,24%	4,28%	4,31%

Summary of Average Return for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,50%	-1,43%	1,04%	3,58%
EMA	5,64%	-4,88%	-1,98%	1,00%
DMAC(SMA)	6,12%	4,99%	5,31%	5,63%
DMAC(EMA)	5,48%	4,17%	4,54%	4,92%
MACD(SMA)	2,68%	-3,54%	-1,80%	-0,03%
MACD(EMA)	-2,03%	-9,36%	-7,32%	-5,24%
ROC	3,80%	-23,30%	-16,38%	-8,83%
RSI	4,40%	3,80%	3,97%	4,14%
BB	8,01%	6,11%	6,65%	7,19%
Buy and Hold	5,25%	5,13%	5,16%	5,20%

outperformed the buy and hold strategy for all possible transaction cost percentages. The DMAC(SMA) indicator outperformed the buy and hold strategy for transaction costs of 0.25% and 0.15%.

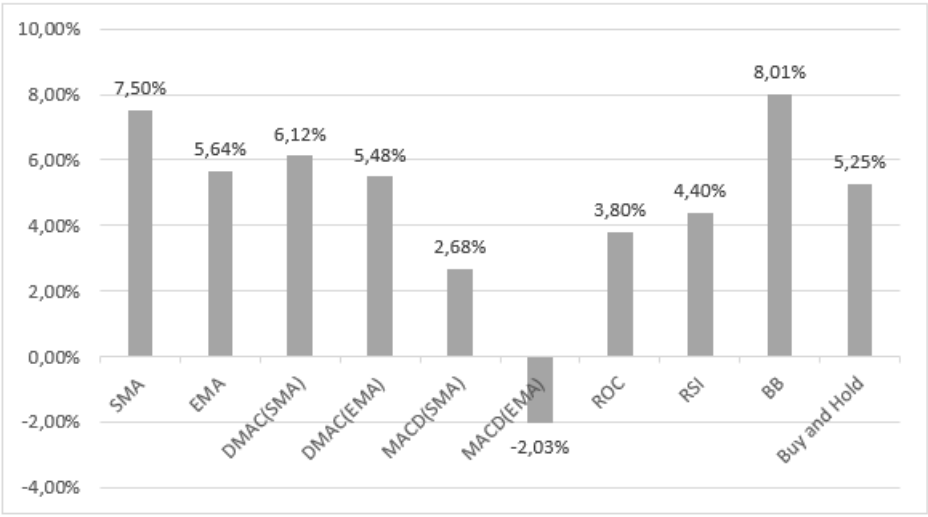

Figure A.33: FTSE 100 - Average returns on the three-year data for no transaction fees (Varying Exchange Rate)

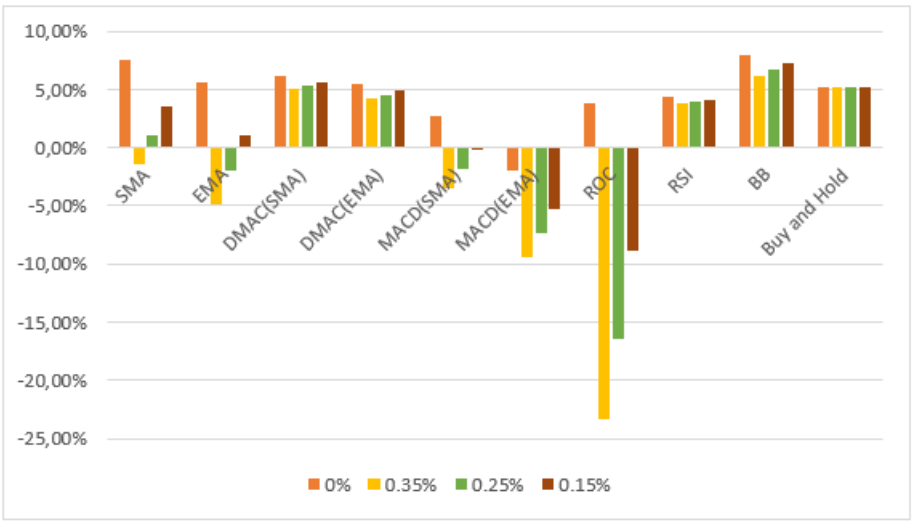

Figure A.34: FTSE 100 - Average returns on the three-year data for all transaction fees (Varying Exchange Rate

A.1.4.2 Five-Year Periods

Constant Exchange Rate

Table A.18 summarises the returns for each of the three periods.

For period A: SMA, BB, EMA, DMAC(SMA), RSI, MACD(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB, DMAC(SMA) and RSI outperformed the buy and hold strategy for all possibilities of transaction costs. When lowering the transaction costs to 0.15%, the SMA indicator also outperformed the buy and hold strategy.

For period B: SMA, EMA, BB, MACD(SMA), RSI, DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) in the absence of transaction costs. BB, RSI and DMAC(SMA) outperformed the buy and hold strategy for all possibilities of transaction costs. DMAC(EMA) outperformed the buy and hold strategy for 0.25% and 0.15% transaction costs. For a transaction cost of 0.15%, SMA and EMA also outperformed the buy and hold startegy.

For period C: SMA, EMA, BB, MACD(SMA), RSI, DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) in the absence of transaction costs. BB, RSI and DMAC(SMA) outperformed the buy and hold strategy for all possibilities of trans-

Table A.18: FTSE 100: Summary of period A, B & C returns for five years (Constant Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,85%	-2,11%	0,37%	2,91%
EMA	5,91%	-4,68%	-1,76%	1,24%
DMAC(SMA)	3,75%	2,74%	3,03%	3,31%
DMAC(EMA)	2,24%	1,03%	1,37%	1,72%
MACD(SMA)	2,48%	-3,78%	-2,03%	-0,25%
MACD(EMA)	-0,36%	-7,81%	-5,74%	-3,62%
ROC	-2,61%	-27,92%	-21,45%	-14,40%
RSI	2,83%	2,30%	2,45%	2,60%
BB	6,08%	4,20%	4,73%	5,27%
Buy and Hold	1,95%	1,88%	1,90%	1,92%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,29%	-2,62%	-0,15%	2,38%
EMA	5,43%	-5,12%	-2,22%	0,77%
DMAC(SMA)	2,68%	1,64%	1,94%	2,23%
DMAC(EMA)	1,49%	0,29%	0,63%	0,97%
MACD(SMA)	2,99%	-3,13%	-1,42%	0,32%
MACD(EMA)	0,29%	-7,04%	-5,01%	-2,92%
ROC	-2,58%	-28,10%	-21,58%	-14,47%
RSI	2,89%	2,31%	2,48%	2,64%
BB	4,20%	2,43%	2,94%	3,44%
Buy and Hold	0,49%	0,42%	0,44%	0,46%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,39%	-2,46%	-0,01%	2,50%
EMA	5,42%	-5,08%	-2,19%	0,79%
DMAC(SMA)	2,17%	1,10%	1,41%	1,71%
DMAC(EMA)	0,81%	-0,48%	-0,12%	0,26%
MACD(SMA)	3,46%	-2,69%	-0,97%	0,78%
MACD(EMA)	0,35%	-6,96%	-4,93%	-2,85%
ROC	-2,07%	-27,67%	-21,13%	-14,00%
RSI	2,69%	2,12%	2,28%	2,45%
BB	4,94%	3,09%	3,61%	4,14%
Buy and Hold	0,36%	0,29%	0,31%	0,33%

Summary of Average Return for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,51%	-0,73%	0,07%	2,38%
EMA	5,59%	-3,00%	-2,06%	0,77%
DMAC(SMA)	2,87%	2,02%	2,12%	2,23%
DMAC(EMA)	1,51%	0,51%	0,63%	0,97%
MACD(SMA)	2,97%	-2,05%	-1,47%	0,32%
MACD(EMA)	0,09%	-5,90%	-5,22%	-2,92%
ROC	-2,42%	-23,36%	-21,39%	-14,47%
RSI	2,81%	2,35%	2,40%	2,64%
BB	5,08%	3,58%	3,76%	3,44%
Buy and Hold	0,93%	0,86%	0,88%	0,90%

action costs. When lowering the transaction costs to 0.15%, SMA, EMA and MACD(SMA) outperformed the buy and hold strategy.

For the average returns of period A, B and C: SMA, EMA, BB, MACD(SMA), DMAC(SMA), RSI and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB, RSI and DMAC(SMA) outperformed the buy and hold strategy for all possibilities of transaction costs. When lowering the transaction costs to 0.15%, SMA and DMAC(EMA) outperformed the buy and hold strategy.

Varying Exchange Rate

Table A.19 summarises the returns for each of the three periods.

For period A: BB, SMA, DMAC(SMA), EMA and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB and DMAC(SMA) outperformed the buy and hold strategy for all possible transaction cost percentages.

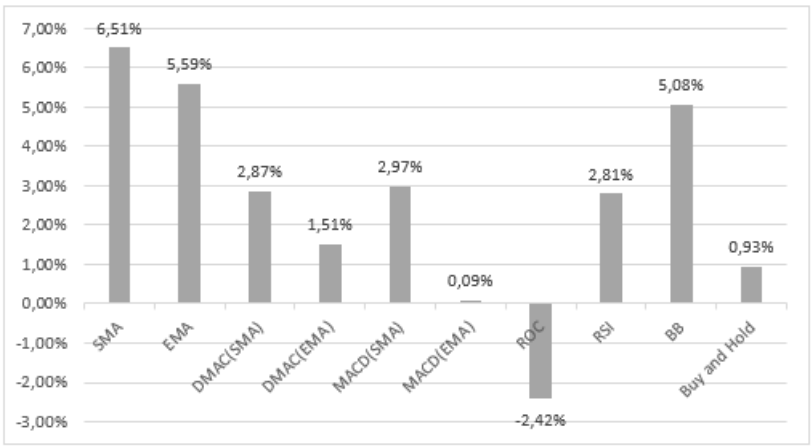

Figure A.35: FTSE 100 - Average returns on the five-year data for no transaction fees (Constant Exchange Rate)

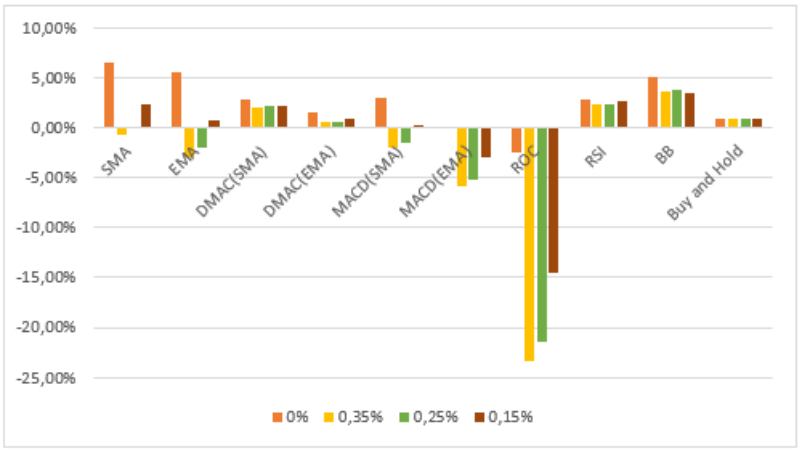

Figure A.36: FTSE 100 - Average returns on the five-year data for all transaction fees (Constant Exchange Rate)

For period B: BB, SMA, DMAC(SMA), EMA and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB and DMAC(SMA) outperformed the buy and hold strategy for all possible transaction cost percentages. For a low transaction cost of 0.15%, DMAC(EMA) also outperformed the buy and hold strategy.

For period C: BB, SMA, EMA and DMAC(SMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB outperformed the buy and hold strategy for all possible transaction cost percentages. For a low transaction cost of 0.15%, the DMAC(SMA) indicator also outperformed the buy and hold strategy.

For the average returns of period A, B and C: BB, SMA, DMAC(SMA), EMA and DMAC(EMA)

Table A.19: FTSE 100: Summary of period A, B & C returns for five years (Varying Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,82%	-1,21%	1,29%	3,86%
EMA	5,87%	-4,72%	-1,81%	1,20%
DMAC(SMA)	6,69%	5,65%	5,95%	6,25%
DMAC(EMA)	5,83%	4,58%	4,94%	5,29%
MACD(SMA)	2,48%	-3,77%	-2,03%	-0,25%
MACD(EMA)	-2,18%	-9,50%	-7,47%	-5,39%
ROC	3,63%	-23,30%	-16,42%	-8,91%
RSI	3,77%	3,22%	3,38%	3,53%
BB	8,91%	6,98%	7,53%	8,08%
Buy and Hold	5,64%	5,57%	5,59%	5,61%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,30%	-2,60%	-0,14%	2,39%
EMA	4,53%	-5,92%	-3,04%	-0,08%
DMAC(SMA)	4,60%	3,54%	3,85%	4,15%
DMAC(EMA)	4,32%	3,08%	3,43%	3,79%
MACD(SMA)	2,28%	-3,80%	-2,10%	-0,37%
MACD(EMA)	-1,89%	-9,06%	-7,07%	-5,03%
ROC	2,68%	-24,22%	-17,35%	-9,86%
RSI	2,63%	2,05%	2,22%	2,38%
BB	7,00%	5,18%	5,69%	6,21%
Buy and Hold	3,53%	3,46%	3,48%	3,50%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,73%	-2,15%	0,31%	2,83%
EMA	4,57%	-5,85%	-2,99%	-0,03%
DMAC(SMA)	4,03%	2,95%	3,26%	3,57%
DMAC(EMA)	3,38%	2,05%	2,42%	2,80%
MACD(SMA)	2,56%	-3,54%	-1,83%	-0,10%
MACD(EMA)	-2,21%	-9,33%	-7,35%	-5,33%
ROC	3,39%	-23,65%	-16,74%	-9,21%
RSI	2,81%	2,24%	2,40%	2,56%
BB	7,59%	5,69%	6,23%	6,77%
Buy and Hold	3,53%	3,46%	3,48%	3,50%

Summary of Average Return for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,95%	-0,32%	0,49%	3,03%
EMA	4,99%	-3,55%	-2,61%	0,36%
DMAC(SMA)	5,11%	4,25%	4,35%	4,65%
DMAC(EMA)	4,51%	3,47%	3,60%	3,96%
MACD(SMA)	2,44%	-2,56%	-1,99%	-0,24%
MACD(EMA)	-2,09%	-7,95%	-7,30%	-5,25%
ROC	3,23%	-18,94%	-16,84%	-9,33%
RSI	3,07%	2,61%	2,67%	2,83%
BB	7,83%	6,29%	6,48%	7,02%
Buy and Hold	4,24%	4,16%	4,18%	4,20%

outperformed the buy and hold strategy (in descending order) in the absence of transaction costs. When considering transaction costs, BB and DMAC(SMA) outperformed the buy and hold strategy.

A.1.4.3 Ten-Year Periods

Constant Exchange Rate

Table A.20 summarises the returns for each of the three periods.

For period A: SMA, BB, EMA, DMAC(SMA), RSI, MACD(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB, DMAC(SMA) and RSI outperformed the buy and hold strategy for all possibilities of transaction costs. When lowering the transaction costs to 0.15%, the SMA indicator also outperformed the buy and hold strategy.

For period B: SMA, EMA, BB, MACD(SMA), RSI, DMAC(SMA) and DMAC(EMA) outperformed the buy and hold strategy (in descending order) in the absence of transaction costs. BB, RSI and DMAC(SMA) outperformed the buy and hold strategy for all possibilities of transaction

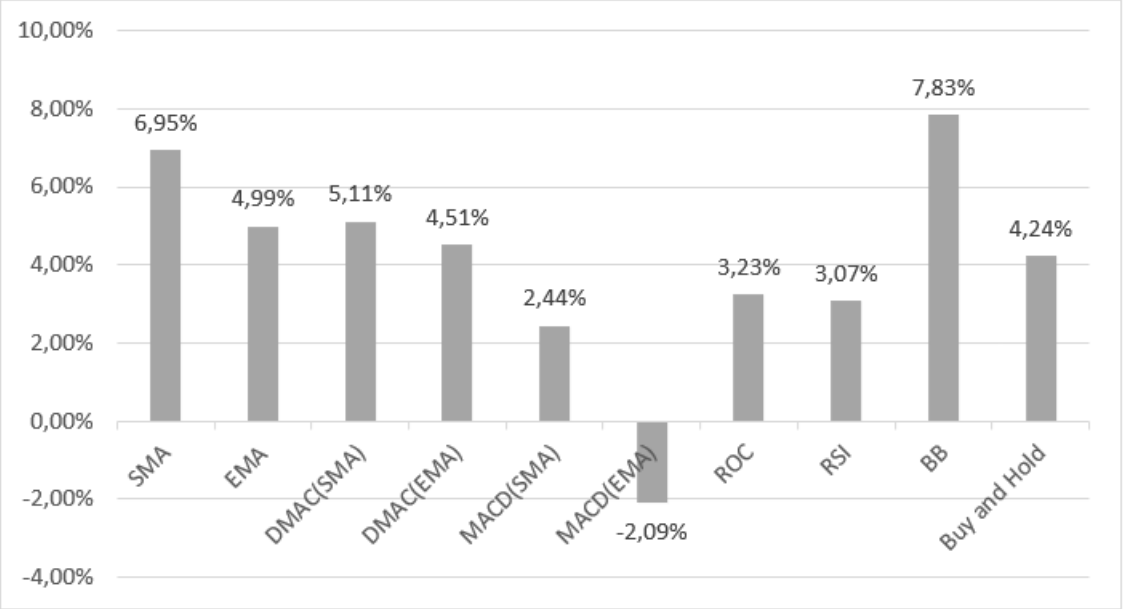

Figure A.37: FTSE 100 - Average returns on the five-year data for no transaction fees (Varying Exchange Rate)

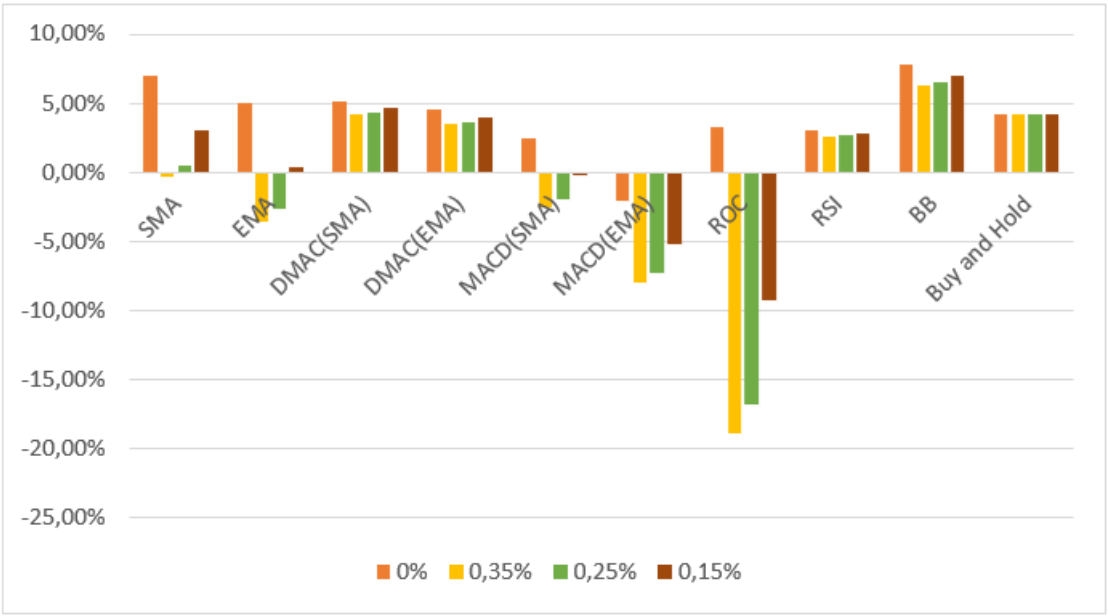

Figure A.38: FTSE 100 - Average returns on the five-year data for all transaction fees (Varying Exchange Rate

costs. DMAC(EMA) outperformed the buy and hold strategy for 0.25% and 0.15% transaction costs. For a transaction cost of 0.15%, SMA and EMA also outperformed the buy and hold strategy.

For period C: SMA, EMA, BB, MACD(SMA), RSI, DMAC(SMA) and DMAC(EMA) outper-

Table A.20: FTSE 100: Summary of period A, B & C returns for ten years (Constant Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,90%	-2,02%	0,45%	2,98%
EMA	5,97%	-4,59%	-1,69%	1,31%
DMAC(SMA)	3,84%	2,86%	3,14%	3,42%
DMAC(EMA)	2,33%	1,15%	1,49%	1,82%
MACD(SMA)	2,53%	-3,70%	-1,96%	-0,19%
MACD(EMA)	-0,38%	-7,83%	-5,76%	-3,64%
ROC	-2,63%	-27,94%	-21,47%	-14,42%
RSI	2,56%	2,06%	2,20%	2,34%
BB	6,01%	4,17%	4,69%	5,21%
Buy and Hold	2,09%	2,05%	2,06%	2,07%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,29%	-2,61%	-0,15%	2,38%
EMA	5,43%	-5,11%	-2,21%	0,77%
DMAC(SMA)	2,68%	1,71%	1,99%	2,26%
DMAC(EMA)	1,48%	0,35%	0,68%	1,00%
MACD(SMA)	2,99%	-3,07%	-1,37%	0,35%
MACD(EMA)	0,29%	-6,98%	-4,96%	-2,89%
ROC	-2,58%	-28,08%	-21,57%	-14,46%
RSI	2,70%	2,16%	2,31%	2,47%
BB	4,21%	2,44%	2,94%	3,44%
Buy and Hold	0,49%	0,45%	0,46%	0,47%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,39%	-2,45%	-0,01%	2,51%
EMA	5,43%	-5,08%	-2,19%	0,79%
DMAC(SMA)	2,16%	1,13%	1,43%	1,72%
DMAC(EMA)	0,81%	-0,45%	-0,09%	0,27%
MACD(SMA)	3,45%	-2,66%	-0,95%	0,79%
MACD(EMA)	0,34%	-6,90%	-4,89%	-2,83%
ROC	-2,07%	-27,68%	-21,13%	-14,00%
RSI	2,65%	2,11%	2,27%	2,42%
BB	5,13%	3,27%	3,80%	4,33%
Buy and Hold	0,36%	0,32%	0,33%	0,34%

Summary of Average Return for period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,53%	-2,36%	0,10%	2,62%
EMA	5,61%	-4,93%	-2,03%	0,96%
DMAC(SMA)	2,89%	1,90%	2,18%	2,47%
DMAC(EMA)	1,54%	0,35%	0,69%	1,03%
MACD(SMA)	2,99%	-3,14%	-1,43%	0,32%
MACD(EMA)	0,08%	-7,24%	-5,20%	-3,12%
ROC	-2,43%	-27,90%	-21,39%	-14,29%
RSI	2,64%	2,11%	2,26%	2,41%
BB	5,12%	3,29%	3,81%	4,33%
Buy and Hold	0,98%	0,94%	0,95%	0,96%

formed the buy and hold strategy (in descending order) in the absence of transaction costs. BB, RSI and DMAC(SMA) outperformed the buy and hold strategy for all possibilities of transaction costs. When lowering the transaction costs to 0.15%; SMA, EMA and MACD(SMA) outperformed the buy and hold strategy.

For the average returns of period A, B and C: SMA, EMA, BB, MACD(SMA), DMAC(SMA), RSI and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB, RSI and DMAC(SMA) outperformed the buy and hold strategy for all possibilities of transaction costs. When lowering the transaction costs to 0.15%, SMA, EMA and DMAC(EMA) outperformed the buy and hold strategy.

Varying Exchange Rate

Table A.21 summarises the returns for each of the three periods.

For period A: BB, SMA, DMAC(SMA), DMAC(EMA) and EMA outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB and DMAC(SMA)

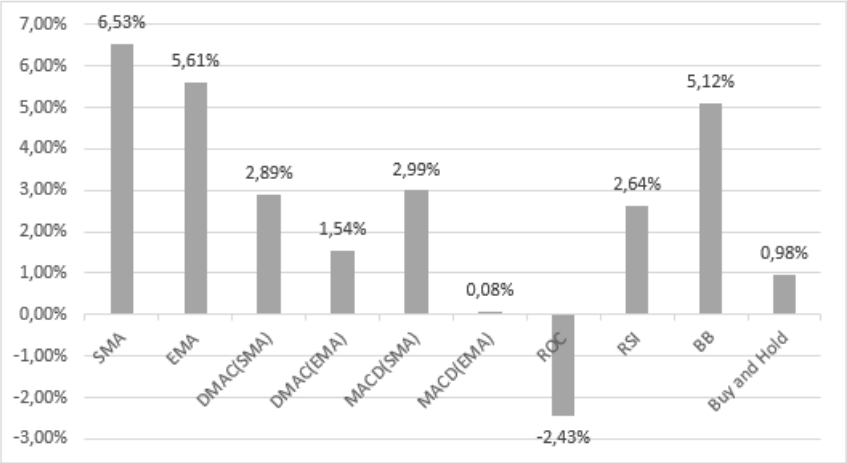

Figure A.39: FTSE 100 - Average returns on the ten-year data for no transaction fees (Constant Exchange Rate)

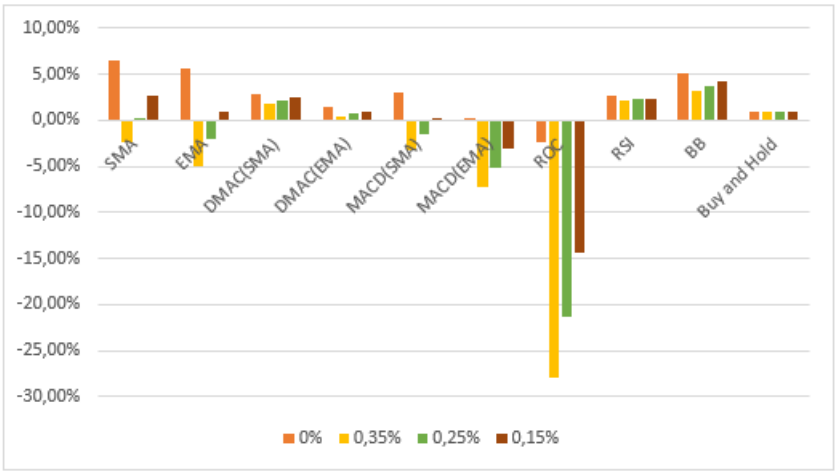

Figure A.40: FTSE 100 - Average returns on the ten-year data for all transaction fees (Constant Exchange Rate)

outperformed the buy and hold strategy for all possible transaction costs percentages.

For period B: BB, SMA, DMAC(SMA), EMA and DMAC(EMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB and DMAC(SMA) outperformed the buy and hold strategy for all possible transaction costs percentages. For a low transaction cost of 0.15%, DMAC(EMA) also outperformed the buy and hold strategy.

For period C: BB, SMA, EMA and DMAC(SMA) outperformed the buy and hold strategy (in descending order) when there are no transaction costs. BB outperformed the buy and hold strategy for all possible transaction costs percentages. For a low transaction cost of 0.15%, the

Table A.21: FTSE 100: Summary of period A, B & C returns for ten years (Varying Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	7,88%	-1,12%	1,37%	3,92%
EMA	5,92%	-4,63%	-1,73%	1,26%
DMAC(SMA)	6,82%	5,81%	6,10%	6,38%
DMAC(EMA)	5,95%	4,74%	5,08%	5,43%
MACD(SMA)	2,54%	-3,69%	-1,95%	-0,18%
MACD(EMA)	-2,21%	-9,52%	-7,49%	-5,41%
ROC	3,61%	-23,32%	-16,43%	-8,93%
RSI	3,72%	3,21%	3,36%	3,50%
BB	9,01%	7,12%	7,66%	8,20%
Buy and Hold	5,81%	5,78%	5,79%	5,80%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,31%	-2,60%	-0,13%	2,39%
EMA	4,54%	-5,92%	-3,04%	-0,08%
DMAC(SMA)	4,68%	3,69%	3,97%	4,25%
DMAC(EMA)	4,39%	3,23%	3,56%	3,89%
MACD(SMA)	2,35%	-3,66%	-1,98%	-0,27%
MACD(EMA)	-1,82%	-8,93%	-6,95%	-4,93%
ROC	2,75%	-24,14%	-17,27%	-9,78%
RSI	2,57%	2,03%	2,19%	2,34%
BB	7,00%	5,18%	5,69%	6,21%
Buy and Hold	3,61%	3,57%	3,58%	3,59%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,74%	-2,13%	0,33%	2,85%
EMA	4,59%	-5,84%	-2,97%	-0,01%
DMAC(SMA)	4,00%	2,95%	3,25%	3,55%
DMAC(EMA)	3,34%	2,05%	2,42%	2,79%
MACD(SMA)	2,52%	-3,53%	-1,84%	-0,12%
MACD(EMA)	-2,23%	-9,28%	-7,32%	-5,32%
ROC	3,35%	-23,67%	-16,77%	-9,24%
RSI	3,08%	2,54%	2,69%	2,84%
BB	7,62%	5,72%	6,26%	6,80%
Buy and Hold	3,51%	3,48%	3,49%	3,50%

Summary of Average Return for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	6,98%	-1,95%	0,52%	3,06%
EMA	5,02%	-5,46%	-2,58%	0,39%
DMAC(SMA)	5,16%	4,15%	4,44%	4,73%
DMAC(EMA)	4,56%	3,34%	3,69%	4,04%
MACD(SMA)	2,47%	-3,63%	-1,92%	-0,19%
MACD(EMA)	-2,08%	-9,25%	-7,25%	-5,22%
ROC	3,24%	-23,71%	-16,82%	-9,32%
RSI	3,12%	2,59%	2,74%	2,89%
BB	7,88%	6,01%	6,54%	7,07%
Buy and Hold	4,31%	4,28%	4,29%	4,30%

DMAC(SMA) indicator also outperformed the buy and hold strategy.

For the average returns of period A, B and C: BB, SMA, DMAC(SMA), EMA and DMAC(EMA) outperformed the buy and hold strategy (in descending order) in the absence of transaction costs. BB outperformed the buy and hold strategy for all possible transaction costs percentages. For transaction costs of 0.25% and 0.15%, DMAC(SMA) also outperformed the buy and hold strategy.

A.2 Multiple Indices

A.2.1 JSE Top 40 and S&P 500 Combination

A.2.1.1 Three-Year Periods

Constant Exchange Rate

Table A.22 summarises the returns for each of the three periods for $b = 100\%$.

For period A: SMA, EMA and DMAC(EMA) indicators outperformed the buy and hold strategy

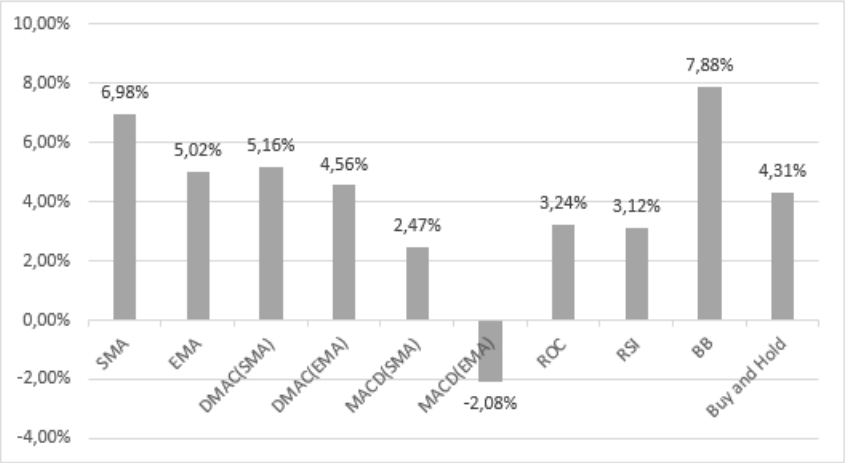

Figure A.41: FTSE 100 - Average returns on the ten-year data for no transaction fees (Varying Exchange Rate)

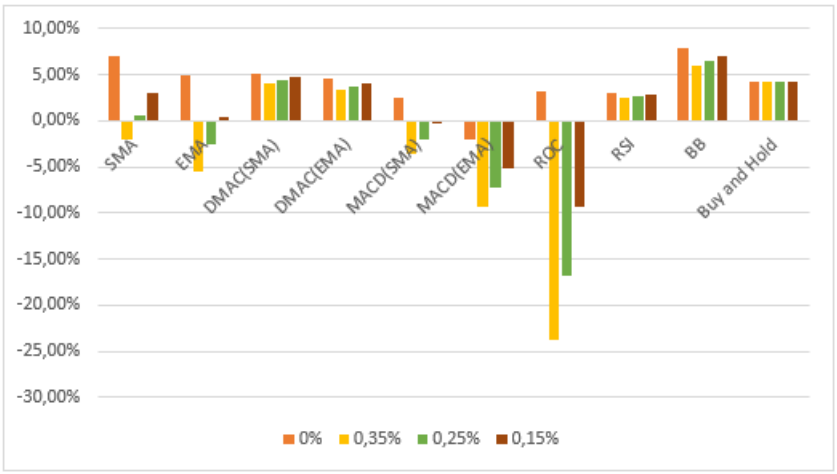

Figure A.42: FTSE 100 - Average returns on the ten-year data for all transaction fees (Varying Exchange Rate

in the absence of transaction costs. When transaction costs are taken into consideration, the buy and hold strategy is unbeatable. The DMAC(EMA) indicator produced returns close to the buy and hold strategy, especially for lower returns.

For period B: SMA, EMA and DMAC(SMA) outperformed the buy and hold strategy. In the presence of transaction costs, the buy and hold strategy is unbeatable except for transaction cost of 0.15% where the DMAC(SMA) indicator produced higher returns than the buy and hold strategy.

For period C: the SMA indicator and EMA indicator outperformed the buy and hold strategy

Table A.22: JSE Top 40 and S&P 500 - Summary of period A, B & C returns for three years (Constant Exchange Rate)

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,34%	0,26%	3,31%	6,45%
EMA	9,80%	-2,17%	1,11%	4,50%
DMAC(SMA)	8,61%	7,53%	7,84%	8,15%
DMAC(EMA)	9,11%	8,20%	8,46%	8,72%
MACD(SMA)	7,76%	0,17%	2,28%	4,44%
MACD(EMA)	5,06%	-3,39%	-1,04%	1,35%
ROC	4,42%	-24,73%	-17,35%	-9,25%
RSI	6,95%	5,96%	6,24%	6,52%
BB	7,50%	5,31%	5,93%	6,56%
Buy and Hold	8,88%	8,62%	8,70%	8,77%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,93%	-0,09%	2,94%	6,07%
EMA	9,07%	-2,60%	0,60%	3,91%
DMAC(SMA)	8,65%	7,57%	7,88%	8,19%
DMAC(EMA)	7,97%	6,92%	7,22%	7,52%
MACD(SMA)	6,75%	-0,77%	1,32%	3,46%
MACD(EMA)	5,09%	-3,31%	-0,98%	1,41%
ROC	4,30%	-24,90%	-17,51%	-9,40%
RSI	8,01%	6,98%	7,28%	7,57%
BB	5,67%	3,46%	4,09%	4,72%
Buy and Hold	8,17%	7,92%	7,99%	8,06%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,95%	0,72%	3,81%	7,00%
EMA	10,45%	-1,35%	1,89%	5,23%
DMAC(SMA)	5,24%	4,06%	4,40%	4,73%
DMAC(EMA)	6,22%	5,28%	5,55%	5,82%
MACD(SMA)	6,04%	-1,28%	0,76%	2,84%
MACD(EMA)	4,28%	-4,16%	-1,82%	0,57%
ROC	4,46%	-24,83%	-17,42%	-9,28%
RSI	6,95%	6,05%	6,31%	6,56%
BB	6,84%	4,59%	5,23%	5,87%
Buy and Hold	9,03%	8,78%	8,85%	8,92%

Summary of Average Returns for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,41%	0,30%	3,35%	6,50%
EMA	9,77%	-2,04%	1,20%	4,54%
DMAC(SMA)	7,50%	6,39%	6,70%	7,02%
DMAC(EMA)	7,77%	6,80%	7,08%	7,35%
MACD(SMA)	6,85%	-0,63%	1,45%	3,58%
MACD(EMA)	4,81%	-3,62%	-1,28%	1,11%
ROC	4,39%	-24,82%	-17,43%	-9,31%
RSI	7,30%	6,33%	6,61%	6,88%
BB	6,67%	4,45%	5,08%	5,72%
Buy and Hold	8,69%	8,44%	8,51%	8,59%

when ignoring transaction costs. When transaction costs are taken into account, the buy and hold strategy is unbeatable.

For the average returns of period A, B and C: only the SMA indicator and EMA indicator outperform the buy and hold strategy. Due to the high number of average annual transactions, the returns of these indicators are eroded when transaction costs are taken into account. None of the indicators outperformed the buy and hold strategy in the presence of transaction costs.

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy. For example the average of the three periods for the DMAC(SMA) indicator, $b = 90\%$ produced a return of 7.6% instead of 7.5% when $b = 100\%$. The buy and hold strategy produced a return of 8.7%. Therefore the higher return of a lower b-value is still not enough to outperform the buy and hold strategy.

Varying Exchange Rate

Table A.23 summarises the returns for each of the three periods for $b = 100\%$.

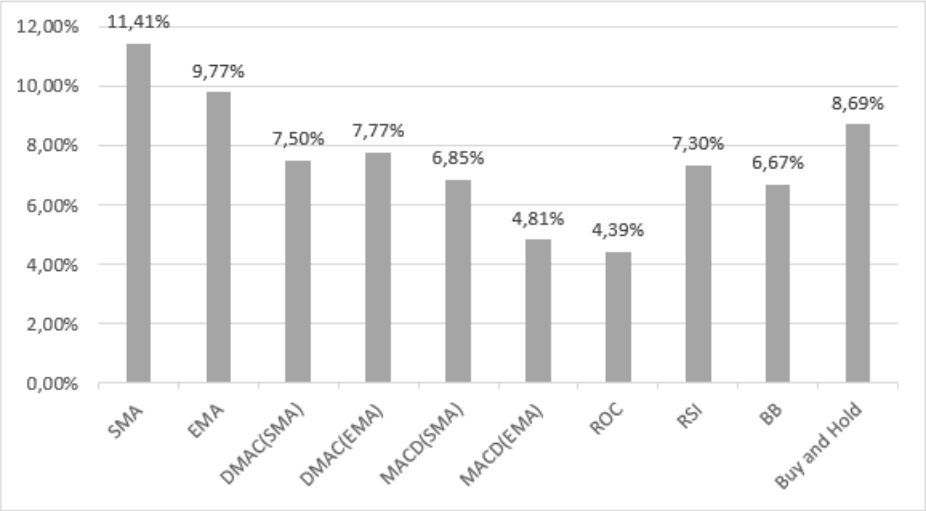

Figure A.43: JSE Top 40 and S&P 500 - Average returns on the three-year data for no transaction fees (Constant Exchange Rate)

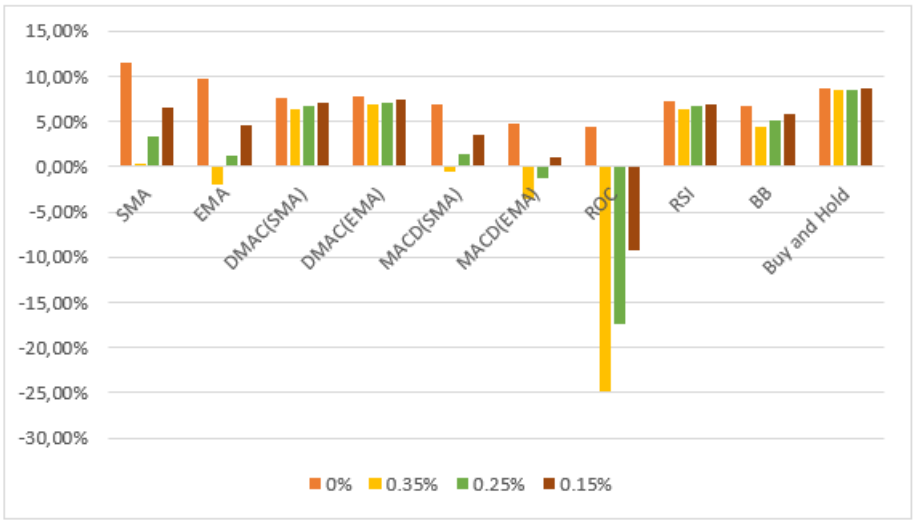

Figure A.44: JSE Top 40 and S&P 500 - Average returns on the three-year data for all transaction fees (Constant Exchange Rate)

For period A: only the RSI indicator did not outperform the buy and hold strategy in the absence of transaction costs; the rest of the indicators performed better than the buy and hold strategy. When transaction costs are taken into consideration only DMAC(EMA), DMAC(SMA) and BB outperformed the buy and hold strategy.

For period B: the buy and hold returns are higher than for period A. Even though the returns are higher, DMAC(SMA) and DMAC(EMA) still outperformed the buy and hold strategy when transaction costs are ignored. For all transaction costs the DMAC(SMA) indicator outperformed

Table A.23: JSE Top 40 and S&P 500 - Summary of period A, B & C returns for three years (Varying Exchange Rate)

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,17%	0,10%	3,14%	6,28%
EMA	9,45%	-2,47%	0,80%	4,17%
DMAC(SMA)	11,38%	10,27%	10,59%	10,90%
DMAC(EMA)	11,91%	10,97%	11,24%	11,50%
MACD(SMA)	10,63%	2,83%	5,00%	7,22%
MACD(EMA)	9,55%	0,74%	3,18%	5,69%
ROC	9,22%	-21,27%	-13,56%	-5,08%
RSI	6,56%	5,57%	5,85%	6,14%
BB	10,93%	8,62%	9,28%	9,93%
Buy and Hold	8,35%	8,10%	8,17%	8,24%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,86%	-0,15%	2,87%	6,00%
EMA	8,85%	-2,80%	0,39%	3,69%
DMAC(SMA)	12,87%	11,75%	12,07%	12,39%
DMAC(EMA)	11,78%	10,70%	11,01%	11,32%
MACD(SMA)	9,78%	2,04%	4,19%	6,39%
MACD(EMA)	9,22%	0,49%	2,91%	5,39%
ROC	9,85%	-20,91%	-13,13%	-4,58%
RSI	7,19%	6,18%	6,47%	6,76%
BB	8,86%	6,37%	7,08%	7,79%
Buy and Hold	11,37%	11,11%	11,19%	11,26%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,18%	0,93%	4,02%	7,21%
EMA	10,44%	-1,36%	1,88%	5,22%
DMAC(SMA)	6,28%	5,09%	5,43%	5,77%
DMAC(EMA)	7,78%	6,83%	7,10%	7,37%
MACD(SMA)	8,80%	1,29%	3,38%	5,52%
MACD(EMA)	7,26%	-1,42%	0,98%	3,45%
ROC	9,53%	-21,19%	-13,42%	-4,88%
RSI	6,38%	5,52%	5,76%	6,01%
BB	10,56%	8,22%	8,88%	9,55%
Buy and Hold	11,27%	11,01%	11,08%	11,16%

Summary of Average Returns for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,40%	0,29%	3,35%	6,50%
EMA	9,58%	-2,21%	1,02%	4,36%
DMAC(SMA)	10,18%	9,04%	9,36%	9,69%
DMAC(EMA)	10,49%	9,50%	9,78%	10,06%
MACD(SMA)	9,74%	2,05%	4,19%	6,37%
MACD(EMA)	8,68%	-0,07%	2,36%	4,84%
ROC	9,53%	-21,13%	-13,37%	-4,85%
RSI	6,71%	5,76%	6,03%	6,30%
BB	10,12%	7,74%	8,41%	9,09%
Buy and Hold	10,33%	10,07%	10,15%	10,22%

the buy and hold strategy. For a lower transaction cost of 0.15%, the DMAC(EMA) also outperformed the buy and hold strategy.

For period C: only the SMA indicator outperformed the buy and hold strategy. In the presence of the transaction costs, none of the indicators outperformed the buy and hold strategy.

For the average returns of period A, B and C: SMA and DMAC(EMA) outperformed the buy and hold strategy when there are no transaction costs. When transaction costs are taken into account, the buy and hold strategy is unbeatable.

For the three-year varying exchange rate case $b = 100\%$ performed the best in all periods. It is therefore not necessary to consider other b values.

A.2.1.2 Five-Year Periods

Constant Exchange Rate

Table A.24 summarises the returns for each of the five periods for $b = 100\%$.

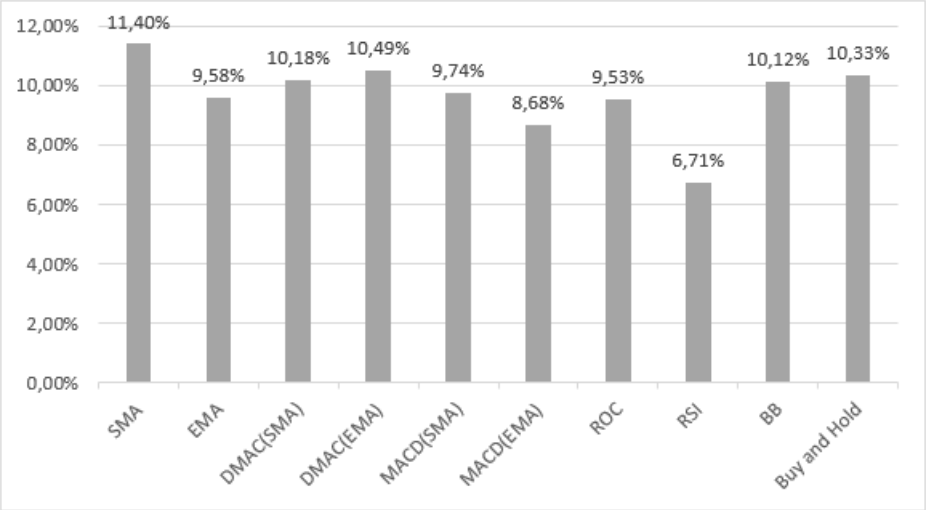

Figure A.45: JSE Top 40 and S&P 500 - Average returns on the three-year data for no transaction fees (Varying Exchange Rate)

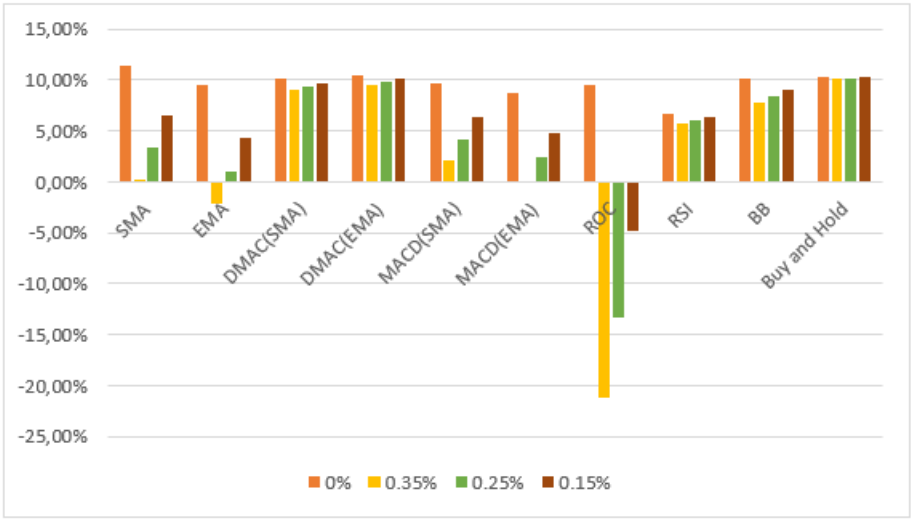

Figure A.46: JSE Top 40 and S&P 500 - Average returns on the three-year data for all transaction fees (Varying Exchange Rate)

For period A: four of the indicators outperformed the buy and hold strategy in the absence of transaction costs. The indicators are: SMA, DMAC(EMA), BB and EMA. When we consider transaction costs, only the DMAC(EMA) outperformed the buy and hold strategy.

For period B: SMA, EMA and DMAC(EMA) outperformed the buy and hold strategy when there are no transaction costs. In the presence of transaction costs, the buy and hold strategy is unbeatable.

Table A.24: JSE Top 40 and S&P 500 - Summary of period A, B & C returns for five years (Constant Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,10%	0,13%	3,15%	6,26%
EMA	9,40%	-2,27%	0,93%	4,24%
DMAC(SMA)	9,11%	8,10%	8,39%	8,68%
DMAC(EMA)	9,90%	9,05%	9,30%	9,54%
MACD(SMA)	7,33%	-0,11%	1,96%	4,08%
MACD(EMA)	5,35%	-2,97%	-0,66%	1,70%
ROC	4,37%	-24,77%	-17,40%	-9,29%
RSI	5,16%	4,32%	4,56%	4,80%
BB	9,63%	7,39%	8,03%	8,67%
Buy and Hold	9,12%	8,97%	9,01%	9,05%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,09%	0,76%	3,87%	7,09%
EMA	10,42%	-1,50%	1,77%	5,15%
DMAC(SMA)	8,31%	7,31%	7,60%	7,88%
DMAC(EMA)	8,79%	7,88%	8,14%	8,40%
MACD(SMA)	5,80%	-1,55%	0,49%	2,58%
MACD(EMA)	4,23%	-4,17%	-1,84%	0,55%
ROC	3,85%	-25,34%	-17,96%	-9,85%
RSI	8,11%	7,19%	7,45%	7,72%
BB	5,65%	3,42%	4,05%	4,69%
Buy and Hold	8,73%	8,57%	8,62%	8,66%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,93%	-0,16%	2,89%	6,03%
EMA	9,49%	-2,17%	1,03%	4,33%
DMAC(SMA)	5,21%	4,10%	4,42%	4,73%
DMAC(EMA)	4,77%	3,71%	4,01%	4,31%
MACD(SMA)	5,55%	-1,70%	0,32%	2,38%
MACD(EMA)	4,16%	-4,08%	-1,80%	0,54%
ROC	3,33%	-25,81%	-18,45%	-10,35%
RSI	7,93%	7,01%	7,27%	7,53%
BB	7,73%	5,42%	6,08%	6,74%
Buy and Hold	7,56%	7,41%	7,46%	7,50%

Summary of Average Returns for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,37%	0,24%	3,30%	6,46%
EMA	9,77%	-1,98%	1,24%	4,57%
DMAC(SMA)	7,54%	6,51%	6,80%	7,10%
DMAC(EMA)	7,82%	6,88%	7,15%	7,42%
MACD(SMA)	6,22%	-1,12%	0,92%	3,01%
MACD(EMA)	4,58%	-3,74%	-1,43%	0,93%
ROC	3,85%	-25,31%	-17,93%	-9,83%
RSI	7,07%	6,17%	6,43%	6,68%
BB	7,67%	5,41%	6,05%	6,70%
Buy and Hold	8,47%	8,32%	8,36%	8,40%

For period C: four of the indicators outperformed the buy and hold strategy in the absence of transaction costs. These indicators are: SMA, EMA, RSI and BB. When considering transaction costs of 0.35% and 0.25%, the buy and hold strategy is unbeatable. For a lower transaction cost of 0.15%, the RSI indicator outperformed the buy and hold strategy.

For the average returns of period A, B and C: only the SMA indicator and EMA indicator outperformed the buy and hold strategy when there are no transaction costs. When transaction costs are taken into account the buy and hold strategy is unbeatable.

For some of the individual periods, a lower b% produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy. It is therefore not necessary to show the results for the lower b%s.

Varying Exchange Rate

Table A.25 summarises the returns for each of the three periods for $b = 100\%$.

For period A: DMAC(EMA) and DMAC(SMA) outperformed the buy and hold strategy in the

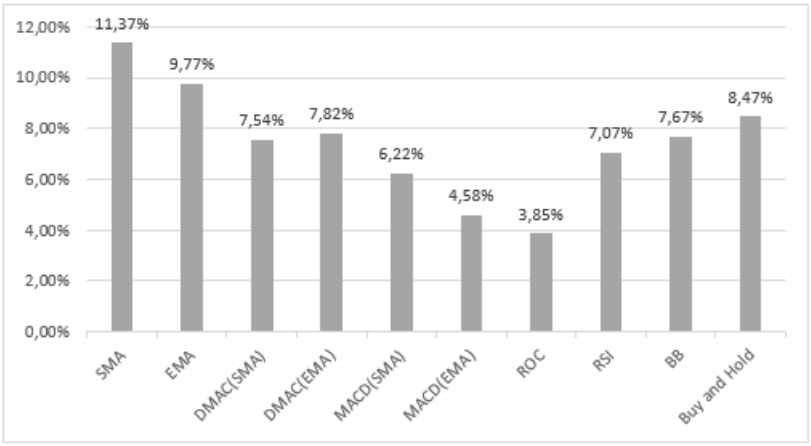

Figure A.47: JSE Top 40 and S&P 500 - Average returns on the five-year data for no transaction fees (Constant Exchange Rate)

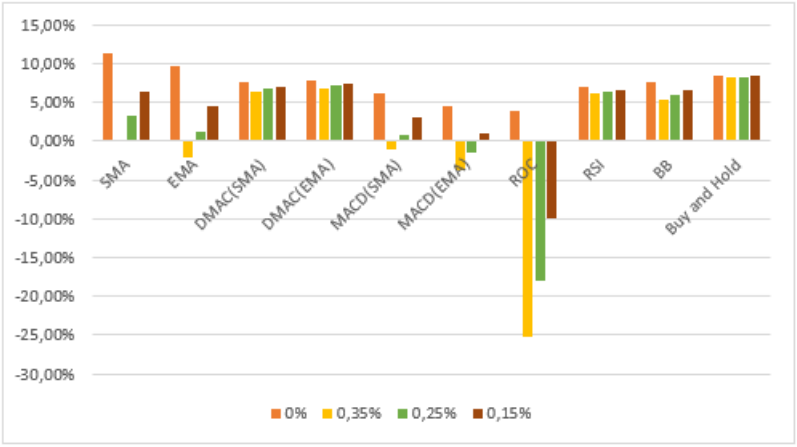

Figure A.48: JSE Top 40 and S&P 500 - Average returns on the five-year data for all transaction fees (Constant Exchange Rate)

absence of transaction costs. The DMAC(EMA) outperformed the buy and hold strategy for all possible transaction cost percentages. For transaction cost percentages of 0.25% and 0.15%, the DMAC(SMA) also outperformed the buy and hold strategy.

For period B, period C and the average returns of the three periods: only SMA outperformed the buy and hold strategy when there are no transaction costs. In the presence of transaction costs, the buy and hold strategy is unbeatable.

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

Table A.25: JSE Top 40 and S&P 500 - Summary of period A, B & C returns for five years (Varying Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,63%	-0,29%	2,72%	5,81%
EMA	8,89%	-2,72%	0,46%	3,75%
DMAC(SMA)	12,66%	11,62%	11,91%	12,21%
DMAC(EMA)	13,46%	12,59%	12,84%	13,09%
MACD(SMA)	9,98%	2,36%	4,48%	6,65%
MACD(EMA)	9,35%	0,71%	3,11%	5,56%
ROC	9,67%	-20,96%	-13,21%	-4,70%
RSI	6,17%	5,25%	5,51%	5,78%
BB	10,59%	7,99%	8,72%	9,47%
Buy and Hold	11,83%	11,67%	11,72%	11,76%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,32%	0,96%	4,08%	7,30%
EMA	10,26%	-1,64%	1,62%	4,99%
DMAC(SMA)	9,40%	8,39%	8,68%	8,96%
DMAC(EMA)	9,94%	9,02%	9,28%	9,54%
MACD(SMA)	8,40%	0,87%	2,97%	5,11%
MACD(EMA)	7,88%	-0,81%	1,60%	4,07%
ROC	8,37%	-22,09%	-14,39%	-5,92%
RSI	7,87%	6,95%	7,21%	7,47%
BB	9,08%	6,73%	7,39%	8,07%
Buy and Hold	10,85%	10,69%	10,74%	10,78%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,98%	-0,12%	2,94%	6,08%
EMA	9,55%	-2,12%	1,08%	4,39%
DMAC(SMA)	6,13%	5,02%	5,33%	5,65%
DMAC(EMA)	5,57%	4,50%	4,81%	5,11%
MACD(SMA)	8,09%	0,67%	2,74%	4,85%
MACD(EMA)	7,59%	-0,92%	1,44%	3,86%
ROC	8,43%	-22,16%	-14,43%	-5,93%
RSI	8,02%	7,10%	7,36%	7,62%
BB	8,96%	6,88%	7,47%	8,06%
Buy and Hold	9,93%	9,77%	9,82%	9,86%

Summary of Average Returns for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,31%	0,19%	3,25%	6,40%
EMA	9,57%	-2,16%	1,05%	4,38%
DMAC(SMA)	9,40%	8,34%	8,64%	8,94%
DMAC(EMA)	9,66%	8,70%	8,97%	9,25%
MACD(SMA)	8,83%	1,30%	3,40%	5,53%
MACD(EMA)	8,27%	-0,34%	2,05%	4,49%
ROC	8,82%	-21,74%	-14,01%	-5,52%
RSI	7,35%	6,43%	6,69%	6,96%
BB	9,54%	7,20%	7,86%	8,53%
Buy and Hold	10,87%	10,71%	10,76%	10,80%

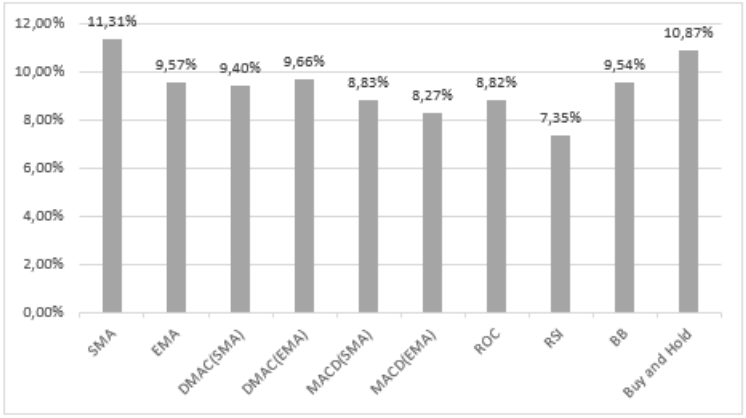

Figure A.49: JSE Top 40 and S&P 500 - Average returns on the five-year data for no transaction fees (Varying Exchange Rate)

A.2.2 JSE Top 40, S&P 500 and NIFTY 50 Combination

A.2.2.1 Three-Year Periods

Constant Exchange Rate

Table A.26 summarises the returns for each of the three periods for $b = 100\%$.

Figure A.50: JSE Top 40 and S&P 500 - Average returns on the five-year data for all transaction fees (Varying Exchange Rate)

Table A.26: JSE Top 40, S&P 500 and NIFTY 50 - Summary of period A, B & C returns for three years (Constant Exchange Rate)

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,85%	-0,20%	3,10%	6,52%
EMA	12,15%	-1,85%	1,96%	5,92%
DMAC(SMA)	7,88%	6,68%	7,02%	7,36%
DMAC(EMA)	10,98%	9,98%	10,26%	10,55%
MACD(SMA)	11,52%	2,95%	5,33%	7,76%
MACD(EMA)	6,09%	-3,30%	-0,71%	1,96%
ROC	5,86%	-25,76%	-17,84%	-9,07%
RSI	6,80%	5,70%	6,02%	6,33%
BB	9,50%	6,81%	7,57%	8,33%
Buy and Hold	10,16%	9,91%	9,98%	10,05%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,96%	-0,91%	2,35%	5,71%
EMA	10,76%	-2,92%	0,81%	4,68%
DMAC(SMA)	8,95%	7,79%	8,12%	8,45%
DMAC(EMA)	9,41%	8,35%	8,65%	8,95%
MACD(SMA)	11,04%	2,52%	4,88%	7,30%
MACD(EMA)	6,08%	-3,19%	-0,63%	2,00%
ROC	6,33%	-25,45%	-17,49%	-8,68%
RSI	9,19%	8,01%	8,35%	8,68%
BB	10,84%	8,14%	8,90%	9,67%
Buy and Hold	9,46%	9,20%	9,28%	9,35%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	12,49%	0,15%	3,53%	7,03%
EMA	12,46%	-1,49%	2,31%	6,25%
DMAC(SMA)	6,38%	5,12%	5,48%	5,83%
DMAC(EMA)	9,24%	8,28%	8,55%	8,82%
MACD(SMA)	8,96%	0,65%	2,96%	5,32%
MACD(EMA)	4,10%	-5,14%	-2,58%	0,04%
ROC	5,39%	-26,11%	-18,22%	-9,49%
RSI	8,19%	7,13%	7,43%	7,74%
BB	9,05%	6,34%	7,11%	7,88%
Buy and Hold	10,97%	10,71%	10,78%	10,85%

Summary of Average Returns for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,77%	-0,32%	2,99%	6,42%
EMA	11,79%	-2,09%	1,69%	5,62%
DMAC(SMA)	7,73%	6,53%	6,87%	7,22%
DMAC(EMA)	9,88%	8,87%	9,15%	9,44%
MACD(SMA)	10,51%	2,04%	4,39%	6,79%
MACD(EMA)	5,42%	-3,88%	-1,31%	1,33%
ROC	5,86%	-25,77%	-17,85%	-9,08%
RSI	8,06%	6,95%	7,27%	7,58%
BB	9,79%	7,09%	7,86%	8,63%
Buy and Hold	10,20%	9,94%	10,01%	10,09%

For period A: four of the indicators outperformed the buy and strategy in the absence of transaction costs. These four indicators are: EMA, SMA, MACD(SMA) and DMAC(EMA). In the presence of transaction costs, only the DMAC(EMA) outperformed the buy and hold strategy.

For period B: MACD(SMA), SMA, BB and EMA outperformed the buy and hold strategy in the absence of transaction costs. When considering transaction costs of 0.35% and 0.25%, none

of the indicators outperformed the buy and hold strategy. For a lower transaction cost of 0.15%, the BB indicator outperformed the buy and hold strategy.

For period C: only the SMA indicator and EMA indicator outperformed the buy and hold strategy for no transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeatable.

For the average returns of periods A, B and C: SMA, EMA and MACD(SMA) outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeatable.

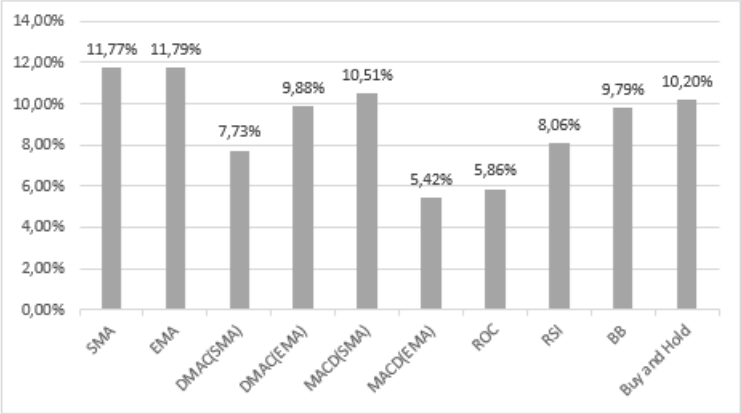

Figure A.51: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the three-year data for no transaction fees (Constant Exchange Rate)

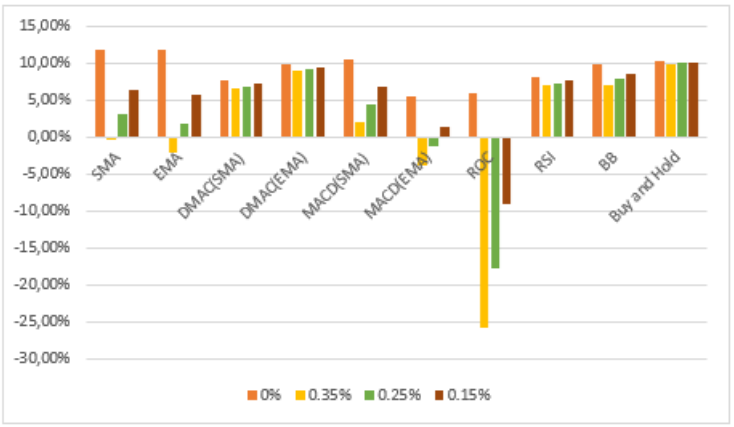

Figure A.52: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the three-year data for all transaction fees (Constant Exchange Rate)

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the

higher returns are not enough to outperform the buy and hold strategy. In the next section, the results for the JSE Top 40, S&P 500 and NIFTY 50 combination are discussed.

Varying Exchange Rate

Table A.27 summarises the returns for each of the three periods for $b = 100\%$.

Table A.27: JSE Top 40, S&P 500 and NIFTY 50 - Summary of period A, B & C returns for three years (Varying Exchange Rate)

Summary Period A				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,78%	-0,48%	2,87%	6,35%
EMA	12,75%	-1,24%	2,57%	6,52%
DMAC(SMA)	6,42%	5,16%	5,52%	5,88%
DMAC(EMA)	10,03%	9,06%	9,34%	9,62%
MACD(SMA)	11,73%	3,20%	5,57%	7,99%
MACD(EMA)	8,86%	-0,80%	1,87%	4,61%
ROC	9,55%	-23,20%	-15,00%	-5,92%
RSI	9,54%	8,50%	8,80%	9,09%
BB	9,25%	6,43%	7,23%	8,03%
Buy and Hold	12,62%	12,36%	12,44%	12,51%

Summary Period B				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,08%	-1,70%	1,53%	4,87%
EMA	11,27%	-2,46%	1,28%	5,16%
DMAC(SMA)	12,22%	11,04%	11,37%	11,71%
DMAC(EMA)	12,88%	11,79%	12,10%	12,41%
MACD(SMA)	13,97%	5,23%	7,66%	10,14%
MACD(EMA)	11,04%	1,34%	4,02%	6,77%
ROC	11,70%	-21,68%	-13,32%	-4,07%
RSI	11,70%	-21,68%	8,87%	9,21%
BB	9,72%	8,54%	8,30%	9,12%
Buy and Hold	12,49%	12,22%	12,30%	12,37%

Summary Period C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,78%	-0,48%	2,87%	6,35%
EMA	12,75%	-1,24%	2,57%	6,52%
DMAC(SMA)	6,42%	5,16%	5,52%	5,88%
DMAC(EMA)	10,03%	9,06%	9,34%	9,62%
MACD(SMA)	11,73%	3,20%	5,57%	7,99%
MACD(EMA)	8,86%	-0,80%	1,87%	4,61%
ROC	9,55%	-23,20%	-15,00%	-5,92%
RSI	9,55%	-23,20%	-15,00%	9,09%
BB	9,54%	8,50%	8,80%	8,03%
Buy and Hold	13,22%	12,95%	13,03%	13,10%

Summary of Average Return for Period A, B and C				
3 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,21%	-0,89%	2,43%	5,85%
EMA	12,25%	-1,65%	2,14%	6,07%
DMAC(SMA)	8,36%	7,12%	7,47%	7,82%
DMAC(EMA)	10,98%	9,97%	10,26%	10,55%
MACD(SMA)	12,48%	3,88%	6,26%	8,71%
MACD(EMA)	9,59%	-0,09%	2,59%	5,33%
ROC	10,27%	-22,70%	-14,44%	-5,30%
RSI	10,26%	-12,13%	0,89%	9,13%
BB	9,50%	7,82%	8,11%	8,39%
Buy and Hold	12,78%	12,51%	12,59%	12,66%

For period A: the EMA indicator outperformed the buy and hold strategy in the absence of transaction costs. When taking transaction costs into account, the buy and hold strategy is unbeatable.

For period B: DMAC(EMA) and MACD(SMA) outperformed the buy and hold strategy when there are no transaction costs. The buy and hold strategy is unbeatable for transaction costs of 0.35% and 0.25%. For a transaction cost of 0.15%, the DMAC(EMA) indicator outperformed the buy and hold strategy.

For period C: the buy and hold strategy is unbeatable with and without transaction costs.

For the average returns of period A, B and C: the buy and hold strategy is unbeatable with and without transaction costs.

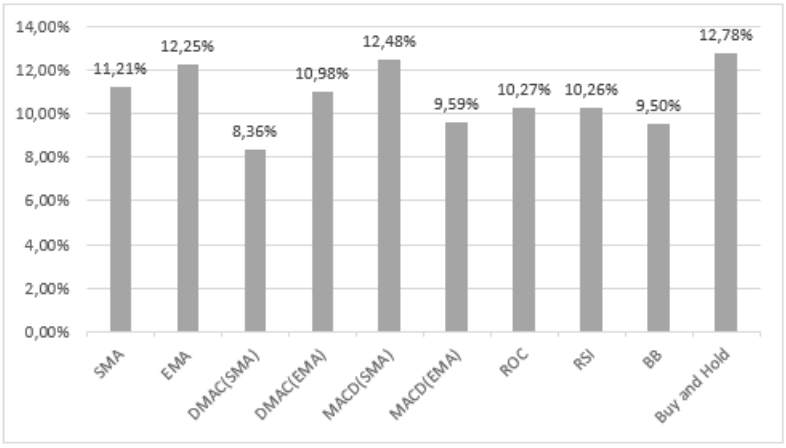

Figure A.53: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the three-year data for no transaction fees (Varying Exchange Rate)

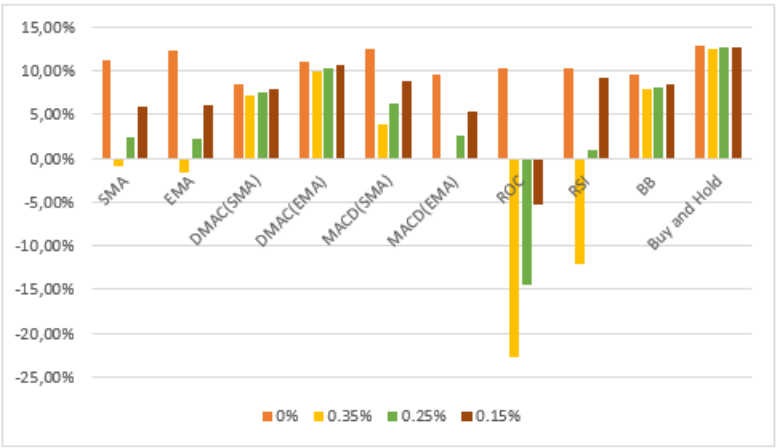

Figure A.54: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the three-year data for all transaction fees (Varying Exchange Rate)

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

A.2.2.2 Five-Year Periods

Constant Exchange Rate

Table A.28 summarises the returns for each of the three periods for $b = 100\%$.

Table A.28: JSE Top 40, S&P 500 and NIFTY 50 - Summary of period A, B & C returns for five years (Constant Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,26%	-0,50%	2,73%	6,06%
EMA	11,45%	-2,24%	1,49%	5,36%
DMAC(SMA)	8,51%	7,38%	7,70%	8,02%
DMAC(EMA)	9,48%	8,51%	8,79%	9,06%
MACD(SMA)	11,23%	2,78%	5,12%	7,52%
MACD(EMA)	6,09%	-3,23%	-0,65%	1,99%
ROC	6,15%	-25,63%	-17,67%	-8,86%
RSI	7,32%	6,20%	6,51%	6,83%
BB	10,39%	7,61%	8,40%	9,19%
Buy and Hold	10,75%	10,59%	10,64%	10,68%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,94%	-0,22%	3,11%	6,56%
EMA	11,71%	-2,13%	1,64%	5,56%
DMAC(SMA)	7,35%	6,24%	6,55%	6,87%
DMAC(EMA)	8,82%	7,94%	8,19%	8,44%
MACD(SMA)	9,76%	1,37%	3,70%	6,08%
MACD(EMA)	4,31%	-4,91%	-2,36%	0,25%
ROC	4,94%	-26,53%	-18,65%	-9,93%
RSI	9,35%	8,26%	8,57%	8,88%
BB	8,36%	5,76%	6,50%	7,24%
Buy and Hold	10,40%	10,25%	10,29%	10,34%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,17%	-0,90%	2,41%	5,83%
EMA	11,48%	-2,25%	1,49%	5,38%
DMAC(SMA)	5,79%	4,60%	4,94%	5,28%
DMAC(EMA)	7,78%	6,74%	7,04%	7,33%
MACD(SMA)	7,39%	-0,77%	1,49%	3,81%
MACD(EMA)	3,39%	-5,60%	-3,11%	-0,56%
ROC	5,51%	-26,06%	-18,15%	-9,40%
RSI	8,35%	7,28%	7,58%	7,89%
BB	9,65%	7,04%	7,78%	8,52%
Buy and Hold	8,70%	8,55%	8,59%	8,64%

Summary of Average Returns for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,46%	-0,54%	2,75%	6,15%
EMA	11,55%	-2,21%	1,54%	5,43%
DMAC(SMA)	7,22%	6,07%	6,40%	6,72%
DMAC(EMA)	8,69%	7,73%	8,01%	8,28%
MACD(SMA)	9,46%	1,13%	3,44%	5,81%
MACD(EMA)	4,60%	-4,58%	-2,04%	0,56%
ROC	5,54%	-26,07%	-18,16%	-9,40%
RSI	8,34%	7,24%	7,56%	7,87%
BB	9,47%	6,80%	7,56%	8,32%
Buy and Hold	9,95%	9,80%	9,84%	9,88%

For period A: EMA, SMA and MACD(SMA) outperform the buy and hold strategy when there are no transaction costs. In the presence of transaction costs, the buy and hold strategy is unbeatable.

For period B: SMA and EMA outperform the buy and hold strategy in the absence of transaction costs. When considering transaction costs, the buy and hold strategy is unbeatable.

For period C: EMA, SMA and BB outperform the buy and hold strategy when there are no transaction costs. The buy and hold strategy is unbeatable in the presence of transaction costs.

For the average returns of period A, B and C: the returns are the same as period B. EMA and SMA outperforms the buy and hold strategy in the absence of transaction costs, but the buy and hold strategy is unbeatable when considering transaction costs.

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

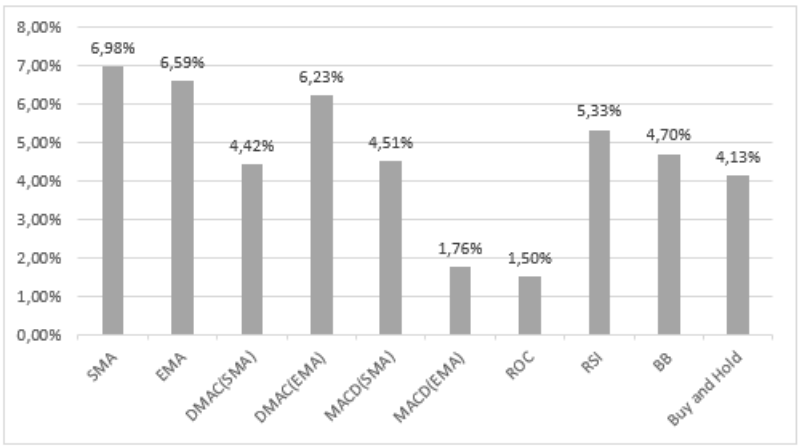

Figure A.55: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the five-year data for no transaction fees (Constant Exchange Rate)

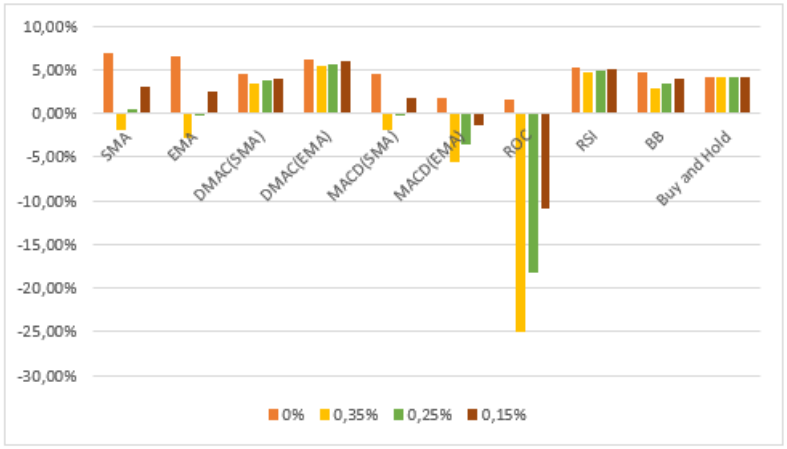

Figure A.56: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the five-year data for all transaction fees (Constant Exchange Rate)

Varying Exchange Rate

Table A.29 summarises the returns for each of the three periods for $b = 100\%$.

For period A: the MACD(SMA) indicator outperformed the buy and hold strategy in the absence of transaction costs. When considering transaction costs, the buy and hold strategy is unbeatable.

For period B, period C and the average returns of period A, B and C: the buy and hold strategy is unbeatable with and without transaction costs.

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the

Table A.29: JSE Top 40, S&P 500 and NIFTY 50 - Summary of period A, B & C returns for five years (Varying Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,00%	-1,63%	1,56%	4,86%
EMA	11,73%	-1,99%	1,75%	5,63%
DMAC(SMA)	11,34%	10,18%	10,51%	10,84%
DMAC(EMA)	11,79%	10,81%	11,09%	11,37%
MACD(SMA)	14,12%	5,44%	7,85%	10,32%
MACD(EMA)	11,00%	1,24%	3,94%	6,71%
ROC	10,73%	-22,43%	-14,13%	-4,94%
RSI	9,59%	8,44%	8,77%	9,10%
BB	12,02%	9,27%	10,05%	10,83%
Buy and Hold	13,31%	13,15%	13,20%	13,24%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,29%	-0,80%	2,51%	5,94%
EMA	11,96%	-1,91%	1,86%	5,79%
DMAC(SMA)	7,72%	6,60%	6,92%	7,24%
DMAC(EMA)	9,01%	8,13%	8,38%	8,63%
MACD(SMA)	12,62%	4,01%	6,40%	8,84%
MACD(EMA)	8,71%	-0,90%	1,75%	4,48%
ROC	9,07%	-23,64%	-15,45%	-6,38%
RSI	8,96%	7,91%	8,21%	8,51%
BB	8,25%	5,74%	6,45%	7,17%
Buy and Hold	14,09%	13,93%	13,97%	14,02%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,29%	-1,69%	1,60%	4,99%
EMA	11,88%	-1,90%	1,86%	5,75%
DMAC(SMA)	5,36%	4,17%	4,51%	4,85%
DMAC(EMA)	8,71%	7,65%	7,95%	8,26%
MACD(SMA)	9,86%	1,51%	3,83%	6,20%
MACD(EMA)	8,40%	-1,02%	1,58%	4,26%
ROC	9,73%	-23,11%	-14,89%	-5,79%
RSI	10,67%	9,50%	9,83%	10,17%
BB	6,88%	4,51%	5,18%	5,86%
Buy and Hold	12,98%	12,82%	12,86%	12,91%

Summary of Average Returns for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,53%	-1,37%	1,89%	5,26%
EMA	11,86%	-1,93%	1,82%	5,72%
DMAC(SMA)	8,14%	6,99%	7,31%	7,64%
DMAC(EMA)	9,84%	8,87%	9,14%	9,42%
MACD(SMA)	12,20%	3,65%	6,03%	8,45%
MACD(EMA)	9,37%	-0,23%	2,43%	5,15%
ROC	9,84%	-23,06%	-14,82%	-5,70%
RSI	9,74%	8,62%	8,94%	9,26%
BB	9,05%	6,51%	7,23%	7,95%
Buy and Hold	13,46%	13,30%	13,34%	13,39%

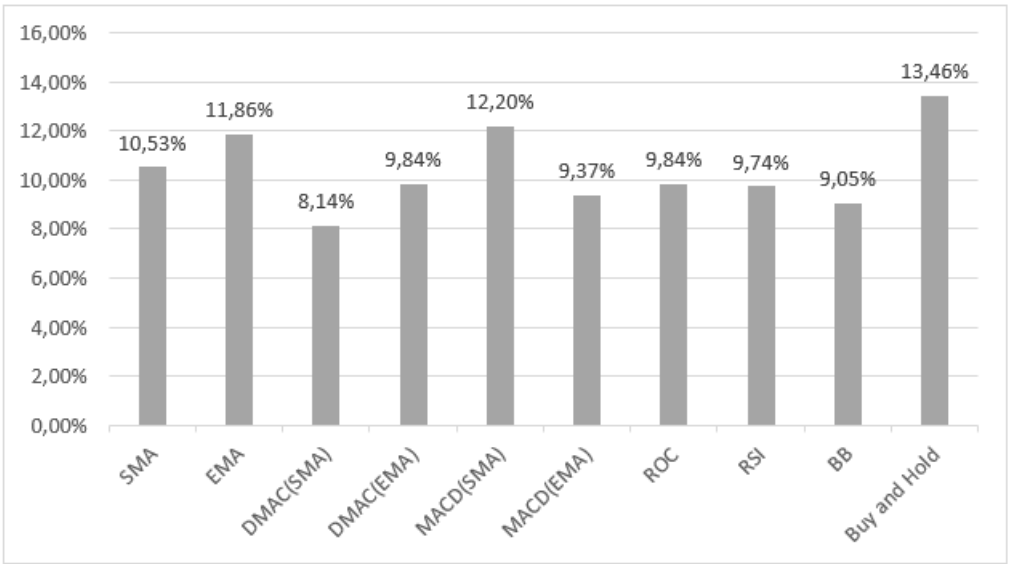

Figure A.57: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the five-year data for no transaction fees (Varying Exchange Rate)

higher returns are not enough to outperform the buy and hold strategy.

Figure A.58: JSE Top 40, S&P 500 and NIFTY 50 - Average returns on the five-year data for all transaction fees (Varying Exchange Rate)

A.2.3 JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 Combination

A.2.3.1 Five-Year Periods

Constant Exchange Rate

Table A.30 summarises the returns for each of the three periods for $b = 100\%$.

For period A and B: the SMA indicator outperformed the buy and hold strategy in the absence of transaction costs. When considering transaction costs, the buy and hold strategy is unbeatable.

For period C: SMA and EMA outperformed the buy and hold strategy in the absence of transaction costs. Once again when considering transaction costs, the buy and hold strategy is unbeatable.

For the average returns of period A, B and C: only the SMA indicator outperformed the buy and hold strategy when there are no transaction costs. When considering transaction costs, the buy and hold strategy is unbeatable.

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

Table A.30: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Summary of period A, B & C returns for five years (Constant Exchange Rate)

Summary Period A				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,92%	-0,85%	2,64%	6,26%
EMA	10,83%	-4,27%	-0,18%	4,08%
DMAC(SMA)	7,94%	6,80%	7,12%	7,45%
DMAC(EMA)	9,20%	8,16%	8,46%	8,75%
MACD(SMA)	7,97%	-0,42%	1,91%	4,29%
MACD(EMA)	4,98%	-4,87%	-2,16%	0,64%
ROC	3,26%	-28,57%	-20,64%	-11,83%
RSI	7,09%	6,08%	6,37%	6,66%
BB	9,43%	6,86%	7,59%	8,32%
Buy and Hold	11,74%	11,58%	11,63%	11,67%

Summary Period B				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,81%	-1,21%	2,34%	6,03%
EMA	10,56%	-4,55%	-0,46%	3,81%
DMAC(SMA)	7,46%	6,32%	6,64%	6,97%
DMAC(EMA)	8,75%	7,76%	8,04%	8,33%
MACD(SMA)	7,52%	-0,77%	1,53%	3,88%
MACD(EMA)	4,39%	-5,31%	-2,64%	0,11%
ROC	2,84%	-28,82%	-20,93%	-12,17%
RSI	5,63%	4,69%	4,96%	5,23%
BB	7,77%	5,34%	6,03%	6,72%
Buy and Hold	10,82%	10,67%	10,71%	10,76%

Summary Period C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,80%	-1,95%	1,53%	5,14%
EMA	9,95%	-5,11%	-1,03%	3,22%
DMAC(SMA)	4,18%	2,98%	3,32%	3,66%
DMAC(EMA)	4,21%	2,98%	3,33%	3,68%
MACD(SMA)	5,46%	-2,64%	-0,39%	1,91%
MACD(EMA)	3,10%	-6,30%	-3,71%	-1,04%
ROC	2,56%	-28,85%	-21,02%	-12,32%
RSI	6,87%	5,88%	6,16%	6,45%
BB	3,62%	1,65%	2,21%	2,77%
Buy and Hold	9,82%	9,67%	9,71%	9,76%

Summary of Average Return for Period A, B and C				
5 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,51%	-1,34%	2,17%	5,81%
EMA	10,45%	-4,65%	-0,56%	3,71%
DMAC(SMA)	6,53%	5,37%	5,70%	6,03%
DMAC(EMA)	7,39%	6,30%	6,61%	6,92%
MACD(SMA)	6,98%	-1,28%	1,02%	3,36%
MACD(EMA)	4,16%	-5,50%	-2,83%	-0,10%
ROC	2,88%	-28,75%	-20,86%	-12,11%
RSI	6,53%	5,55%	5,83%	6,11%
BB	6,94,%	4,62%	5,27%	5.94%
Buy and Hold	10,80%	10,64%	10,69%	10,73%

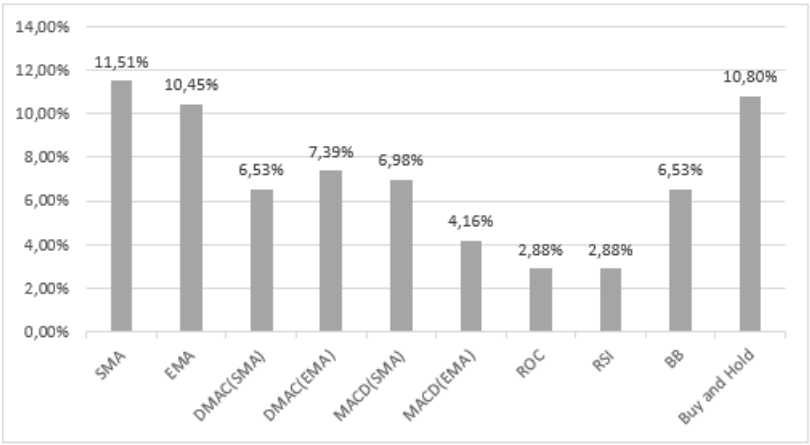

Figure A.59: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the five-year data for no transaction fees (Constant Exchange Rate)

A.2.3.2 Ten-Year Periods

Constant Exchange Rate

Table A.31 summarises the returns for each of the three periods for $b = 100\%$.

For period A, B, C and the average returns of the three periods: SMA and EMA outperformed

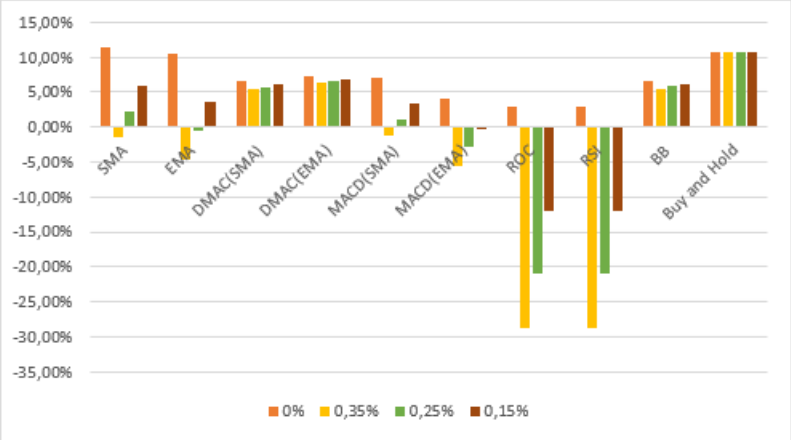

Figure A.60: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the five-year data for all transaction fees (Constant Exchange Rate)

Table A.31: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Summary of period A, B & C returns for ten years (Constant Exchange Rate)

Summary Period A				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,97%	-0,76%	2,72%	6,33%
EMA	10,97%	-4,08%	0,00%	4,25%
DMAC(SMA)	7,49%	6,38%	6,70%	7,01%
DMAC(EMA)	9,04%	8,05%	8,33%	8,61%
MACD(SMA)	8,11%	-0,25%	2,07%	4,44%
MACD(EMA)	5,03%	-4,78%	-2,07%	0,71%
ROC	3,28%	-28,53%	-20,60%	-11,80%
RSI	7,01%	6,04%	6,32%	6,59%
BB	7,85%	5,42%	6,11%	6,80%
Buy and Hold	9,12%	9,04%	9,07%	9,09%

Summary Period B				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,81%	-1,21%	2,34%	6,03%
EMA	10,56%	-4,55%	-0,46%	3,81%
DMAC(SMA)	7,52%	6,46%	6,76%	7,07%
DMAC(EMA)	8,75%	7,79%	8,07%	8,34%
MACD(SMA)	7,60%	-0,65%	1,64%	3,99%
MACD(EMA)	4,47%	-5,18%	-2,52%	0,22%
ROC	2,96%	-28,70%	-20,81%	-12,04%
RSI	5,54%	4,64%	4,90%	5,15%
BB	8,38%	5,79%	6,52%	7,26%
Buy and Hold	9,19%	9,12%	9,14%	9,16%

Summary Period C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	10,65%	-2,07%	1,41%	5,01%
EMA	10,13%	-4,96%	-0,88%	3,39%
DMAC(SMA)	6,93%	5,81%	6,13%	6,45%
DMAC(EMA)	7,21%	6,11%	6,43%	6,74%
MACD(SMA)	5,35%	-2,69%	-0,46%	1,83%
MACD(EMA)	3,09%	-6,25%	-3,67%	-1,02%
ROC	2,38%	-28,96%	-21,14%	-12,46%
RSI	5,91%	4,96%	5,23%	5,51%
BB	7,05%	4,56%	5,26%	5,97%
Buy and Hold	7,51%	7,43%	7,45%	7,48%

Summary of Average Return for Period A, B and C				
10 Years				
	0%	0.35%	0.25%	0.15%
SMA	11,48%	-1,35%	2,16%	5,79%
EMA	10,55%	-4,53%	-0,45%	3,82%
DMAC(SMA)	7,31%	6,22%	6,53%	6,84%
DMAC(EMA)	8,33%	7,32%	7,61%	7,90%
MACD(SMA)	7,02%	-1,20%	1,08%	3,42%
MACD(EMA)	4,19%	-5,40%	-2,75%	-0,03%
ROC	2,88%	-28,73%	-20,85%	-12,10%
RSI	6,16%	5,21%	5,48%	5,75%
BB	7,76%	5,26%	5,97%	6,68%
Buy and Hold	8,61%	8,53%	8,55%	8,57%

the buy and hold strategy in the absence of transaction costs. When transaction costs are taken into account, the buy and hold strategy is unbeatable.

For some of the individual periods, a lower $b\%$ produced higher returns than $b = 100\%$, but the higher returns are not enough to outperform the buy and hold strategy.

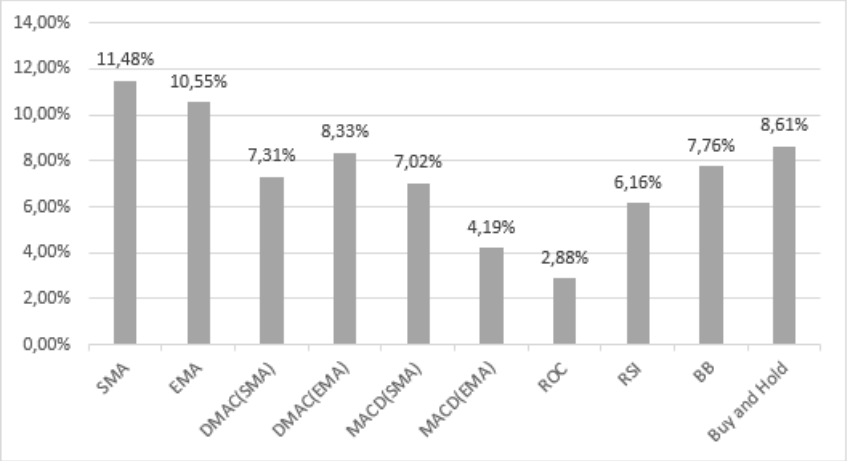

Figure A.61: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the ten-year data for no transaction fees (Constant Exchange Rate)

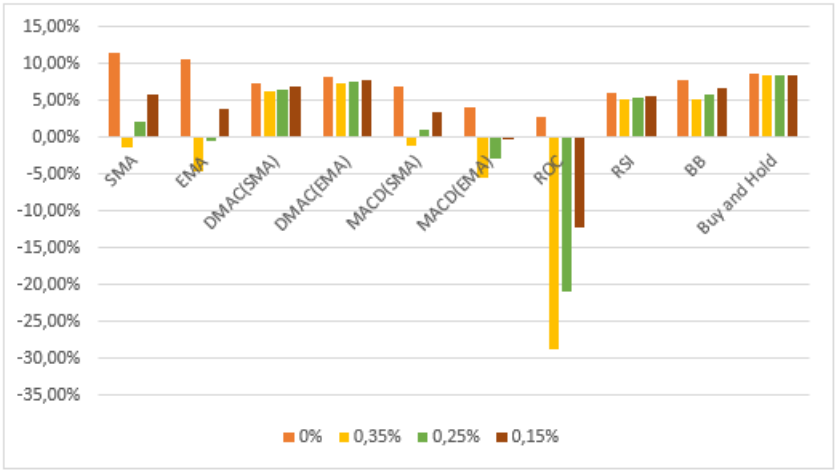

Figure A.62: JSE Top 40, S&P 500, NIFTY 50 and FTSE 100 - Average returns on the ten-year data for all transaction fees (Constant Exchange Rate)