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**Institute of Mathematical
Sciences**

**SCHOOL OF FINANCE AND APPLIED
ECONOMICS**

**APPLICATION OF TECHNICAL ANALYSIS IN
TRADING FOREX; COMPARISON OF TREND
INDICATORS VS OSCILLATORS**


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**A research proposal Submitted in Partial Fulfilment for the award of
Bachelor of Business Science.**

1 DECLARATION

I hereby declare that this research proposal is my original work. It has not been presented by any other person from any other institution known and unknown to me.

Signed.....


Date.....
15/2/17

This research proposal has been submitted for examination with my approval as the Supervisor

Signed.....


Date.....
17/02/2017

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ABSTRACT

This paper tests the hypothesis that in the long term, the use of technical analysis can produce positive returns. It particularly looks at the use of two of the most commonly used types of technical analysis which are momentum based indicators and oscillators. In order to assess the performance of this types of technical analysis, two popular momentum based indicators are chosen, namely Moving Average and Bollinger bands, while two popular oscillators are chosen namely, Relative Strength Index and Moving Average Convergence common. To gauge the performance of the indicators, the parameters of each of the indicators is subjected to six most traded currency pairs which were USDJPY, EURUSD, USDCAD, GBPUSD, USDCHF and AUDUSD. The daily closing prices of each of the currency pairs are used, and based on the parameters of the individual indicator, a buy or sell signal is conveyed by the indicator, and the profit or loss, of each of the signals is measured and summed up so that comparison of performance is possible. Daily closing prices from 2000-2015 are used.

The findings suggest it is possible for technical analysis tools to make positive returns over the long term. It also suggests that momentum indicators are better than oscillators and that Bollinger bands are the best of the four indicators measured in this paper.

1 INTRODUCTION

1.1 Background to the study

In a report titled “Global FX Market Update”, by Aite Group, every single day, billions of dollars are traded every day on the global forex market. Currencies such as EURUSD, EURGBP, AUDUSD, USDJPY, among others are traded as traders try to speculate movements in prices in these currencies, to make a profit. It is estimated, in the report that in 2016, the daily volumes being traded on the FOREX market are about USD\$4 Trillion per day. The trading volumes have increased significantly as it has become easier as technology has enabled more people to access the FOREX market by use of laptops, computers and phones. An increase in brokers who offer currency trading services has also increased accessibility. (King;2010)

There are various trading platforms that enable traders access tools needed for successful forecasting. Examples of this platforms include MetaTrader 4(MT4), MetaTrader 5(MT5) and NinjaTrader.

There are various players in the Forex Market such as institutions, individual traders and recently, there has been introduction of powerful computers that transact larger number of orders within a short period of time, with the help of complex algorithms. This use of complex computers to trade is known as High-frequency trading (HFT) and it accounts for about 70% of all transactions in the FOREX market.

Ideally, there are two methods of analyzing the securities to invest in; Technical analysis and fundamental analysis. Fundamental analysis is the examination of the underlying forces that affect the wellbeing of the economy, industry, groups and companies (Investopedia) .Technical analysts on the other hand, believe that the historical performance of stock markets is an indication of future performance, and it is possible for one to develop profitable trading rules using historical prices, charts and related statistics (Chong;2014) .

There are various known general theories that are against Technical Analysis. The most well-

known one is the Efficient Market Hypothesis (EMH) that states prices of assets fully reflect all publicly available information. Therefore, according to EMH, prices follow a Random Walk and it is not possible to make abnormal gains in the market using historical information.

Technical analysis is more related to short and medium term investments and is applicable for the determination of exact prices for opening or closing positions(Masteika;2012). Technical analysts used tools known as technical indicators which they use to try and forecast the market. These tools have mathematical formulas which are able to produce a buy or sell signal, based on the price movements. Another aspect of these tools is there exist certain trading rules which must be followed, in order to make a profit. An example of a trading rule is that using one of the technical indicators, known as a Relative Strength Index, if the lines go past the 70 mark, it generates a sell signal while if the line goes below 30, it generates a buy signal.

In Kenya, according to the Kenya Bankers Association report, 2010, trading of FOREX is limited to some of the banks such as Cooperative Bank, Barclays Bank and Standard Chartered, as they try to diversify their portfolio and maintain the value of the funds they hold in deposits. Multinational investment institutions such as Futures First are also involved in trading, but are mainly focused on futures (Futures first report,2015) . For a long time, there have been no dedicated places for learning about trading using technical analysis. However, some of the multinational companies have begun setting up, and schools such as Royal Institute, in Kenya, have cropped up, and this could therefore increase the technical analysis education in Kenya. This paper, could therefore shed a lot of light in this area that has not been greatly covered in Kenya.

In this paper, a broader look is taken on technical indicators instead of comparing indicators one by one and thus, the paper shall look at Oscillators and Momentum based indicators.

1.2 Problem Statement

Many studies done before, on the topic of Technical Analysis, use stock market as their data points. However, the movement of stock market data can be predicted by using both fundamental analysis and technical analysis, in equal measures. However, in Forex market, fundamental analysis is very limited as it involves macroeconomic analysis and Country Events announcements. This makes it difficult to use and thus, most Forex Traders prefer to use technical analysis. Therefore, technical analysis can be seen to impact the Forex market, much more significantly, as compared to its impact in the stock market. Therefore, there is a gap in terms of finding the use of technical analysis in Forex.

In Kenya, the Forex market is not well developed and there are very few institutions or individuals who teach technical analysis. However, according to the NSE (Nairobi Stock Exchange) website, the NSE announced plans to begin a derivatives market in June 2016. Also, with the introduction of securities such as I-Reits, D-Reits and the possible introduction of an Alternative Market Segment in the Nairobi Stock Exchange, all this shows that there is a lot of progress in the Kenya financial markets.

There is therefore a knowledge gap in terms of the Forex tools and its effectiveness and this paper, seeks to close that gap

Also, studies done on technical analysis, seek to do two main things,

- 1) Find about the most profitable indicator by comparing two or more indicators.
- 2) Or find out if using these technical indicators will produce a profit if compared to a buy and hold strategy.

In this paper, a broader look at technical indicators is taken, instead of comparing indicators one by one. There are several classifications of indicators, which are based on the intrinsic formulas they use to forecast the future. These classifications are trend indicators, Oscillators and Volume indicators. This research paper shall look at Oscillators and Momentum based indicators. The

indicators selected to represent the Momentum indicators are Moving Averages and Bollinger Bands while the indicators representing the Oscillators are MACD and RSI based on the popularity of these indicators and previous works done on them.

1.3 **Research Questions**

- 1) Is it possible to beat the market using technical analysis?
- 2) Between an oscillator and trend based indicator, which one of them is most profitable?

1.4 **Research Objectives**

- 1) Assess whether use of technical analysis generates profit over long term period
- 2) Assess the performance of momentum based indicators compared to trend based indicator,

2 LITERATURE REVIEW

This section is split into two sections, the first part will be about the general idea of Technical Analysis and the second part will be about the 4 individual technical indicators namely RSI(Relative Strength Index) , MACD(Moving Average Convergence Divergence) , Moving Averages and Bollinger Bands.

2.1 General perspective of technical analysis

Several studies have been done on technical analysis with each taking a different approach based on its core content, methodology and the data used for the study.

Technical analysis has become quite popular in trading the markets. Neftci in his study; Naive trading rules in Financial Markets and Weiner- Kolmogorov Prediction Theory, states the results of a questionnaire survey, conducted for the Bank of England, reveals that at least 90 % of respondents use technical analysis when forming views at one or more time horizons.

To give an insight into Technical Analysis, Taylor, (1992) in his study; The use of Technical analysis in the foreign exchange market, gives more insight to technical analysis by stating that technical analysts, analyze the financial markets by providing forecasts or trading advice on the basis of largely visual inspection of past prices, without regard to any underlying economic or 'fundamental' analysis.

In terms of effectiveness of technical analysis, there have been mixed reactions in terms of whether it is profitable. Neelay, Weller and Dittmar(1997) in their study; Is Technical Analysis in the foreign Exchange Market Profitable , uses genetic programming techniques to find out if technical trading rules are profitable and bring excess returns. His findings were that these rules had a strong evidence of excess returns over the period between 1981- 1995 after comparing six different exchange rates.

According to Park and Irwin (2007), their study shows that 24 out of 38 studies report that technical analysis is profitable and even give a profit range of between 5 to 10 % per year

However, there are various critics of technical analysis. Malkiel, in his book; A Random Walk Down Wall Street, notes that a true technical analyst doesn't ever care to know what business or industry a company is in as long as a certain pattern is seen. For a technical analyst, according to Burton, a chart shapes in the form of an "inverted bowl" means the same for Microsoft as it does

Coca- Cola.

Nefcti in his study; Naive trading rules in Financial Markets and Weiner- Kolmogorov Prediction Theory, does a study of technical analysis in terms of comparing it to Wiener- Kolmogorov prediction theory. In his study, he states that Technical analysis is much more preferred to the Weiner prediction model even though it (Weiner process) provides optimal linear forecasts

2.2 Technical analysis tools

This paper now looks at the second part of the Literature Review by introducing the individual tools and previous works done on them.

2.2.1 Relative strength index

This tool was developed by J. Welles Wilder. This is the Relative Strength Index (RSI) is a momentum oscillator that measures the speed and change of price movements. The RSI oscillates between zero and 100. Traditionally, and according to Wilder, RSI is considered overbought when above 70 and oversold when below 30. Signals can also be generated by looking for divergences, failure swings and centerline crossovers. RSI can also be used to identify the general trend.

RSI is calculated as follows,

So as to simplify the calculation, RSI has been broken down into its basic components which is RS, Average Gain and Average Loss. This RSI calculation is based on 14 periods, which is the default suggested by Wilder in his book. Losses are expressed as positive values, not negative values.

$$RSI = 100 - \frac{100}{1+RS} \dots\dots\dots\text{Equation 2.2.1-1}$$

$$RS = \text{Average Gain/Averageloss} \dots\dots\dots\text{Equation 2.2.1-2}$$

$$\text{First Average Gain} = \text{Sum of Gains over the past 14 periods} / 14 \dots\dots\dots\text{Equation 2.2.1-3}$$

$$\text{First Average Loss} = \text{Sum of Losses over the past 14 periods} / 14 \dots\dots\dots\text{Equation 2.2.1-4}$$

The second, and subsequent, calculations are based on the prior averages and the current gain loss:

$$\text{Average Gain} = [(\text{previous Average Gain}) \times 13 + \text{current Gain}] / 14 \dots \text{Equation 2.2.1-5}$$

$$\text{Average Loss} = [(\text{previous Average Loss}) \times 13 + \text{current Loss}] / 14 \dots \text{Equation 2.2.1-6}$$

Taking the prior value plus the current value is a smoothing technique. This also means that RSI values become more accurate as the calculation period extends

Earlier authors have tried to tweak the RSI formula in order to try and make it more accurate for trading. In Morosan (2011) study; Relative Strength Index Revised, the study aims to test empirically, the functioning of the classic RSI form (presented above) and a reconfigured form of the RSI that accounts for trading volume in its formula. His conclusion was that the reconfigured RSI version he proposed generated higher gains compared to the classic form RSI. However, there have been critics of the RSI and how it performs in making returns in the market. Abbey and Doukas, in their study; is technical analysis Profitable for individual Currency Traders, studied the RSI by coming up with a model that took into account 4 Technical analysis tools including RSI. However, the conclusion made by the author is that technical analysis is not profitable as the results showed losses. However, it can be argued that in this case, the bulk of the attributes were due to the other three technical indicators and not just RSI.

According to Kannan and Sekar (2010), the RSI is a profitable indicator when used between 1985 to 2012 foreign exchange indexes.

2.2.2 MACD (moving average convergence divergence)

This indicator was developed by Gerald Appel and stands for the Moving Average Convergence/Divergence oscillator (MACD). It is known to be one of the simplest and most effective momentum indicators available. The MACD works by turning two trend-following indicators, moving averages, into a momentum oscillator by subtracting the longer moving

average from the shorter moving average.

As its name implies, the MACD is all about the convergence and divergence of the two moving averages. Convergence occurs when the moving averages move towards each other. Divergence occurs when the moving averages move away from each other. The shorter moving average (12-day) is faster and responsible for most MACD movements. The longer moving average (26-day) is slower and less reactive to price changes in the underlying security.

The MACD fluctuates above and below the zero line as the moving averages converge, cross and diverge. Traders can look for signal line crossovers, centerline crossovers and divergences to generate signals

Signal line crossovers are the most common MACD signals. The signal line is a 9-day EMA (Exponential Moving Average) of the MACD Line. As a moving average of the indicator, it trails the MACD and makes it easier to spot MACD turns. A bullish crossover occurs when the MACD turns up and crosses above the signal line. A bearish crossover occurs when the MACD turns down and crosses below the signal line. Crossovers can last a few days or a few weeks, it all depends on the strength of the move.

Calculation of the MACD is as follows,

MACD Line: (12 day EMA (Exponential Moving Average)-26 day EMA)

Signal Line: 9 day EMA of MACD Line

MACD Histogram: MACD Line- Signal Line

In terms of looking at profitability of this indicator, several studies have been done.

Terence Tai Eung Chong & Wing- Kam Ng in their study; Technical analysis and the London Stock Exchange, examine two oscillators – the Moving Average Convergence–Divergence (MACD) and the Relative Strength Index (RSI) – to see if these rules are profitable. Using 60-year data of the London Stock Exchange FT30 Index, it is found that the RSI and the MACD rules can generate returns higher than the buy-and-hold strategy in most cases.

They have also been some studies done that disapprove the MACD's capabilities of returning

profits for an investor. According to Safwan Mohd Nor & Gunetrane Wickremasinghe (2014) in their study; Profitability of MACD and RSI trading rules in the Australian stock market, they investigate the profitability of two popular technical trading rules i the Moving Average Convergence Divergence (MACD) and the Relative Strength Index (RSI) i in the Australian stock market. They use data from 1996 to 2014 on the Australian All Ordinaries Index, and find that the MACD generally performs poorly, although the RSI shows some profit potentials. However, MACD also is seen to be a good indicator often beating other popular indicators. According to M. Hashemi Tilehnouei, and B. Shivaraj, in their study; A comparative study of two Technical analysis tools: MACD and RSI, they find that MACD is much better than RSI in buy, hold and sell signals.

2.2.3 Bollinger bands

Developed by John Bollinger, Bollinger Bands are volatility bands placed above and below a moving average. Volatility is based on the standard deviation, which changes as volatility increases and decreases. The bands automatically widen when volatility increases and narrow when volatility decreases. This dynamic nature of Bollinger Bands also means they can be used on different securities with the standard settings

Calculation of the Bollinger Bands is as follows,

Middle Band = 20-day simple moving average (SMA)

* Upper Band = 20-day SMA + (20-day standard deviation of price x 2)

* Lower Band = 20-day SMA - (20-day standard deviation of price x 2)

$$\sigma = \sqrt{\frac{\sum_{j=1}^N (X_j - \bar{X})^2}{N}} \dots\dots\dots \text{Equation 2.2.3-1}$$

$$\bar{X} = \frac{\sum_{j=1}^N X_j}{N} \dots\dots\dots \text{Equation 2.2.3-2}$$

$$\text{Upper band} = \bar{X} + 2\sigma \dots\dots\dots \text{Equation 2.2.3-3}$$

Middle band = \bar{X} Equation 2.2.3-4

Lower band = $\bar{X} - 2\sigma$Equation 2.2.3-5

In terms of effectiveness of Bollinger Bands, several studies have been done on them. Joseph Man- Joe Leung and Terence Tai –Leung Chong (2003), who compared Bollinger Bands and Moving Average envelopes. According to the study, Bollinger Bands capture sudden price fluctuations better compared to moving average envelopes, but do not however, outperform the moving averages envelopes

Apart from looking at the profitability, there has been attempts to make the Bollinger Bands more effective. According to Mathew Butler and Dimitar Kazakov, in their study; Particle Swarm Optimization of Bollinger Bands, the authors investigate the profitability of the Bollinger Bands under fine tuning of parameters via particle swarm optimization under 4 different fitness functions; Profitability, Sharpe ratio, sortino ratio and accuracy.

One key rule about using any technical analysis tool is that they should be used together with another form of analysis. This is echoed by K. Senthamarai Kannan, P. Sailapathi Sekar (2010), who state that the wise technical analyst will always use a number of indicators before making a decision to trade a particular stock. Bollinger Bands (BB) are not a standalone indicators as they do not generate explicit buy or sell signals and are generally used to provide a form of guideline, indicating possible trend reversals. In this case, if the current price breaks through the lower Bollinger band it is considered a buy signal, while if it breaks through the upper band it is considered a sell signal.

2.2.4 Moving averages

Moving averages smooth the price data to form a trend following indicator. They do not predict price direction, but rather define the current direction with a lag. Moving averages lag because they are based on past prices. Despite this lag, moving averages help smooth price action and filter out the noise.

The two most popular types of moving averages are the Simple Moving Average (SMA) and the Exponential Moving Average (EMA).

A simple moving average is formed by computing the average price of a security over a specific number of periods. Most moving averages are based on closing prices. A 5-day simple moving average is the five day sum of closing prices divided by five. As its name implies, a moving average is an average that moves. Old data is dropped as new data comes available. This causes the average to move along the time scale. Below is an example of a 5-day moving average evolving over three days.

Daily Closing Prices: 11,12,13,14,15,16,17Equation 2.2.4-1

First day of 5-day SMA: $(11 + 12 + 13 + 14 + 15) / 5 = 13$Equation 2.2.4-2

Second day of 5-day SMA: $(12 + 13 + 14 + 15 + 16) / 5 = 14$Equation 2.2.4-3

Third day of 5-day SMA: $(13 + 14 + 15 + 16 + 17) / 5 = 15$Equation 2.2.4-4

The first day of the moving average simply covers the last five days. The second day of the moving average drops the first data point (11) and adds the new data point (16). The third day of the moving average continues by dropping the first data point (12) and adding the new data point (17). In the example above, prices gradually increase from 11 to 17 over a total of seven days.

Exponential moving averages reduce the lag by applying more weight to recent prices. The weighting applied to the most recent price depends on the number of periods in the moving average. There are three steps to calculating an exponential moving average. First, calculate the simple moving average. An exponential moving average (EMA) has to start somewhere so a simple moving average is used as the previous period's EMA in the first calculation. Second, calculate the weighting multiplier. Third, calculate the exponential moving average. The formula

below is for a 10-day EMA.

SMA: $10 \text{ period sum} / 10$ Equation 2.2.4-5

Multiplier: $(2 / (\text{Time periods} + 1)) = (2 / (10 + 1)) = 0.1818$ (18.18%).....Equation 2.2.4-6

EMA: $\{\text{Close} - \text{EMA}(\text{previous day})\} \times \text{multiplier} + \text{EMA}(\text{previous day})$Equation 2.2.4-7

Even though there are clear differences between simple moving averages and exponential moving averages, one is not necessarily better than the other. Exponential moving averages have less lag and are therefore more sensitive to recent prices - and recent price changes. Exponential moving averages will turn before simple moving averages. Simple moving averages, on the other hand, represent a true average of prices for the entire time period. As such, simple moving averages may be better suited to identify support or resistance levels.

And according to K. Senthamarai Kannan, P. Sailapathi Sekar (2010) their work Financial Stock Market Forecast using Data Mining Techniques, the most popular indicator is the moving average. This shows the average price over a period of time. For a 30 day moving average you add the closing prices for each of the 30 days and divide by 30. The most common averages are 20, 30, 50, 100, and 200 days. Longer time spans are less affected by daily price fluctuations. A moving average is plotted as a line on a graph of price changes. When prices fall below the moving average they have a tendency to keep on falling. Conversely, when prices rise above the moving average they tend to keep on rising.

Using the Dow Jones Industrials, Brock et al. (1992) showed that moving average technical trading rules had some predictive abilities in both conditional means and variances. Further, they showed that these results were relatively stable over their 90 year sample period.

N. Vandewalle and M. Ausloos (1998) did a very interesting article where they looked at the Moving Average indicator from a physics perspective. They found that the density of crossing points between two moving averages is shown to be a measure of long-range power-law correlations in a signal.

William Brock and Josef Lakinishok (1992) in their article; Simple Technical Trading Rules and the Stochastic Properties of Stock Returns, did a comparison of two popular trading rules, Moving average and trading range break- by utilizing Dow Jones Index from 1897 to 1986. The results of this were strongly in favor of these technical analysis tools with buy signals being less volatile than sell signals.

According to Lento (2007) A moving average rule compares a short run moving average to a long run moving average. There are two variants of the MACO: variable length moving average (VMA), and the fixed length moving average (FMA). The VMA generates a buy (sell) signal whenever the short moving average is above (below) the long moving average. The FMA stresses that the returns for a few days following the crossing of the moving averages should be abnormal. The

MACO rules try to identify a change in a trend. This simple rule has a large variety of forms based on the time frame selected for each moving average.

3 METHODOLOGY

3.1 Research design

The Research design used in this proposal is experimental. This is because in this study, a hypothesis test is done on whether or not technical analysis is profitable in trading Forex as well as finding out which tool is the most effective.

3.2 Population and sampling

The population used in this research is the prices of currency pairs. The data selected will be based on the most frequently traded currencies in the world, which In turn will give us a good overview of whether the tools of technical analysis will work. The study shall examine the following currency pairs: EURUSD, GBPUSD, USDCHF, AUDUSD, USDJPY, and USDCAD Currencies are based on the most widely traded ones

3.3 Data collection

3.3.1 Data sources

The data used in this research will be Currency pair prices. The source of this information is obtained from the US Foreign Exchange. This is because, looking at the currency pairs that will be used in the research, all of them have the US Dollar component. The US Dollar is widely used and it is the currency that is mostly traded in FOREX.

The data used will be daily price.

3.4 Data analysis

3.4.1 Method of combining indicators

Since Oscillators versus Momentum based indicators are being compared, they shall be compared by combining two indicators each.

This combination of indicators will be done in two ways,

3.4.1.1 1st METHOD: COMBINED BUY AND SELL SIGNAL

In this method, a buy and sell signal will be generated based on the currency prices following the respective trading rules of each indicator. This is done with the expectation that increasing the rules that govern the trading signals, will increase the probability of the trade being in the correct expected direction (Long or Short)

3.4.1.2 2nd METHOD: EQUAL WEIGHTING OF INDIVIDUAL INDICATORS

In this method, a 50-50 weighting will be done on the two indicators in each category, so as to give a combined profit and loss for the category.

This will be in the form of,

$50 \%(\text{Indicator 1 Profits and Losses}) + 50 \%(\text{Indicator 2 Profits and Losses}) = \text{Combined P\&L}$

In comparing and combining the indicators, the paper first looks at the trading rules for each individual indicator, in order to determine buy and sell signals and compare them.

3.5 Trading Rules

Certain trading rules are needed in order to convey a buy or sell signal.

3.5.1 Bollinger Band Trading rule

For the Bollinger band, a buying signal comes about when the closing price of the currency pair crosses above the lower Bollinger Band, from below and sells when the closing price crosses beneath the upper Bollinger Band from above. The parameters used in the Bollinger Bands will be the 20 day moving average

3.5.2 Moving Average

For the moving Average, the 8 day and 18 day Moving Average will be used. A buy signal is generated when the 8 day moving average line crosses over the 18 day moving average from below, while a sell signal is generated when the 8 day moving average crosses the 18 day moving average from above, and goes below the 18 day moving average.

3.5.3 MACD (Moving Average Convergence Divergence)

For the Moving Average Convergence Divergence a buy signal is generated when MACD difference (calculated using the 12- and 24-day exponential moving averages) crosses over zero and establishes a short position when the MACD difference crosses below zero. Traders that

utilize the MACD difference are capitalizing on the strength of momentum to generate profits. Momentum of the intermediate trends is strongest when the difference between the 12- and 24-day exponential moving averages is greatest. Traders will enter long positions when momentum is moving up (MACD difference > 0) and short when momentum is moving down (MACD difference < 0).

3.5.4 RSI (Relative Strength Index)

For the Relative Strength Index strategy, a buy signal is generated when the RSI technical indicator reaches 30, and a sell signal is generated when the RSI technical indicator reaches 70. An RSI value of 70 (30) indicates to a trader that the currency is currently overbought (oversold) and a trader will then enter a short (long) position anticipating that the currency rate will move down (up) in the future.

3.6 ROBUSTNESS TESTING

To ensure that there will be robustness in our data, calculation of the profit and losses of the trading rules is done on the different sub periods of 5 years each

2000-2005

2005-2010

2010-2015

3.7 STATISTICAL SIGNIFICANCE

This paper tests the significance of the results using the bootstrapping approach developed by Levich and Thomas (1993). This approach, first, observes the data sets of Closing prices with the sample size denoted by $N+1$ that corresponds to a set N returns. The m ($m=1, \dots, M$) permutation of these N returns ($M = N!$) is related to a unique profit measure ($X[m, r]$) for the r th trading rule variant ($r=1, \dots, R$) used in this study. Thus, for each variable, a new series can be generated by randomly reshuffling the returns of the original series.

From the sequence of M returns, the starting and ending data points of the randomly generated time series are fixed at their original values. This maintains the distributional properties of the

original data. However, the time series properties are random.

In this bootstrapping simulation one can thus generate one of the various notional paths that the returns could have taken from time t (starting day) to time $t+n$ (ending day). The notional paths are generated 500 times for each data set. Technical trading rules are then applied to each of the 100 random series and the profits $X [m, r]$ are measured. This process generates an empirical distribution of the profits. The profits calculated on the original data set are then compared to the profits from the randomly generated data sets.

The null and the alternative hypotheses are given by:

H0: the trading rules provide no useful information.

H1: the trading rules provide useful information

4 DATA ANALYSIS AND FINDINGS

4.1 INTRODUCTION

The data has been analyzed according to the following objectives;

- 1) Is technical analysis profitable over a long period of time
- 2) Between oscillators and momentum indicators, which one is more profitable

To understand the analysis of the study, a brief outline of how a trade is taken, managed and profit or loss is realized, is important.

4.1.1 Outline of a trade

A trader makes use of a technical based indicator, to determine whether to buy or sell as this indicators make use of past history to make a future prediction. In this study, the indicators are the aforementioned (MACD, RSI, Bollinger Bands and Moving Averages). Once the signal is formed, the respective trade is put in place. The trade can be closed based on a number of factors. In this study, the basis of closing a trade, is the emergence of a signal opposite to the currently opened trade. To illustrate this, if at a point in time, a buy signal is currently running, and one of the technical indicators gives off a sell signal, then the buy signal is closed, and subsequently, a sell signal is opened. Vice versa occurs if a sell signal is currently running and one of the indicators gives off a buy signal.

The profit and loss of each of the trades was calculated by finding the price difference between the time the trade was taken and when it was closed. The calculations also took into consideration whether the trade was a buy or a sell. Once the price difference was found, in order to show the profit or loss in a uniform manner, it was shown in units called pips, which is used in the financial markets. To illustrate this, if a buy trade was taken at 1.30245 and the trade is closed at 1.30284, then the profit is calculated as $[1.30284 - 1.30245] = 0.00039$. This then needs to be converted to pips, which is done by multiplying the result by 10,000. This therefore becomes, $[10,000 * 0.00039]$ which results to 3.9 pips. If a trade was taken, and the volume of the units bought were one lot (100,000 units), then the profit of this trade would have been $(3.9 \text{ pips} * 1 \text{ lot} * 10) = \39 profit. This is how the profit or loss will be calculated.

With the above strategy outlined, once the data (daily price of the currency pair) is entered, then

a sell or buy signal needs to be produced based on the unique parameters of each of the indicators. To facilitate this, the data was entered into a spreadsheet, and the respective formulas of the indicators were used, to enable the formation of the signals.

The daily prices of 6 currency pairs, from a period of 2000 to 2015, were entered into the spreadsheet. The currency pairs were EURUSD, USDCHF, AUDUSD, USDJPY, USDCAD and GBPUSD.

The section below shows an extract showing the arrangement of data and the formulas used to enable the generation of signals and a more comprehensive explanation of the analysis.

4.2 Data Analysis

4.2.1 Bollinger Bands

Table 4.2-1; Bollinger band extract

Bollinger Bands (20,2)	Price	Middle Band 20-day SMA	20-day Standard Deviation	Upper Band 20-day SMA + STDEVx2	Lower Band 20-day SMA - STDEVx2
29-May-09	90.70	88.71	1.29	91.29	86.12
1-Jun-09	92.90	89.05	1.45	91.95	86.14

The above was is an extract of the spreadsheet used for the analysis. The parameters used are the 20 day Simple moving average (SMA) which is average of the prices for the last 20 days from a given date. The 20 day standard deviation is also used, which is the standard deviation of prices for the last 20 day. The upper band of the Bollinger band is $[20 \text{ day SMA} + 2(\text{Standard Deviation})]$ and the lower band is $[20 \text{ day SMA} - (2 * \text{Standard Deviation})]$.

For the Bollinger band, a buying signal comes about when the closing price of the currency pair crosses above the lower Bollinger Band, from below and sells when the closing price crosses beneath the upper Bollinger Band from above. Therefore, we compare the column with the daily prices, and the column with upper and lower band, and based on the outcome, then a signal is formed. If the price is within the bands, and is neither above the upper band, or lower band, then

no signal is formed, and no trade is taken.

With this rules and formulas in the place, the following is the summary of the findings of this indicator, based on the respective currency pairs.

Table 4.2-2; Bollinger Band results

Currency Pair	Buy/Sell signal	Number of trades	Profit/Loss
EURUSD	Buy	119	+8232 pips
	Sell	135	
USDCHF	Buy	29	+2 pips
	Sell	30	
AUDUSD	Buy	69	+0.7748
	Sell	88	
USDJPY	Buy	50	+110 pips
	Sell	50	
USDCAD	Buy	143	+207 pips
	Sell	146	
GBPUSD	Buy	51	+102 pips
	Sell	51	
TOTAL			+8653.7748 pips

4.2.2 Moving Averages

Table 4.2-3; Moving Averages extract

Date	Price	8-day SMA	18-day SMA
24-Mar-10	22.27	22.23	22.21
25-Mar-10	22.19		

This is also an extract of the spreadsheet used for the analysis of Moving Average. The parameters used are the 10 day Simple moving average (SMA) which is average of the prices for the last 10 days from a given date. The 18 day simple moving average is also used which is the average of the prices of the last 18 days from a given date.

For the moving Average, we shall use the 8 day and 18 day Moving Average. A buy signal is generated when the 8 day moving average line crosses over the 18 day moving average from below, while a sell signal is generated when the 8 day moving average crosses the 18 day moving average from above, and goes below the 18 day moving average.

The moving average shows trends, and therefore, to make the results more accurate, the moment a trade changes its status from buy to sell or vice versa, then that is the when the trade is taken, since even after the trade is taken, one of the moving averages will always remain above the other and it simply shows a trend at that point, as supposed to when to enter a trade.

With this rules and formulas in the place, the following is the summary of the findings of this indicator, based on the respective currency pairs.

Table 4.2-4; Moving Average results

Currency Pair	Buy/Sell signal	Number of trades	Total profit/loss
EURUSD	Buy	131	+23 pips
	Sell	132	
USDCHF	Buy	143	-0.0371 pips
	Sell	144	
AUDUSD	Buy	129	+0.1559
	Sell	131	
USDJPY	Buy	61	+1.3 pips
	Sell	60	
USDCAD	Buy	131	+0.5242 pips
	Sell	130	
GBPUSD	Buy	142	+0.0166 pips
	Sell	141	
TOTAL		24.9596 pips	

4.2.3 4.3 RSI

Table 4.2-5; RSI extract

Date	Close	Change	Gain	Loss	Average Gain	Average Loss	RS	14-day RSI
6-Jan-10	46.00	-0.28		0.28	0.22	0.11	1.97	66.32
7-Jan-10	46.03	0.03	0.03		0.21	0.10	1.99	66.55

For the RSI, several variables have to be taken to consideration, as the extract above shows. The close column, is the closing price of the daily prices in a specific currency pair. The change is the difference between the current closing price of the day and the previous daily price. For the next two columns, the Gain and Loss columns, a formula is inserted so that if the change in prices is positive, then it is considered a gain, while if the change is negative, then it is considered a loss. This is achieved by inputting the formula, =IF (change>0, GAIN, else it is LOSS). The parameters used in the RSI are 14 days. For the Average gain, average of the last 14 days that had gains is calculated and the same is done for the Average loss, where the average of the last 14 days that had a loss, are calculated. With this calculations, Relative Strength (RS) is calculated by dividing the Average Gain by the Average loss; Average Gain/Average loss.

Finally, the RSI is calculated as; $100 - [100 / (1 + RS)]$. This gives values which will give off either a buy or sell signal. For the Relative Strength Index strategy, a buy signal is generated when the RSI technical indicator reaches 30, and a sell signal is generated when the RSI technical indicator reaches 70. An RSI value of 70 (30) indicates to a trader that the currency is currently overbought (oversold) and a trader will then enter a short (long) position anticipating that the currency rate will move down (up) in the future. With this rules and formulas in the place, the following is the summary of the findings of this indicator, based on the respective currency pairs.

Table 4.2-6; RSI results

Currency Pair	Buy/Sell signal	Number of trades	Total profit/loss
EURUSD	Buy	119	+4788 pips
	Sell	135	
USDCHF	Buy	50	-0.0979 pips
	Sell	51	
AUDUSD	Buy	50	-0.1948 pips
	Sell	50	
USDJPY	Buy	54	-80 pips
	Sell	55	
USDCAD	Buy	38	+0.3625 pips
	Sell	37	
GBPUSD	Buy	44	+0.136 pips
	Sell	45	
TOTAL			+4708.2058 pips

4.2.4 4.4 MACD

Table 4.2-7; MACD extract

Date	Close	Smoothing constant $2(12+1)$	12 day EMA	Smoothing constant $2(26+1)$	26 day EMA	9 day EMA
6-Jan-10	46.00	0.1538461	-0.28	0.07407407		
7-Jan-10	46.03		0.03		0.03	

For the MACD, the main parameters needed for the calculations are 12 day EMA and 26 day EMA. The 12 day EMA is found by [(12 day smoothing constant*12 day SMA) +previous 12 day SMA]

While the 26 day EMA is [(26 day smoothing constant*26 day SMA) +previous 26 day SMA]

And 9 day EMA is [(9 day smoothing constant*9 day SMA) +previous 9 day SMA]

For the signal, then the formula used is,[12 day EMA-26 day EMA].

For the Moving Average Convergence Divergence a buy signal is generated when MACD difference (calculated using the 12- and 24-day exponential moving averages) crosses over zero and establishes a short position when the MACD difference crosses below zero. Traders will enter long positions when momentum is moving up (MACD difference > 0) and short when momentum is moving down (MACD difference < 0). The 9 day EMA is used as a reference point.

With this rules and formulas in the place, the following is the summary of the findings of this indicator, based on the respective currency pairs.

Table 4.2-8; MACD results

Currency Pair	Buy/Sell signal	Number of trades	Total profit/loss
EURUSD	Buy	140	+2971 pips
	Sell	139	
USDCHF	Buy	49	+0.3381 pips
	Sell	49	
AUDUSD	Buy	119	+238 pips
	Sell	119	
USDJPY	Buy	54	-36 pips
	Sell	55	
USDCAD	Buy	143	+287 pips
	Sell	143	
GBPUSD	Buy	52	+1.4 pips
	Sell	52	
TOTAL		3461 pips	

5 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

Certain conditions were used to choose when to enter, exit, and take profits. One of the considerations was the order Cancels Order structure. In this consideration, a buy order, when generated, would close a previous sell order, and a sell signal when generated would close a previous buy order. Another consideration was that there is no adding onto positions. If, a certain signal is generated, such as a sell signal, and before that sell trade is closed, the indicator shows another signal similar to the trade, such as another sell signal, then, another trade is not opened. Instead, the original trade is left to run. One last one was that there is no stop loss or take profit. There is no stop loss or take profit as trades are closed when another signal different from the current signal is generated. This follows the Order Cancels Order principle.

The results above are given on a pips basis. Pips are a unit of measurement used in profit and loss of trading.

The pips show the price movement, and the profit or loss depend on the volumes being traded. In order to make this results more comprehensible, the paper uses an example of an investor trading with \$500,000.

For this paper, for every \$1000, the volume traded is 0.1 lots. This is based on ensuring the capital is protected, and that every trade risks only 2 % of the total capital. Therefore, for \$500,000, the volume traded is 50 lots. With this in mind, then the results translate to the following, *Table 5.1-1; Overall Performance*

Bollinger Bands	8653 pips
Amount earned	\$4,326,500
MACD	3461 pips
Amount earned	\$1,730,500
Moving Average	24 pips
Amount earned	\$12,000
RSI	4708 pips
Amount earned	\$2,354,000

5.2 CONCLUSION

Some of the indicators show profit, while others show a loss. Those difference in profit and loss is also shown in use of different currency pairs as some indicators seem to have performed better in some currency pairs compared to others.

EURUSD seems to have the best results among the currency pairs, while Bollinger Bands is seen to have the best results among the indicators.

In terms of Momentum indicators versus oscillators, then the oscillators are better when combined, though the performance of the Bollinger Band, which is a momentum indicator, performed very well.

5.3 RECOMMENDATIONS

From the analysis above, at times, a trade would be profitable but by waiting for the next signal to be generated so that the trade is closed, take profit levels could be taken. This would ensure more consistency as well as ensuring that trading is done more effectively. Same goes for stop losses levels, which should also be implemented so that capital can be protected and losses are kept to a minimum. Another important concept is to stay clear of news and announcements. This study looks at technical analysis which involves looking at historical prices, and trying to forecast future prices based on the patterns seen in the past. Therefore, when announcements and news is coming out, such as Level of unemployment announcement by the USA, GDP level announcement by the Germany, Trade balance report, and such other announcements, a technical trader should not trade in this markets when it is known that these announcements are about to be released. By doing so, then the technical analysis done becomes much more effective. It is also important to use a combination of indicators. Certain indicators do well during certain conditions and therefore, by using different indicators, trading can become more effective. For example, during a trending condition in the market, then a momentum indicator can be used as they are able to pick out trends quite well. Using a diversified pool of currency pairs will improve results. From the above analysis, the same indicators when applied to different currency pairs have different results. This seems to suggest that in order to ensure efficiency then a trader could use

different currency pairs to reduce risk and maximize profit. Changing parameters of some of the Indicators could also lead to better results. Some of the indicators used such as moving average, could work better if some of its parameters are changed. For example, instead of using 14 period moving average, a 21 moving average could be used. This could make the results better as price has the signals being given off are more effective. This could largely change the performance of the indicator.

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