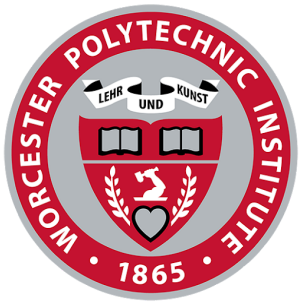
Trading and Investing System Development

An Interactive Qualifying Project

Submitted to the Faculty of

WORCESTER POLYTECHNIC INSTITUTE

in partial fulfilment of the requirements for the Degree of Bachelor of Science



WPI

By
Joseph Salice

Report Submitted to:
Professor Michael Radzicki

Abstract

The purpose of this interactive qualifying project was to create a trading system that could operate in the forex market and produce a positive gain. This forex trading system used a combination of Bollinger bands, MACD and the Parabolic SAR indicators to determine when to make a trade and when to get out of one.

Table Of Contents

Chapter 1: Introduction

The purpose and goal of this interactive qualifying project is to design a trading system that can reliably make positive trades in the forex market and to increase personal financial management and personal financial awareness for the average investing citizen. Roughly half of Americans are saving 5% or less of their incomes, including 18% who don't save anything. In addition, less than 3 out of every 10 Americans save more than 10% of their earnings. The majority of Americans are saving very little of their personal income. Of course saving a portion of one's income is better than spending it all and living paycheck to paycheck, as saving allows one to prepare for future unanticipated needs and to prepare for retirement. However, the majority, if not all savings accounts, cannot keep up with the US's average yearly inflation rate target of 2%. This means that even saving is not good enough for people, since their investment returns are typically less than inflation, which means that the purchasing power of their savings declines every year. If barely half of US citizens save, one can imagine how difficult it will be for Americans who do save to understand how to invest intelligently.

The effects of the Recession and the big market losses took their toll on Americans' sense of job security, confidence in the economy and the equity markets, and the financial means to invest. Therefore, the main goal of this interactive qualifying program is to persuade those who are looking for ways to increase their investing alternatives and potential returns to take control of their financial well being in the present and in the future.

Nonetheless, investing one's own savings is not for everyone and is certainly not easy. It's why many people choose to work with a financial advisor. Anyone with a computer or

smartphone may think that because trading is easier than ever, anybody can do it without any work or analysis. If the value of your savings increases you have more wealth, which you can choose to spend on things you might need or want, boosting the economy.

Acquiring and accessing information today is easier than ever. The Internet is a tool investors can use for feedback and to search out lower trading fees and for faster trading. There are many options for an individual to invest and trade on their own. There is less paperwork, no meeting with a broker nor significant commissions to pay. There are internet investing applications like robinhood that have no fees whatsoever and are completely free to use. Today anyone can access information on which stock investing gurus pick, and how they allocate their assets. In other words investing along a range of asset classes, equities, bonds, forex, for example, can improve potential returns without taking added risk.

The main asset class this trading system will be focusing on is currency pairs in the forex market.To summarize, the forex market is the buying and selling of different currencies and profiting off the difference from the moving values. The forex market can provide a lot of opportunities to make money but only if a trading plan is followed carefully, since you can lose money just as fast as you can make it in the forex market.

Chapter 2: Trading & Investing Background

Trading and investing are two different methods that people have been honing their skills at for many years. The overall goal of investing and trading is the same, which is to achieve an increase in personal wealth. The expectation of both investing and trading is driven by the same force, a desire for profit. However before investing your money in the stock or forex markets, the basics of each should be understood.

In a broad sense, trading and investing could be described as two similar methods, however if they are examined closely, investments are more of a long-term increase in wealth, with the method of buying and holding. The goal of investing is to accumulate wealth over an extended period, typically measured in years. Investors buy stocks or currencies if they think the overall trend of the object that they are investing is positive. And similarly, they would short sell after a long period of time, when they believed the object will experience depreciation, or the overall market may be headed for a decline, bringing their investments along.

Compared to investing, trading tends to be more frequent in buying and selling. Investors on the other hand consider more on the long-term expectation of an asset and are willing to take short-term losses when compared to long term gains. Traders however are trying to profit from short term moves up or down in a financial asset (an equity, stock or foreign currency). Short sell, which means borrowing and selling at higher price and buying at lower price later, is a method most traders use when they feel that their asset will experience depreciation soon.

One can trade and invest in a range of asset classes such as: 1. equities, which are stock interests or ownership interests in companies such as Apple or Amazon; 2. bonds which are debt

obligations of companies, countries (such as treasury securities of the US government) or states and municipalities; 3. currencies such as the USD, the Euro, the Swiss Franc, etc., and 4. commodities such as gold or oil. All of these assets except for forex are traded on exchanges across the globe. These markets are distinct but have some overlap, for example if commodity prices are high equities of companies that are using them can trade higher and vice versa.

The main asset class this trading system will be focusing on is currency pairs which are the quotation of the relative value of a currency against the value of another currency in the forex market. One of the main reasons the forex market was chosen to trade on is due to its absolutely enormous 5.3 trillion dollars a day trade volume (on average). By comparison the New York Stock Exchange (NYSE) and Tokyo Stock Exchange (TSE) only have an average daily trade volume of 22.4 and 18.9 billion dollars respectively. Due to this high daily trading volume gives the FX market a high liquidity. A high liquidity makes it very easy for anyone to buy and sell currencies which is good for retail traders (us) that trade the spot market. To summarize, the forex market can give you a lot of opportunities to make money, but only if a trading plan is followed carefully since you can lose money just as fast as you can make it.

The time frame on which a trading system is based (hourly frames, daily frames, etc) is crucial because it will help you see or miss big moves in the market. The system being developed will employ a manual method of trading and the time frame and time of day on which trades will be made will be crucial to the success of the trading system. The best time of the day to trade forex (when there is the most liquidity) is definitely during the London/New York Overlap (between the hours of 8am to noon EST), which is when the trading system will focus doing its trades. This overlap period is the busiest time of the day because traders from the two largest

financial centers are duking it out in the forex market. However just because you are trading during the busiest time of the day does not guarantee success, the real key to success lies within trading indicators

Just buying and selling currency pairs at random will not make you money in the forex market. The key to making successful trades that earn you money is being able to use indicators to tell you when it's time to buy or sell. In the forex market there are two types of indicators, leading and lagging indicators. A leading indicator, as the name suggests, gives the trader a signal before a new trend or reversal is about to occur, while a lagging indicator gives a signal after a trend or reversal has started. Based on that description you may think that the obvious choice all the time would be to use leading indicators because they tell you what's going to happen before it happens, however that would be wrong because, while leading indicators can tell you what might happen, it's no guarantee. Therefore leading indicators must be backed up by lagging indicators which tend to be right more often. So, to summarize leading and lagging indicators will be used together in the trading system to help pick out and confirm possible trends in the market for the period of time that the system is trading.

In the forex market more isn't always better when it comes to indicators, if you have too many indicators they all might be saying different things and you would never get a trade off, while having not enough indicators can be unreliable and result in bad trades. For the trading system in forex the trading indicators used will be Bollinger bands, The MACD and the Parabolic SAR. These indicators were selected because as a new trader these indicators are some of the easiest to interpret and are a good combination of leading and lagging indicators. The

MACD and Bollinger bands are lagging indicators while the Parabolic SAR is a leading indicator.

One of the easiest indicators to read in the trading system would be the Bollinger bands. The bands are created by setting up a three 20 day slow moving averages. The upper and lower bands are typically set up two standard deviations away from the middle line which is the unaltered SMA. These bands can be used to measure the market's volatility since the two lines that make up the band can act like mini support and resistance levels; More information on support and resistance can be seen below in figure 1. Two trading tactics that can be used based on the Bollinger bands are called the Bollinger bounce and the Bollinger squeeze, examples of this can be found in figures 5, 6 and 7. The Bollinger Bounce trading tactic is a strategy that relies on the notion that the price always tends to return to the middle of the band, knowing this trading strategy it will be used in the trading system to know when to buy. More specifically, when the price hits the lower Bollinger line it’s time to buy and to sell when the price hits the higher Bollinger line. The Bollinger squeeze is another trading tactic that will be used in the trading system that can be used to catch breakouts early. A breakout is any price movement that occurs outside a defined support or resistance level. Like the name suggests when the Bollinger bands squeeze together it suggests that the market is about to have a breakout and a trade should be entered on whatever side at which the breakout occurs.

Another indicator the trading system will be using is the Moving Average Convergence Divergence (MACD) indicator. This indicator can be used to catch trends early and help spot possible trend reversals. The MACD consists of 2 moving averages (1 fast, 1 slow) and a histogram that measures the distance between the two moving averages. One of the easiest ways

to trade with the MACD is to wait for the fast moving average to cross over or under the slow moving average. This occurrence tends to signal a new trend is occurring and the trade should be entered accordingly.

Lastly one of the indicators used in the trading system will be the Parabolic Stop And Reversal (SAR). Of all the indicators this is one of the easiest to use because it only gives a bullish or bearish signal. Trading using the Parabolic SAR is really easy, basically whenever the dots are above the candles on the chart that is a sell signal, when they are below the candles that's a buy signal. However even with the perfect combination of these indicators success is not guaranteed. There are other important things to consider like the style of trading you will employ, such as technical or fundamental.

When trading in the forex market an important thing to consider is the style of trading you will employ. For the trading system we will be doing a combination of both technical and fundamental analysis. The reasoning behind this is that only using only one style can result in bad trades and a loss of profits. Fundamental analysis is a way of looking at the forex market by analyzing the social, political, and economic forces and how that may affect the value of the currency that is being traded. Technical analysis on the other hand is a style of trading where the history of price movement is used to determine the current market conditions. By themselves technical and fundamental analysis have their shortcomings but when combined, both styles are employed by traders and therefore influence the movement of currencies, this style of trading can create a successful trading system.

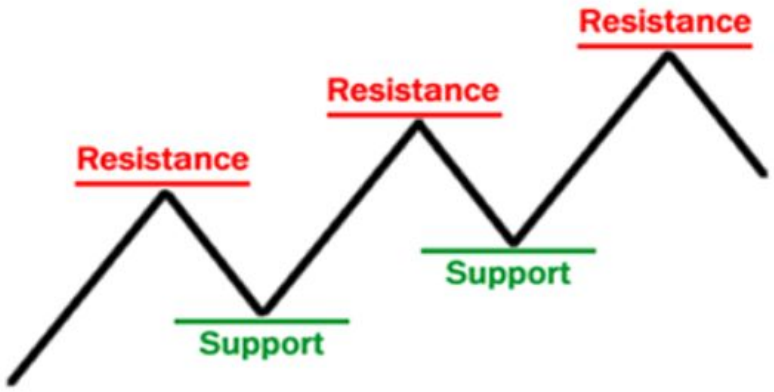


Figure 1: Support and Resistance

In the diagram seen above a simple trading concept is being demonstrated which is referred to as support and resistance levels. In figure 1 this zigzag pattern is making its way up in a bull market. When the price is moving upwards and then stops and drops back, the highest point reached is referred to as the resistance. Resistance levels tell the trader there is a surplus of sellers. When the price stops moving downward and starts moving back up again the lowest point reached is referred to as a support. These support levels indicate a surplus of buyers. The reverse is true of the previous situation during a bearish market or downtrend. Using this knowledge there are two ways to trade: the bounce and the break. Trading the bounce means buying when the price falls toward a support and selling when the precise rises toward a resistance. Trading the break means buying when the price breaks up and through resistance or selling when the price breaks down and through a support.

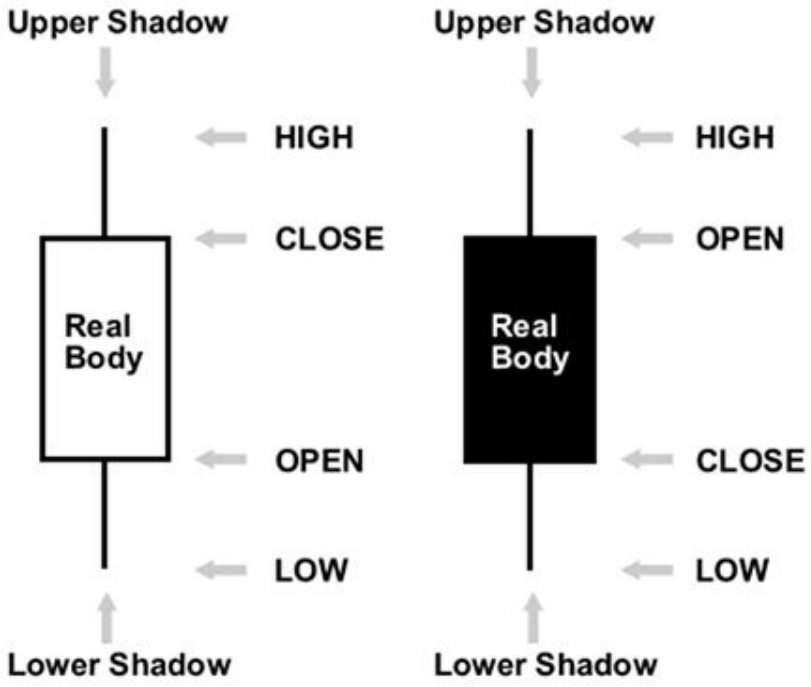


Figure 2: Japanese Candlestick Diagram

In figure 2, one of the most important concepts in forex trading is explained- the Japanese candlestick. These candlesticks can be used on any time frame, be it 30 minutes, one hour or even one day. The Japanese candlestick is formed using the open, high, low and closing price for the selected time frame.

The breadth of the market is a term that is widely used in technical analysis in stock markets. In many respects, the overall status of a country's economy is represented by the status of its equity market, which includes all sorts of listed companies. The breadth of the market could reflect the status of the market. It is calculated by comparing the number of companies that are experiencing advances in value and the amount of companies that are experiencing declines in value. A positive breadth of the market often represents a time when more companies are

positive while a negative breadth of the market often means the market is experiencing decline in value. Therefore, a “bull” market with an uptrend often has high, positive breadth of the market, while a “bear” market with a down trend often has negative breadth of the market.

Future contracts are another means of trading or profiting from movements in the value of certain assets. It is a legal agreement to buy or sell a particular commodity, for example, at a specified time in the future. For example, I can buy gold 90 days from now at a specific price. If I buy this contract for 1oz of gold in 90 days at 2000$/oz and in 90 days gold is worth $2,300 per ounce I will profit from the difference.

Derivatives are instruments one can buy or sell where the value is dependent on the value of the underlying asset and the time remaining on the contract. I can buy an option on apple stock, an option derivative for example can be a put or a call, in the case of a call I have the right to buy the underlying stock at a price in the future, but because it's the derivative instead of the stock I can invest less money to bet on the direction of the stock. In the case of options on stocks, such as Apple, I can buy a call option on Apple stock if I believe that over some period of time the stock is going to appreciate in value. One can buy a put option without having to sell if you believe that over some period of time apple stock will decline in value. In both cases if you are right you can profit without having to buy the stock itself. In both cases they are contracts with limited lives, such as month, 3 months or six months.

In other related analysis, researchers used the same or similar indicators in the forex market in an attempt to create a trading system that can have a positive expectancy, expectunity and system quality. Researchers Seyed Hadi Mir Yazdi and Ziba Habibi Lashkari also used the MACD indicator for the currency pairs, EUR/USD, GBP/USD, USD/CHF and USD/JPY

individually to gauge the effectiveness of the indicator in regards to the amount of profit generated, using hourly market data from a period between 2001 to 2010 (Yazdi S.H.M. & Lashkari Z.H. 2013).

The above research group drew multiple conclusions most importantly of which was that the MACD indicator was far more effective in trades that involved buying the currency pair as opposed to selling. The exact data showed that the total loss generated by the buy signals was only 1,672 pips as opposed to the sell signals which generated a loss of 7,360 pips, which is a considerable difference. Other important conclusions from their research included finding that the most effective currency pair to use with the MACD indicator was the EUR/USD pair and that, overall, just relying on one indicator to generate buy and sell signals will not create a profitable system.

Another trading system with similar characteristics to my work was developed by Murat Öztürk. They had developed a heuristic trading system using technical indicator rules to operate on forex data (Öztürk M., Toroslu I. H., & Fidan G. 2016). In this thesis, a heuristic based trading system on forex data is developed using popular technical indicators. The system is based on a heuristic that combines grounds on selecting and combining the trading rules based on indicators using heuristic methods. The selection of the trading rules is realized by using Genetic Algorithm and a local search method. A weighted majority voting method is proposed to combine the technical indicator based trading rules to form a single trading rule. The experiments are conducted on 2 major currency pairs in 3 different time frames where promising results are achieved (Öztürk M., Toroslu I. H., & Fidan G. 2016).

Chapter 3: Trading System Methodology

This trading system developed for this IQP was designed using a combination of technical analysis, fundamental analysis, momentum indicators, and acquired market knowledge from system development. During trading system development using only one form of market analysis (technical/fundamental) was discovered to be overall a detriment to the trading system so an approach using both forms of analysis was developed. At its basic level, fundamental analysis is based on the economic fundamentals of a selected currency's country. These economic fundamentals cover a vast group of information in the forms of political/economic events, environmental reports/events and even natural disasters. On the other side there is technical analysis, which is the study of price movements in the forex market. In theory, this trading system can look at the overall historical price movements and determine if the currency pair is acting bullish or bearish, as well as the potential price movements. To summarize this trading system was designed using approaches from both forms of these analyses.

When developing the trading system using technical analysis a set of trading rules were developed using the following conditions.

Condition A: Moving Average Convergence and Divergence (MACD)

The MACD is a lagging indicator which can be used to confirm ongoing trends in the market. The MACD consists of 3 important parameters, the first parameter sets the amount of periods that are used to calculate the faster moving average, the second parameter is used to determine the amount of periods that are used in the slower moving average while the final

parameter is the number of bars that are used to calculate the moving average of the difference between the faster and slower moving averages. The usual default for these parameters in trading software is 12, 26, 9. The MACD can give two different signals, divergence or convergence. MACD divergence is when the faster moving average is moving away from the slower moving average while MACD convergence is when the two moving averages get closer to each other.

In figure 3 seen below an example of how to trade using MACD is shown. Since there are two moving averages the faster one will be quicker to react to price movements than the slower moving average. When a new trend occurs the fast line will react first and eventually cross the slow line. The figure below shows an example of this MACD crossover occurring which ended up signalling the start of a new trend.

Figure 3: MACD

Condition B: Parabolic SAR

While the MACD can be used in identifying new trends the parabolic SAR (Stop And Reversal) can be used to identify where a trend ends. The parabolic SAR places dots on the japanese candlestick chart to indicate potential reversals in the price movement. As seen in figure 4 below the dots shift from being below the candles during an uptrend to above the candles when the trend reverses and the price begins to fall.

Trading with the parabolic SAR is simple, when the dots are below the candles the indicator is giving a buy signal. When the dots are above the candles the indicator is giving a sell signal. This indicator is best used when the markets are trending with long rallies and downturns. In a choppy market this indicator does not work as well since there isn't enough time to get an accurate signal.

Figure 4: Parabolic Sar

Condition D: Bollinger Bands

Bollinger bands are a technical indicator developed by John Bollinger, they are used to measure a market's volatility and identify if a market is being oversold or overbought. Simply put this indicator has the two bands contract when the market is quiet and they then expand when the market gets loud.

In figure 5 below the price shows little movement while the bands are close together, however, when the bands spread apart the price moves up.

Figure 5: Bollinger Bands

One of the most important things about Bollinger bands is that the price tends to return to the middle of the bands. These concepts which are used for trading are called the Bollinger bounce/squeeze. An example of the Bollinger bounce in action can be seen in figure 6 below, while an example of the Bollinger squeeze can be seen below in figure 7.

Figure 6: Bollinger Bounce

Figure 7: Bollinger Squeeze

Condition D: Market Moving News

Just as the stock market can be influenced by world news the forex market can be easily influenced by major world events and news. Positive or negative events can affect a country's currency accordingly and an accurate source of world events should be monitored while trading because world events can sometimes greatly affect a nation's currency.

An example of this would be the terrorist attacks that occured on July 14th in Nice, France. On that day a terrorist attack carried out by ISIS caused 86 deaths and 458 injuries. This terrorist attack sent shockwaves throughout related markets such as tourism, airlines and the security sector.

Using these sets of conditions/rules a set of 57 manual trades were made over roughly a 3 month period with the results examined in the following chapter and a trading journal in appendix A.

Chapter 4: Analyzing and Optimizing a Trading System

Forex trading systems can be either manual or automated. For the system described in chapter 3 a manual trading system was designed because a day trading approach was used. A day trader in the forex market usually uses a system of technical signals that create buying or selling decisions for them. The system for a day trader generally has a plan set of rules that outlines what a trader should do when a market indicator such as MACD gives a signal. When this signal is identified a trade is made and recorded into a trading journal, an example of a trading journal can be found in Appendix A where the trading journal for this system is presented.

With the trading system that was described in chapter 3 a set 57 of trades were made following the system's guidelines were made during the time period of late February to April 2017. This mock trading system started off with 50 U.S dollars and ended up with a total of 70 at the end of the test for a profit of 20 dollars, which for the starting size and time period is good. The chart seen below in figure # shows the results of the trading system by displaying the profit/loss per trade and the net profit after each trade was completed.

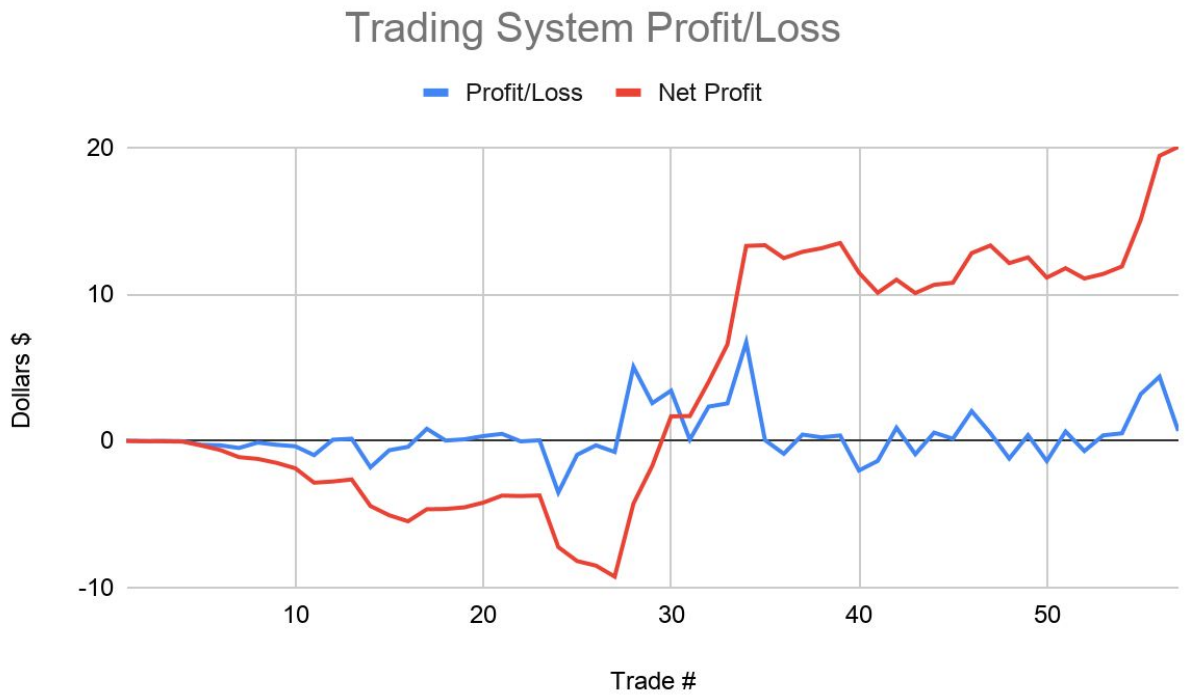


Figure 8: Forex Trading System Profits

In figure 8 the first 10 or so trades were mostly negative trades with a small negative profit; this is because in the beginning I was still developing my trading system and determining what position sizes to use. Looking into the trading journal found in Appendix A you can see the first few trades had very small position sizes as I was still learning how to use the trading platform. However by trade 20 I had finalized my trading plan and set of rules and determined what position sizes work best and by my 30th trade my trading system was in the green.

Figure 9: EUR/JPY forecast predictions

The figure 9 seen above is a forecast model for the EUR/JPY pair and it shows a bullish prediction for the EUR. After confirming by looking at chart indicators I longed the pair and made away with over 40 pips. The second figure seen below shows me entering the trade with a profit tigger active and a trailing stop.

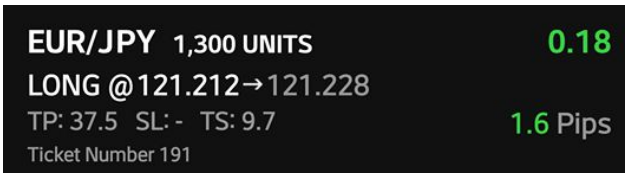


Figure 10: Trade Ticket

The figure 10 seen above shows me entering the trade by longing the euro/yen currency pair at a position size of 1,300 units with a take profit tigger active of 37.5 pips and a trailing stop active of 9.7 pips.

Chapter 5: Summary and Conclusions

Prior to the beginning of this project overall understanding of the forex and stock markets and the world of trading and investing was minimal, mostly just basic terminology. The goal of this IQP was to expand one's knowledge of the financial markets, specifically the forex market and increase one's ability to take control of their financial futures.

Looking at the test trades that were completed the system produced a nice profit when compared to the small starting budget and limited time frame of trading. Some early problems that were encountered was the decision of what lot size to use when buying or selling a currency pair. Looking at the trading journal in appendix A shows for the first few trades the lot size used were too small to make a successful trade so for all trades onward a larger size was used the trades overall became more profitable.

For anyone deciding to extend/modify this system or to do further research in the forex market there are some important facts to consider. Firstly and most important is to never risk what you can't afford to lose. This means that when investing you should not put all your eggs in one basket or all your money into the stock or forex markets. This is because bad things can and will happen and the possibility of having your investments wiped out is always a possibility. Secondly before beginning trading in forex using some of the tactics outlined in this paper it might be best to start out with a training account. This is where you can make real trades with real time price movements, however there is no risk involved because you aren't trading with real cash. To conclude the system created for this project showed how learning about the financial markets can help take control of their finance futures through trading and investing.

References:

Ozturk, M., Toroslu, I. H., & Fidan, G. (2016). Heuristic based trading system on forex data using technical indicator rules. *Applied Soft Computing*, *43*, 170-186.

Yazdi, S. H. M., & Lashkari, Z. H. (2013). Technical analysis of forex by MACD Indicator. *International Journal of Humanities and Management Sciences (IJHMS)*, *1*(2), 159-165.

Liu, Z., & Xiao, D. (2009, August). An automated trading system with multi-indicator fusion based on DS evidence theory in the forex market. In *2009 Sixth International Conference on Fuzzy Systems and Knowledge Discovery* (Vol. 3, pp. 239-243). IEEE.

Deng, S., & Sakurai, A. (2013, March). Foreign exchange trading rules using a single technical indicator from multiple timeframes. In *2013 27th International Conference on Advanced Information Networking and Applications Workshops* (pp. 207-212). IEEE.

Vajda, V. (2014). Could a trader using only "old" technical indicator be successful at the forex market?. *Procedia Economics and Finance*, *15*, 318-325.

BabyPips.com. (2016). *Learn Forex Trading at School of Pipsology*. https://www.babypips.com/learn/forex

Appendix A: Trading Journal

Trade	Profit/Loss	Net Total	Lot Size	Profit
1	0	50	1	0
2	-0.0186	49.98	20	-0.02
3	-0.0018	49.97	10	-0.03
4	-0.024	49.95	50	-0.05
5	-0.2698	49.68	120	-0.32
6	-0.3025	49.38	400	-0.62
7	-0.486	48.89	200	-1.11
8	-0.116	48.77	100	-1.23
9	-0.269	48.5	100	-1.5
10	-0.37	48.13	100	-1.87
11	-0.974	47.15	200	-2.85
12	0.078	47.23	200	-2.77
13	0.145	47.37	100	-2.63
14	-1.8037	45.56	400	-4.44
15	-0.6394	44.93	400	-5.07
16	-0.4072	44.52	400	-5.48
17	0.8232	45.34	500	-4.66
18	0.0226	45.36	1000	-4.64
19	0.1051	45.47	138	-4.53
20	0.3258	45.79	500	-4.21
21	0.4775	46.27	500	-3.73
22	-0.0357	46.24	1000	-3.76
23	0.04	46.28	1000	-3.72
24	-3.52	42.76	2000	-7.24
25	-0.9473	41.81	2000	-8.19
26	-0.3034	41.5	950	-8.5
27	-0.7553	40.75	1000	-9.25
28	5.0373	45.73	1930	-4.27

29	2.57	48.3	500	-1.7
30	3.42	51.67	750	1.67
31	0.088	51.69	2200	1.69
32	2.3337	54.02	830	4.02
33	2.55	56.57	2500	6.57
34	6.7157	63.28	1300	13.28
35	0.0502	63.33	1400	13.33
36	-0.88	62.45	1000	12.45
37	0.4275	62.88	750	12.88
38	0.24	63.12	1000	13.12
39	0.3648	63.48	1400	13.48
40	-2.0194	61.46	1500	11.46
41	-1.3656	60.09	1400	10.09
42	0.8933	60.98	1300	10.98
43	-0.9096	60.07	1000	10.07
44	0.56	60.63	1000	10.63
45	0.1453	60.77	950	10.77
46	2.0236	62.79	3000	12.79
47	0.52	63.31	1000	13.31
48	-1.2025	62.11	1000	12.11
49	0.387	62.5	900	12.5
50	-1.3764	61.12	1000	11.12
51	0.6373	61.76	1000	11.76
52	-0.6939	61.06	1400	11.06
53	0.375	61.37	2500	11.37
54	0.5145	61.88	1500	11.88
55	3.18	65.06	2000	15.06
56	4.375	69.42	2500	19.42
57	0.675	70.03	2500	20.03