June 2017

Trading System Development

David Francis Zielinski  
*Worcester Polytechnic Institute*

Muhaimin Islam  
*Worcester Polytechnic Institute*

Obianuli Ebubechukwu Obiora  
*Worcester Polytechnic Institute*

Follow this and additional works at: [https://digitalcommons.wpi.edu/iqp-all](https://digitalcommons.wpi.edu/iqp-all)

**Repository Citation**


This Unrestricted is brought to you for free and open access by the Interactive Qualifying Projects at Digital WPI. It has been accepted for inclusion in Interactive Qualifying Projects (All Years) by an authorized administrator of Digital WPI. For more information, please contact digitalwpi@wpi.edu.
Trading System Development

An Interactive Qualifying Project
Submitted to the Faculty
Of

In Partial Fulfillment of the requirements for the
Degree of Bachelor of Science

By:
David Zielinski
Obi Obiora
Muhammad Islam

Submitted to:
Professors
Michael Radzicki
Fred Hutson
Acknowledgements

We would like to thank Professor Michael Radzicki, and Professor Fred Hutson for the wisdom and guidance throughout this IQP.
Abstract:

The purpose of this Interactive Qualifying project is to investigate different aspects of trading systems and combine different strategies from different traders to come up with a trading system that is able produce profits each year. To accomplish this goal members of the group researched fundamental concepts and theories about trading and how to develop a trading systems. In our case both manual and automated trading strategies were employed. Team members then scientifically developed their own systems so that an ordinary citizen can follow and implement the work that is done. Members allocated funds to different asset classes upon discussion with the team and all the trade information including our rational to take certain trades is logged. Our team used data technical and fundamental analysis to execute trades. We finally analyzed the performance of system as a whole.
Chapter 1:

Introduction

In today's world of faster communication and the wide usage of the internet, people have been taking more control of their financial goals by trading and investing online. People can use trading platforms such as Trade Station or E-Trade in order to take advantage of the analytical indicators to evaluate the charts of stocks or Forex to spot potential trends.

However, even though so many of these websites claim that it's so easy to trade with these platforms even a baby could do it, one would need to learn much more about the markets, and how they move in order to turn a profit. One would need to take into account many factors such as the news, new products from the company, and state of the economy among many other things.

This project is currency based because some of our team members plan to employ the strategies learnt from this project to real currency trading upon completion of this project. In the case of stocks under the current regulations one needs to have at least $25,000 in his/her account to day trade but in the case of currency the amount is much smaller. It was optimal to use currency to as it is possible to have a small account and still day trade with currency. The report discusses the testing processes and analysis results that shaped our system and our learning process while working on this project.

In addition to trading stocks in the U.S., people are now able to trade currencies in the Foreign Exchange Market, or Forex Market, through the use of the online trading platforms.
Through Forex, people can take advantage of the fluctuating exchange rates in order to buy one currency pair at a low rate, and sell back at a higher rate. Forex and other asset classes will be discussed later in this report.

Our team used a combination of both manual and automated trading systems on both the stock market and the Forex market. The systems that we had researched prior to building our own consisted of automated trading strategies, or a strategy that involved fundamental analysis or manual trading. We used these systems as a starting point to investigate strategies to trading that would work well in relation to our goals.

One of our goals in building our system was to develop a diversified system of systems in order to balance out any losses one teammate might have encountered. One member of our team focused completely on stocks, using fundamental analysis to invest long-term in companies in which he thought would succeed. The other two members of our group focused on the Forex market, using a combination of manual trading and automated trading over shorter periods of time, taking advantage of the volatility of the market to turn a profit.

By taking into account all the factors that influence the markets, and learn how to use indicators to place trades, anyone is able to try their hand in the trading market, and have the potential to make a decent profit from trading and investing.
Chapter 2:

Trading and Investing

Although the words Trader and Investor are used interchangeably there are differences when it comes to what it means to be a trader or an investor. There are also differences in mindsets of a trader and the mindset of an investor to that matter.

Trading and Investing are two very different methods of attempting to profit from the financial markets. The goal of investing is to gradually build wealth over an extended period of time through buying and holding a portfolio of stocks, basket of stocks, mutual funds, bonds and other investment instruments. Investors often enhance their profits by compounding or reinvesting their profits and dividends into additional shares of stocks. Though the market fluctuates investors think that the price will rebound and losses will be eventually recovered. Investors are typically more concerned about market fundamentals, such as management forecasts and price/earnings ratios etc.

Trading on the other hand involves the more frequent buying and selling of stocks, commodities, currency pairs or other instruments, with the goal of generating returns that outperform buy-and-hold investing. While investors may be content with a 10 to 15% annual return, traders might seeks a 10% return each month. Trading Profits are generated through buying at a lower price and selling at a higher price within a relatively short period of time. However, the reverse is true as well in that case trading profits are made by selling at a higher price and buying to cover at a lower price to profit in failing markets. Traders also use a trailing
stop to stop loss order automatically losing positions within a specified period of time and often use a protective stop loss order to automatically close out losing positions.

Traders often employ technical analysis tools to employ technical analysis tools such as moving averages and stochastic oscillators to find high profit probability trading setups. There are style difference in traders as well. A trader’s style refers to the timeframe of the holding period of the position that the trader is holding. Traders generally fall into the following category:

- **Position Trader** – positions are held from months to years
- **Swing Trader** – positions are held from days to weeks
- **Day Trader** – positions are held throughout the day only with no overnight positions
- **Scalp Trader** – positions are held for seconds to minutes with no overnight traders

**Pros and Cons**

Both of these strategies (Trading and Investing) to make money in the Financial Market has pros and cons.

Making long term investments requires knowledge of company’s’ financial essentials, understanding Free Cash flows, Discounted Cash flow valuations, Relative valuation multiples etc. Although one can have the opportunity to make a lot profit with trading it is possible to lose a lot of money in trading. The risk in Trading is higher than the risk in investing. One can lose more money in
Day Trading Pros and Cons

Pros

- **Potential to make substantial profits**: The biggest lure of day trading is the potential for spectacular profits. However, this is May only be a possibility for the rare individual who possesses all the traits—such as decisiveness, discipline and diligence—required to become a successful day trader.

- **Be your own boss**: The day trader works alone, independent from the whims of corporate bigwigs. He can have a flexible working schedule, take time off whenever needed, and work at his own pace, unlike someone on the corporate treadmill.

- **Never a dull moment**: Long-time day traders love the thrill of pitting their wits against the market and other professional’s day in and day out. The adrenaline rush from rapid-fire trading is something that not many traders will admit to, but is a big factor in their decision to make a living from trading, compared with spending their days selling widgets or poring over numbers in an office cubicle.

- **Expensive education not required**: For many jobs in finance, having the right degree from the right university is a prerequisite just for an interview. Day trading, in contrast, does not require an expensive education from an Ivy League school. While there are no formal educational requirements for becoming a day trader, courses in technical analysis and computerized trading may be very helpful.

- **Self-employment benefits**: As a self-employed individual, a day trader can write off certain expenses for tax purposes, which cannot be claimed by an employed individual.

---

Cons

- **Risk of substantial losses**: In an investor publication titled "Day Trading: Your Dollars at Risk," the U.S. Securities and Exchange Commission points out that, "...Day traders typically suffer financial losses in their first months of trading, and many never graduate to profit-making status." (SEC, 2005) While the SEC cautions that day traders should only risk money they can afford to lose, the reality is that many day traders incur huge losses on borrowed monies, either through margined trades or capital borrowed from family or other sources. These losses may not only curtail their day trading career, but also put them in substantial debt. (http://www.investopedia.com/terms/m/margin.asp)

- **Significant start-up and ongoing costs**: Day traders have to compete with high-frequency traders, hedge funds, and other market professionals who spend millions to gain trading advantages.(references hedge funds and High Freq. Traders). In this environment, a day trader has little choice but to spend heavily on a trading platform\(^3\), charting software, state-of-the-art computers, and the like. Ongoing expenses include costs for obtaining live price quotes and commission expenses that can add up because of the volume of trades.

- **Be your own boss**: To really make a go at it, a trader must quit his day job and give up his steady monthly paycheck. From then on, the day trader must depend entirely on his own skill and efforts to generate enough profit to pay the bills and enjoy a decent lifestyle.

- **High stress and risk of burnout**: Day trading is stressful because of the need to watch multiple screens to spot trading opportunities, and then act quickly to exploit them.

\(^3\) [http://www.investopedia.com/terms/t/trading-platform.asp](http://www.investopedia.com/terms/t/trading-platform.asp)
This has to be done day after day, and the requirement for such a high degree of focus and concentration can often lead to burnout.

Swing Trading Pros and Cons

Pros

- *Does not have to be your full-time job*: Anyone with the knowledge and investment capital can try swing trading. Because of the longer timeframe (from days to weeks as opposed to minutes and hours), trades do not have to be constantly monitored. A swing trader can even maintain a separate full-time job (as long as he or she is not checking trading screens all the time at work).

- *Potential for significant profits*: Trades generally need time to work out, and keeping a trade open for a few days or weeks may result in higher profits than trading in and out of the same security multiple times a day.

- *Constant monitoring not required*: The swing trader can set stop losses in place. While there is a risk of a stop being executed at an unfavorable price, it beats the constant monitoring of all open positions that is a downfall of day trading.

- *Less stress and risk of burnout*: Since swing trading is seldom a full-time job, there is much less chance of burnout through stress. Swing traders usually have a regular job or other source of income from which they can offset or mitigate trading losses.

---

4 http://www.investopedia.com/articles/active-trading/052815/pros-cons-day-trading-vs-swing-trading.asp#ixzz4dnmPSpp6
• **Expensive investment not required:** Swing trading can be done with just one computer and conventional trading tools. It does not require the state-of-the-art technology of day trading.

**Cons**

• **Higher margin requirements:** Since swing trading usually involves positions held at least overnight, margin requirements are higher. Maximum leverage is usually two times one's capital. Compare this with day trading where margins are four times one's capital.

• **Risk of substantial losses:** As with any style of trading, swing trading can also result in substantial losses. Because swing traders hold their positions for longer than day traders, they also run the risk of larger losses.

**Cycle and Trend**

In the economy, there are cycles of expansion and contraction, also called growth and recession, respectively. These two periods are seen through indicators such as employment, GDP, personal income, and industrial production among many others. Since 1945, there have been 11 business cycle with the last one ending in 2009. Each cycle averages around 69 months, with the period of expansion lasting around 58 months, and contraction lasting only 11. The reason for the great differences in the duration of each cycle is that the economy is always in a natural state of growth.  

The figure below shows a general form for each business cycle. The graph starts during a period of expansion where the economy is growing. When this period starts to end, the growth slows and the economy hits a peak. At this point, the economy starts to drop well below the

---

5 [http://www.investopedia.com/terms/t/trend.asp?ad=dirN&qo=investopediaSiteSearch&qs=0&o=40186](http://www.investopedia.com/terms/t/trend.asp?ad=dirN&qo=investopediaSiteSearch&qs=0&o=40186)
peak and the economy is said to be in recession. The recession then starts to slow until it hits a bottom limit, or a trough. At this point, the default mode of expansion takes over and the economy starts to grow again during a time of recovery in which the economy returns back to the point at which it started to drop. Once the economy surpasses the peak of its previous expansion period, a new period of expansion is said to have taken place and the cycle repeats.

![Phases of the Business Cycle]

Figure 2.1 Phases of the Business Cycle

Trends differ from cycles in that within a certain cycle, there are trends that occur for shorter periods of time. Traders usually focus on the trends of a market such that they will go long on a trade during an uptrend because they are expecting more growth and their purchase will rise in value. Conversely, traders will short in a downtrend speculating that the price will continue to drop. However, investors focus more on the cycle of the economy. Given that investors will place trades for a longer period of time, they care more about the long term trend of the economy rather than the local uptrends and downtrends.

---

6 http://www.investopedia.com/terms/p/peak.asp
7 http://www.investopedia.com/terms/t/trough.asp
Four Asset Classes and Inter Market Analysis

Equities:

There are many different types of equities that exist in the financial world. The main equity in focus will be stocks. Stocks are essentially ownership in a company. Stocks are traded on stock exchanges like the New York Stock Exchange, as well as other exchanges all over the world. The prices of stocks fluctuate in relation to the status of a company. If a company continues to do well and is turning a profit, the prices of the stocks will continue to rise, and the opposite occurs if the company is doing poorly. The price of stocks also fluctuate with the news. The announcement of a new product, or some scandal that has gone on in the company will impact the price of the company’s stock positively or negatively respectively.  

Bonds:

Bonds are issued by an entity, which borrows funds from outside parties that are to be paid back with a fixed interest after a pre-defined period. When an entity such as a company, municipality or sovereign government wants to raise funds, they are able to issue bonds directly to investors instead of going to the bank for a loan. The entity will issue a bond that contractually states what the interest rate (coupon) is, and defines the date on which the funds (bond principal) must be returned. This date is called the maturity date.

---

8[http://www.investopedia.com/terms/e/equity.asp?ad=dirN&qo=investopediaSiteSearch&qs=0&o=40186](http://www.investopedia.com/terms/e/equity.asp?ad=dirN&qo=investopediaSiteSearch&qs=0&o=40186)
There are a variety of bonds that can be issued by entities. The first type is called zero-coupon bond. This bond does not offer regular coupon payments, instead they are given out at a discount and will be repaid at their face value on the maturity date. Second are convertible bonds. Convertible bonds are bonds in which an option allows the bondholder to convert the unpaid bond into stock if they so choose. Lastly, callable bonds are bonds that have the risk of being called back due fluctuation of the interest rates. 

Currencies:

A currency is a generally accepted form of money that is issued by the government and used almost universally within an economy. Currency can come in the form of coins and paper notes and are the basic medium of exchange for commodities in a country. Currencies usually differ from country to country with the exception of the euro, which is the accepted currency for all European countries. Usually the central banks of the country have the sole right to produce and issue money into circulation.

Currency is traded by investors on the Foreign Exchange market or Forex for short. This market takes advantage of the fluctuating exchange rates between currencies. Investors and Traders know how buy and sell currencies in order to turn a profit.

Commodities:

---

9 http://www.investopedia.com/terms/b/bond.asp?ad=dirN&qo=investopediaSiteSearch&qs=0&o=40186
10 http://www.investopedia.com/terms/c/currency.asp?ad=dirN&qo=serpSearchTopBox&qs=1&o=40186
Generally speaking, a commodity is a basic good that is can be interchanged with other commodities of similar types. Different producers may produce the same commodity, however, the quality of the product may differ. The minimum standard that a commodity needs to meet is called the basic grade. One example of a commodity that can be traded is oil. Oil can be produced by many different companies, and even though the product quality is not always the same, it is still the commodity oil. Other examples of commodities include gold, silver, other natural materials, as well as things like grains and corn. Commodities can also include things such as currencies and indices, and go so far as to include cell phone minutes and other intangibles. (Investopedia)

Commodities are usually bought and sold via futures contracts. These contracts standardize the quantity and minimum quality of the commodity in question. For example, one oil contracts is for 1,000 barrels of crude oil, and also states the minimum requirement of the quality of the oil in order to fulfill the future contract. 11

Futures contracts are traded by two different groups of traders. The first of the traders and the buyers and producers. These types of traders are the ones responsible for producing or taking the physical commodity and paying for it. For example, if an oil producer is afraid that the price of crude oil will drop in the near future, the producer will enter into a future contract with a buyer to sell the oil at a specific price on a specific date. This is how the oil producer is able to manage his or her risk and still produce a profit.

The second type of futures traders are speculators. These traders never intend to buy the actual product, but are interested in profiting from the volatility of the market. These speculators buy a contract, and sell it back at a higher price in order to turn a profit.

Intermarket Analysis:¹²

Intermarket analysis is a type of technical analysis in which the relationships between the four asset classes assessed. In general, the U.S. dollar and commodities trend in opposite directions, commodities and bonds trend in opposite directions, and stock prices and bond prices trend in the same direction.¹³ However, in different market conditions, these relationships are not always true.

An inflationary market is caused by the price of commodities rises, and subsequently pushes the price of goods upward. Due to the inflation, interest rates begin to rise, and due to this rise. Because the relationship between bond prices and interest rates is inverse, the result of rising interest rates caused the price of bonds to fall. Prices of bonds and stocks are positively correlated this means price of bonds and stocks are

The overarching asset class that affects the others is the price of commodities. The price of commodities affect bonds, which in turn affect stocks. Because the USD and commodity prices generally trend in opposite directions, when the USD drops with respect to other currencies, the price increase is seen in commodities. (Investopedia)

¹²http://www.investopedia.com/terms/c/commodity.asp?ad=dirN&qo=investopediaSiteSearch&qs=0&qo=40186
¹³ Inter-market Analysis & Sector Rotation Michael J. Radzicki PhD
However, the relationships listed above are not always correct. Some of the relationships will change and become inverse or become positive relationships when the economy becomes deflationary. In this type of environment, there shows an inverse relationship between stocks and bonds, inverse between commodities and bonds, a positive relationship between stocks and commodities, and an inverse relationship between the USD and commodities.

Intermarket analysis is not used to give a specific buy or sell signal, rather it is used to confirm trends of the four asset classes. By doing intermarket analysis, one can spot potential trend reversals and act accordingly with any positions held.

How Businesses Respond to the Business Cycle

The economy fluctuates over time in periods of expansion and recession. These periods are reflected in the increase or decrease of indicators such as employment, personal income, and production. The dates for each cycle are determined by the National Bureau of Economic Research or NBER.

Business cycles do not occur over a predefined period. Each cycle consists of four phases, expansion, peak, contraction, and trough. These phases do not occur at regular intervals. The average period of growth is around 58 months, while the average period of recession is 11 months, making the average cycle last around 69 months. Between 1945 and 2009, there have been 11 cycles with the last cycle ending with the Great Recession between 2007 and 2009. In 2009, the recession hit a trough, and the economy started to grow again.
Recessions can take a tremendous toll on the stock markets, and cause markets around the world to decrease. For example, during the great recession in 2007, world markets dropped over 50% in just 18 months, which is comparable to the drop during the Great Depression in the 1930's. 14

Advantages and Disadvantages

Although one is able to trade each of the four asset classes, there are advantages and disadvantages to each of them. Liquidity is one of the factors to consider when trading. Liquidity15 is the degree to which an asset can be bought or sold in the market without change in price. The four asset classes, stocks, bonds, currencies, and commodities, are liquid. This can be taken as a good thing, because when the average person trades, they can expect that the price of the asset will not fluctuate greatly, so the assets can be much more predictable. This predictability allows for the indicators to be used in trading systems to spots trends and execute trades.

Buying on margin is another aspect of trading that can be very beneficial to traders who do not have the funds to buy as much of an asset as they want. Buying on margin is basically taking a loan out to pay for an asset. When buying on margin, one must put a down payment, somewhere between 25% and 40% of the price one plans to spend. Even though this may seem like a foolproof way to trade, there is a catch. Usually brokers mandate that one keeps a minimum balance in the margin account for maintenance. This amount is regulated by the Federal Reserve’s Regulation T. This regulation states that an investor must put down an initial payment of 50% to enter any trade. Secondly, at any given time during the position, the investor must have at least 25% equity in the account. If the equity in the account falls below 25%, the broker may


15 http://www.investopedia.com/terms/l/liquidity.asp
issue a margin call. A margin call\textsuperscript{16} is a demand issued by the broker that says that the investor must put more equity into the account until it reaches the minimum equity needed to reach the maintenance cost of the margin account.

**Taxing Asset Classes:**

All four of the major asset classes are subject to taxes under federal law. No matter what kind of asset one holds, or how long it is held, there are always taxes that are taken from one’s profit.

For stocks, bonds and commodities, the investor owes a capital gains tax on any profit made when the stock is held over one year. The amount the investor is taxed is based on one’s specific tax bracket. For example, investors falling into the 10-15\% tax bracket, don’t pay any capital gains taxes, but everyone else must pay at least 15\%, and anyone who makes over $400,000 per year pays 20\% of his or her profit. In addition, if the asset is held for less than one year, the investor must pay an income tax on the profits, which is significantly higher than capital gains tax. This gives investors a reason to invest for a long time, rather than to trade short term. Although this may seem like a lot, there is a clause in the Federal Income Tax Regulations that states that up to $3,000 in losses may be used to offset one’s taxes. This provides for some kind of incentive if someone is not able to turn a profit, but still invests money.\textsuperscript{17}

\textsuperscript{16} \url{http://www.investopedia.com/terms/m/maintenancemargin.asp}

\textsuperscript{17} \url{http://time.com/money/collection-post/2791159/how-are-stocks-taxed/}
\url{https://www.thebalance.com/filing-taxes-on-commodities-trading-809335}
\url{http://www.traderplanet.com/articles/view/164104-how-currency-traders-can-reduce-their-taxes/}
Taxation for currencies trades a little different from stocks, bonds, and commodities. Although the capital gains and income taxes still apply to trading currencies, traders are able to opt out of this form of taxation via Section 988 of the Internal Revenue Code and adopt section 1256. This section states that Forex traders are subject to much lower income taxes on trades in the Forex market. However, this section also states that Forex traders are not able to claim losses on their federal taxes, leaving much more room for error and loss of money.\textsuperscript{17}

**Account Requirements and Position Sizing.**

For someone who wants to start trading and investing on their own must know about the minimum amount needed in his or her account at any given time. Per the Office of Investor Education and Advocacy, a day trader trading stocks cannot have any less than $25,000 in his or her account at one time. If the account falls below this value, the trader will not be able to place any more trades until the account is replenished up to or over $25,000. As a way of protecting oneself from falling under the minimum, it is recommended to start with at least $30,000 in the account. With this account size, the trader is able to buy on margin up to four times what is in his or her account. Buying on margin, as said previously, can go a long way in turning a profit in the stock market.

Forex accounts, on the other hand, are very different from stock market accounts. There is not legal minimum amount required in order to start trading on the Forex market. This is one of the reasons why the Forex market is much more accessible than the stock market. Although there is no minimum required by law, most brokers require that an initial balance of $100 is deposited in order to open an account.
Although there is not a legal limit one can place on a specific trade, it is widely standard that a trader only risks 1% on a single trade. For example, with a stock market account size of $30,000, only $300 can be risked at one time. Similarly, for an account size of $100 in a forex account, one should risk only $1 per trade. This rule is called position sizing. It is a useful strategy to use because as the trader makes more, and has more in the account, he or she is able to risk more per trade for a bigger payoff, or vice versa given a smaller account.  

Sector Rotation

The economy is made up of three different sectors, Primary, Secondary, or manufacturing, and Tertiary, or Service sector. The Primary sector consists of the extraction of raw materials such as fishing, wool, oil, and coal. The secondary, or manufacturing sector, is called such because it takes combines raw materials to produce products of a higher value. An example of this is spinning wool, a raw material, to produce a sweater that can be sold at a higher price than the raw material. The tertiary sector, or service sector, is basically the intangible aspect of providing a service that one cannot normally do. These services include banking, insurance, and retail, and can even include tourism and dining.

Financial institutions such as hedge funds or investing funds are very good at diversifying their portfolios to include a small piece from each of each of the sectors of the economy, and small pieces from each of the four asset classes. In this way, they can balance their losses by counting on a different sector or investment to provide some type of gain.

---

18 https://www.thebalance.com/minimum-capital-required-to-start-day-trading-stocks-1031142
http://www.investopedia.com/terms/p/positionsizing.asp
https://www.thebalance.com/minimum-capital-required-to-start-day-trading-forex-1031370
Sector rotation is a strategy that is focused on moving money to different sectors of the economy in order to beat the trends. This type of strategy was developed by the NBER based on data that was gathered dating back to 1854.

The NBER releases data that can be interpreted to gather much insight on the state of the economy, and determine which of the four stages the market is in. Although the market cycle is similar to the economic and business cycles, the market cycle attempts to predict the future state of the economy from three to six months beforehand. Financial Institutions use the data from the market cycle in order to allocate funds to the four sectors of the economy to beat the trends that they think will be coming. 

Fundamental and Technical Analysis:

Although there is no definitive answer whether technical analysis can be used as a whole substitution for fundamental analysis, there is little doubt that combining the strengths of both strategies can help investors better understand the markets and gauge the direction in which their investments might be headed. In this article, we’ll look at the pros and cons of technical analysis and the factors that investors should consider when incorporating both strategies into one market outlook.

19 http://www.investopedia.com/articles/trading/05/020305.asp
20 http://www.economicshelp.org/blog/12436/concepts/sectors-economy/
21 Blending Fundamental and Technical Analysis, Investopedia
This section will give you (the reader) a brief overview of the stock market and how to interpret its behavior in a very general sense. But first let’s discuss what exactly a stock exchange is and how it works. A stock exchange is a marketplace connecting stock buyers and stock sellers, this is important to note because a stock exchange does not own shares. Although the average American will likely use a broker to place orders at an exchange, if you made the drive to the New York Stock Exchange and met all the requirements, you would be able to conduct trading yourself on the floor. Stock Exchanges give people a place to liquidate their shareholdings, an idea backed by the fundamentals of supply and demand. In order to set stock prices, exchanges will track the supply and demand for a particular stock ultimately determining its price. Additionally many exchanges most notably the New York Stock Exchange provide several protections for investors by ensuring that companies meet a set of minimum requirements before having a listing on the exchange a well having a market capitalization of 40 million USD.

With this covered we can now discuss ways to determine how the “market” is performing. In general we use three terms to discuss performance, upward trending, downward trending, and trading sideways. As you may have guessed trending upward or downward refers to the whether or not the market as a whole is doing well. For example if the market is gaining “points” over a prolonged period of time we could say that the market is trending upward. Breaking this down to its most basic definition, it means that the average price of all the stocks for sale is going up. By contrast in a downward trending market we saw the opposite effects, with markets losing points and average stock prices falling. The last term listed above was sideways trending. A market that is experiencing a sideways trend is neither trending upward nor downward. The market may gain or lose points so often that the net effect is a situation where the market remains largely the same and stock prices on average trade at near above or below the same levels consistently. Again these terms help us describe very generally how the market as a whole is performing. However,
in-order to attain deeper understanding of how the different sectors which make up the market are performing, analysts track what we call indexes. These indexes are composed of different large companies and typically help us understand how different sectors as a whole are performing. Some of the most notable of these indexes are the Dow Jones Industrial Average, and the S&P 500. Additionally, investors may seek to understand the behavior of the market by using technical analysis. This form of analysis involves using raw data and drawing conclusions from the data alone. One technique called market breadth tries to gauge the markets direction by looking at the companies who are performing well relative to the companies who are declining. Positive market breadth tells us that more companies are advancing then are declining. Analysts characterize this sort of behavior as bullish. By contrast when more companies are declining relative to advancing companies in the market, the behavior is characterized as bearish.  

Derivatives

Derivatives are a type of financial instrument where the value is determined from an underlying asset. Broken down even further, in investing we typically talk about two forms of derivatives. These are futures contracts and options contracts. Unlike stocks and other equities, derivatives are largely trade over the counter (OTC) and they allow traders especially those who trade internationally to better regulate exchange rates. In order to better understand this idea we will look closely at how both of these contracts work starting first with futures contracts.

Futures Contracts can be looked at as an agreement between two parties (buyer and seller) that a specific good or financial instrument can be bought or sold at a specific price and date predetermined in the contract. The contracts also detail how much of the asset a buyer or

---

22 http://www.investopedia.com/articles/basics/04/092404.asp
http://www.investopedia.com/terms/b/bull.asp
seller must be willing to purchase and sell as well as things like the quality of the goods in question. So how can an individual “invest” by using futures contracts, in other words where does its value come from? To understand this concept we’ll look at a seller of oil. The price of oil is typically volatile, and with time its value can be substantially larger, or the opposite can happen and its value would have decreased. In a case like this, both buyer and seller have something to gain by using a futures contract. As a seller, one would want to ensure that the cost at which they are selling their goods does not fall below a certain point. In order to ensure this a seller might have a futures contract made for buyers to purchase detailing a set amount of barrels he is willing to sell and at what price for a given date. Assuming the price chosen is $70 and the amount of barrels is 50, the seller is looking to make a minimum of $3500. In this case a buyer would only agree to the terms of this contract under the assumption that price of oil at the specified date would be greater than $70 per barrel. If price exceeds the $70 per barrel threshold set by the contract at the date of expiry the seller is still obligated to sell at the price outlined in the contract. Assuming the price of oil was at $75, then the loss here on the part of the seller is about $250. Similarly if the price dropped under by this same increment, the seller would see profit of $250. Depending on the position (long or short) the value of this futures contract could have either been positive or negative $250.

Option contracts work a bit differently and what’s important to note is that there are two common types of option contracts, call and put options. Call options give the owner the right to buy stocks at a certain price called the strike price. For example if shares of Microsoft were trading at $50 and an investor had reason to believe there price would rise substantially over the next month, that investor might look into getting a call option for that particular stock rather than buying the stock outright. The writer of a call option contract usually owns shares in the security detailed in the contract. As a buyer you are required to pay a premium on the call option. The idea here is that if the price does go above your strike price, you have the option to then buy the amount of
shares specified in the call option contract to be sold at market value. The goal here would be for
the investor to recover the premium paid as well as some profit. Conversely a put option gives an
owner of shares the right to sell them at a given price working in the opposite direction. An investor
writing a put option assumes the share price of a stock will decrease over time and is looking to
avoid losing out right. To do this they right a put option giving them the right to sell their stock to
the buyer of that option at the strike price during a given period. If the buyer agrees and the price
falls below the strike price, the seller will still sell shares at the strike price making the difference
between market value equal to the value of the put option contract.

Chapter 3: Trading Systems

There are many different ways to buy and sell stocks, bonds, currencies, or
commodities. The first, and most obvious way, is to invest with a hedge fund, or hire a broker to
use his knowledge to invest the money. The second way is to invest your own money yourself,
but using some sort of trading platform. These trading platforms allow for the average person to
buy and sell one or more of the four asset classes listed above. This provides a lot more
freedom when dealing with your own money.

Brokerage accounts are arrangements between a broker, or “someone who buys and
sells goods or assets for others”\(^\text{23}\), and an investor, or someone who invests money into the
account. Under these types of accounts, there are different types depending on what the
investor wants to do with his or her money.

\(^\text{23}\) * [http://www.dictionary.com/browse/broker](http://www.dictionary.com/browse/broker)
The cash account is a very straightforward account in which the investor must pay in full
the amount due on any transactions. This type of account is owned entirely by the client and is
in his or her name. 24

A margin account differs from a cash account in that the client is able to borrow money
from the broker or fund in order to leverage transactions. In most cases, the client is able to buy
as much as double what he or she could using a cash account. However, the client must sign an
agreement called a hypothecation, which states that the client must put forth an asset as collateral
for taking a loan. The broker also must document that the client has been informed of all risks
associated with this type of account. A margin account must have at least $2,000 in it, while a day
trader’s account must have at least $25,000. 25

Investing Styles:

Investment style refers to different style characteristics of equities and financial
derivatives within a given investment philosophy. The style is determined by personal traits of
the investor for example gender, social status, wealth, tax situation etc. But generally risk/return
ratio assuming rational trading decisions.

There are different asset classes that someone can invest in.

The asset classes that are generally traded in the Financial Market are:

1) Stocks
2) Bonds
3) Options
4) Currency pairs

25 http://www.investopedia.com/terms/h/hypothecation.asp
5) Exchange Traded Funds
6) Mutual Traded Funds

Stocks:

A stock, commonly referred to as equity, is a share of ownership within a corporation. As an owner of a stock the owner has part of the corporation's assets and equities. The stock owner is also entitled to their share of the company earnings have voting rights based on the stock. Stocks are a great way to raise capital through selling an investor a share which are ownership positions. In today's day and age stock certificates are kept electronically at a brokerage this way the stocks are easy to be traded.

Bonds

A bond is a debt investment in which an investor loans money to an entity (typically corporate or governmental) which borrows the funds for a defined period of time at a variable or fixed interest rates. Bonds are used by companies, municipalities, states and sovereign governments to raise money and finance a variety of projects and activities. Owners of bonds are debt holders, or creditors, of the issuer.

When companies or other entities need to raise money to finance new projects, maintain ongoing operations, or refinance existing other debts, they may issue bonds directly to investors instead of obtaining loans from a bank. The indebted entity (issuer) issues a bond that contractually states the interest rate coupon that will be paid and the time at which the loaned funds (bond principal) must be returned (maturity date).  

26 http://www.investopedia.com/terms/b/bond.asp#ixzz4ev58eloc
Options:

An option is a financial derivative that represents a contract sold by one party (the option writer) to another party (the option holder). The contract offers the buyer the right, but not the obligation, to buy (call) or sell (put) a security or other financial asset at an agreed-upon price (the strike price) during a certain period of time or on a specific date (exercise date).

Currency Pairs:

A currency pair is the pricing structure of the currencies traded in FOREX market. The value of a currency is a rate and is determined by its comparison to another currency. First listed in a pair is called the base second listed is called the quote currency. For example, Euro/USD = 1.0682 means to buy 1 Euro one needs to pay 1.0682 USD. In this case Euro is the base currency and USD is the quote currency.

All currency pair trading involves simultaneous buying of one currency, and selling of another currency. When one buys a currency pair, the base currency is bought, and the quote currency is sold. The opposite occurs when one sells the pair, the base currency is bought back, and the quote currency is sold.

Major currency pairs are the most popular currency pairs traded daily in the Forex Market. These pairs include EUR/USD, GBP/USD, USD/JPY, USD/CHF.

The forex market is traded almost exclusively online through platforms such as TradeStation or E-Trade. Because of the unlimited access, the Forex markets stay open 24/7 and are able to be traded at any time of any day. Even though the markets are always open, the currency pairs do not always show volatility. The times that show the most volatility in the forex markets are at the openings of the world’s major stock markets.
This chart shows the opening hours for the four major markets around the world. There is increased volatility in the Forex markets during the openings of each of these markets, with even more volatility during the London, New York overlap.

**Exchange Traded Funds:**

An ETF, or exchange traded fund, is a marketable security that tracks an index, a commodity, bonds, or a basket of assets like an index fund. Unlike mutual funds, an ETF trades like a common stock on a stock exchange. ETFs experience price changes throughout the day as they are bought and sold. (Ken Hawkins)

---

Mutual Funds:

A mutual fund may choose to focus its portfolio on a particular type of security or combine types of securities as an investment strategy. No matter what it invests in, a mutual fund is considered a marketable security, because it can provide a financial return and is highly liquid.

Time Frames

Day trading

Day trading is basically defined as buying and selling assets within a single day, without carrying the positions over to the next day. This time frame is most popular among traders in the stock and Forex markets. Day trading takes advantage of small price movements over a small time frame by using both high leverage, and strategies designed for short term trading. Although this may seem like a no-brainer for traders who don’t want to spend a lot of time in the market, day trading has a very high risk if one does not have the appropriate knowledge to trade.

The day trader must first need to possess a significant knowledge of trends. This knowledge can come from recognizing trends or using indicators to spot trends that are about to happen. A good trader will know how to use indicators to their advantage and profit from them. Secondly, a trader must have sufficient capital. In other words, a day trader must only place trades with money they can afford to lose. This is done with risk management, and position sizing. “Trading should be as boring as watching paint dry.” (M. Radzicki) thirdly, a day trader must have a strategy they will implement. Among day trading strategies are Swing Trading, Arbitrage, News trading, and Acquisitions trading. These systems have
combinations of low medium or high risk paired with medium to high rewards. (These systems will be discussed more in chapter 4.) Finally, a good day trader must possess a high level of discipline. He or she must be able to follow their system without fail every time. Success in day trading is impossible without doing so. For this reason many traders have started to use automated trading systems that place trades automatically (These systems will also be discussed later on).

Stock Investing Styles

There are several different investing styles an investor can use when building a portfolio and each of these styles comes with their own set of advantages and disadvantages. In this section we will briefly discuss a few popular investing styles and some of their pros and cons, starting with Value investing.

Value Investing is defined as a strategy that targets stocks that an investor believes are undervalued. This is to say that there current market value is less than what investors believe it should be based on a company’s long term goals and current available data regarding a company’s finances. In order to understand this strategy it is important consider why there would be a discrepancy in the price of a company’s stock on the market vs. what an investor thinks it should be. Consider Tesla and Uber. Both of these companies have market capitalizations above 40 billion however neither company is considered profitable yet. Although Uber has yet to go public, Tesla is, and currently shares of Tesla are trading at 310 USD per share. A value investor may look at this and state that the company is overvalued. Ultimately this is because the company has not brought in enough revenue to back up the claim made by their evaluation. This however does not stop people from investing in Tesla. The reason being that investors are assuming the company will be able to make good on their investment because of a variety of things most notably what the company’s projections are as far as deliverables and financials. A value investor might
short a stock like Tesla if they had reason to believe the stock was overvalued. However, in most cases value investors like Warren Buffet would rather look for stocks like Square INC (trading at $17 a share) that have strong financials not necessarily reflected in their stock price. Also, keep in mind that stock prices (stated before) are determined by a stock exchange and are priced based mainly on supply and demand.

Growth Investing is a style that focuses on capital gains above all else. An investor using this style would target companies that are likely to outperform their industry in terms of earnings. In this case a company with an extremely high stock price might be chosen because it is expected to be more reliable in terms of turning a profit for investors. This type of strategy works well for a bull market because share prices are increasing and this encourages buying. A strategy some Growth Investors utilize is the CANSLIM strategy created by William J. O’Neil. In this model, each letter of the acronym CANSLIM stands for a factor that an investor should look at when considering what stocks to buy. In order the letters of the acronym stand for Current Quarter Earnings, Annual earnings increase (5 yr.), New Products, management and events, Small supply and large demand, Leader stock choices, Institutional sponsorship, Determining Market direction by checking market averages daily. According to William, an investor should look at these aspects of a company before deciding to buy shares of its stock, furthermore this strategy aligns with the goals of growth investing making it a strategy for growth investors to follow.

The last strategy we will touch on briefly would be a Hybrid system which combines the two investing strategies discussed above. If an investor decides to create a hybrid system out of the two outlined strategies above then it considered a hybrid system because it combines two different strategies. Of course there are many types of hybrid systems that work based on other styles of investing, but what makes them Hybrid systems, is the combination of multiple styles of investing.
Logic:

Support and Resistance

A support level is a level where the price tends to find support as it falls. This means the price is more likely to "bounce" off this level rather than break through it. However, once the price has breached this level, by an amount exceeding some noise, it is likely to continue falling until meeting another support level.

A resistance level is the opposite of a support level. It is where the price tends to find resistance as it rises. This means the price is more likely to "bounce" off this level rather than break through it. However, once the price has breached this level, by an amount exceeding some noise, it is likely to continue rising until meeting another resistance level.

If a stock price is moving between support and resistance levels, then a basic investment strategy commonly used by traders, is to buy a stock at support and sell at resistance, then short at resistance and cover the short at support. The strategy is described in the following charts:

Figure 3.2: Support and Resistance levels
Trend Following Strategies:

Trend following strategy traders attempt to isolate and extract profits from trends. There are multiple ways to make a trend following strategy. There are certain indicators that have stood the test of time and remained popular for trend traders. Some of the popular trend following strategies are:

1) Moving Average Crossover
2) MACD (Moving Average Convergence Divergence)
3) RSI (Relative Strength Index) Strategy

There are many other trend following strategies. The described strategies below are used extensively in our automated trading systems.
Moving Average Crossover

The moving average crossover strategy is geared toward finding the middle of a trend. A trend defines price action in which prices move in a specific direction over a period of time. Generally, trends are either upward or downward, as sideways movements are considered consolidation and not trends. Most of the time—approximately 70%—capital markets trade in tight consolidative patterns and only trend 30% of the time. With this in mind, it is important to be able to define a trend and jump on as soon as it is recognizable.

A moving average strategy identifies an uptrend and downtrend by having a fast and slow moving average buffer. If the average of the slow buffer is higher than the fast buffer it is a downtrend and a breakdown; the complement of this condition, which is fast moving average is higher than the slow moving average it is breakout and uptrend.28 Uptrends signal a buy signal and downtrends signal a sell signal.

![Simple Moving Average (2-SMA's)](https://www.moneyshow.com/articles/currency-42784/how-to-enhance-your-moving-average-crossover-strategy/)

Figure 3.3: Example of Simple Moving Average Crossover

---

MACD:

The MACD is just the difference between a 26-day and 12-day exponential moving average of closing prices (an exponential moving average or EMA is one where more weight is given to the latest data). A 9-day EMA, called the "signal" (or "trigger") line is plotted on top of the MACD to show buy/sell opportunities.

![MACD Diagram](image)

*Figure 3.4: MACD Example*

Relative Strength Index

Relative Strength Index, or RSI, is a momentum indicator that fluctuates between 0 and 100 providing overbought and oversold signals. RSI readings above 70 signals bullish and 30 signals bearish in general. RSI is calculated based on Gains over the last 13 periods and current gain. 29 When the market is overbought, this tells the trader that it is overvalued and thus, it will start to trend downward. Conversely, when it is oversold, it is undervalued, and will soon start to trend back upward.

Bollinger Bands

Bollinger bands are an indicator used in technical analysis that measure volatility of an asset class. The bands are usually placed two standard deviations above and below the simple moving average. The bands work in a way that when the market becomes more volatile, the bands widen, and when the market is less volatile, they contract.

Figure 3.5: A simple RSI example

---

31 http://www.investopedia.com/terms/b/bollingerbands.asp
Swing Trading:

Swing Trading is a short term trading method that can be used when trading stocks and options. Whereas Day Trading positions last less than one day, Swing Trading positions typically last two to six days, but may last as long as two weeks.

Most of the swing trading strategies are based on a trend following systems. In one of our systems we implement a swing trading strategy where different trend following technical indicators were used as well as fundamental analysis was done to make the strategy have better expectancy. The strategy was automated to save time.  

Long-term position trading

Long-term position trading is employed by investors who believe a company’s stock price will continue to rise with time. Aside from looking at a company’s financials or future deliverables,  

investors who make trades based on gut feeling may also employ this tactic. In the long run this style of trading is advantageous if you’re an investor that can be swayed easily by changes in the market. For example a stock may perform poorly over the course of a few weeks and some investors (day traders typically) may decide to take a trade-off that would have otherwise recovered and matured. In addition, other advantages of this style of trading include low commission costs. This is easy enough to understand as commission is paid per trade, so if a trade is placed once and a position is held for a long-term period, other than any applicable overnight fees, commission costs do not get applied to your trade until you close out your position. This allows an investor to make as much money as possible without paying much commission because only a single trade was placed.

Active Investing

An active investing approach is one in which an investor does not buy and hold onto stocks for a long term period. Rather an investor will pay attention to market data on a daily basis and try to not participate in down swings. This could mean making several trades in a single day which could result in high commission costs. In order to offset this, active investors will likely by larger volumes of stock to capitalize on small upswings in share price.

Personalized Objectives:

- High Annual Return: Most important objective of our system is to have a high annual return around 10%. To achieve that, we need high winning percentage of our trades as well as a robust system for different markets.
• Short Term Investments: Time Invested: Traders who trade as a hobby or as a side job don’t want to invest a lot of time each day in trading, and would rather do short term day trading.

• No Losing Trades: Some investors do not want to lose any money, and will make it an objective that they don’t have any losing trades. However, this rule may make the entry and exit rules too strict that trades are never even placed.

• No Overnight Trades: With some asset classes, including currencies, there is a fee or adjustment cost when trades are held overnight. This is a place where there can be a needless loss of money.

• Good Risk Reward Ratio.

A typical system will have personalized objectives or goals that will act as a measure of the systems performance. There are lots of different objectives that systems can designed to achieve and in this section we will cover some of the various objectives starting with High Winning Percentage.

A system that is geared for high winning percentages will be built with metrics that allow it to differentiate between stocks and other equities that will yield positive returns vs. those that will yield negative returns. These systems are more robust than say a High Annual return system because they will try and eliminate the possibility of down swings and close out positions if they detect that a downswing will occur. Conversely, a system geared for High Annual Return may operate on metrics that allow it to determine which stocks will show the most grown over a year. At the same time the system must also determine how to best allocate money across the stocks it selects in order to maximize return on investment for investors as well. Other systems are designed to be robust across different markets. For example the tech sector or the real estate sector. Systems that are robust enough to yield positive returns across different markets must be able to operate on metrics that can be applied more generally and operate without metrics that
are sector specific for the most part. Additionally some systems may not be designed to for performance in terms of max yield, or even max yield across different sectors. Other systems are designed not to hold trades over night (day traders) and some are designed not to spend much time in the market. In summary personalized objectives allow for systems to be unique in what they were designed to achieve.

**Entry Rules:**

Trading systems are simply a collection of rules that work together to execute trades based on indicators that are chosen by the investor. There are different rules that are used based on what kind of system one wants. For example, there are systems that consist of long only rules, and others that are short only, while still there are others that do both.

However, in order to execute a trade, a system needs entry rules and exit rules, each of which are based upon different indicators that an investor may choose. One system specifically is the Bollinger Band Bounce Trade. This system implements Bollinger Bands as an indicator and as a trigger to buy or sell an asset. This system looks at the Bollinger Bands as a type of support and resistance that is used to trade over a ranging market, rather than a market with greater volatility. The entry rule states that when the price hits the bottom band, the price is expected to rise, so the system will tell the user to long. Similarly, when the price hits the top band, it is expected to drop, so the system tells the user to short.

Other entry rules, indicators, and triggers are used without technical analysis, rather, the rules look at a company’s or economy’s performance, the news, and even new products and come up with a way to buy or sell depending on how they feel the company or an economy will perform.
Exit Rules

In addition to entry rules, a complete trading system also requires a set of exit rules it must follow every time the system is utilized. Perhaps more important than entry rules, a systems exit strategy helps protect against outright loss, and over time can help a trader maintain healthy day to day profit margins, however, this is not to say that a systems exit will never allow loss to occur. In order to understand this ideology we look at three scenarios that may cause a typical system to trigger exit protocol, the first of which, is with a profit.

Some systems will automatically exit a position long or short after a set number of bars have passed. An individual employing this exit strategy for their system would likely have seen a recurring pattern for an equity or currency pair giving them reason to believe that they will be able to exit with a profit if they wait the specified amount of bars before exiting. Other with profit exit strategies include end of day exits (used most notably by day traders), as well as profit targets. Defined respectively, a system employing and end of day exit strategy would close out all positions at the end of the day whereas a system using profit target exit strategies would exit as soon as a profit target was hit. Targets can be set as a specific change in dollar amount the equity or currency or as a percentage. Alternatively, automated systems may use trailing stops as an exit strategy in order to minimize loss and maximize profit. Trailing stops are useful because they allow a position long or short to be closed one a set value is reached. Because of this, you can limit loss as well as profit, allowing for a more reliable system.

A second scenario that will cause a system to trigger exit protocol is in the presence of loss. This idea is pretty straight forward however there are different strategies that systems may follow. Systems that follow an exit strategy using end of day stops will automatically close out
positions the end of the day. This might be useful for an investor trading an equity that carries an overnight fee. Other scenarios include systems that close after noticing in-activity in a stock for a set amount of bars.

**Position Sizing Rules:**

To have a successful trading system it needs to have position sizing rules to make the most profit of trades.

Some basic position sizing rules are:

1) Martingale Techniques
2) Anti-Martingale Techniques
3) Fixed Position Sizing

**Martingale Technique:** If an asset class is breaking down or a downtrend the system would increase the size of the position. It is betting strategy hoping that the price of the asset will go up thus the loss will be covered.

**Anti-Martingale Technique:** If an asset class is breaking out or has an uptrend a successful system would increase the position size and in the case of breaking down or a downtrend the system would decrease the size of the position.

Another example of this strategy might be fixed Fractional Position sizing based on the trader’s account.
Manual Trading VS Algorithmic Trading:

To have a successful trading strategy it is important to stick to the system rules that one create for a system. But when one is trading real money in a system it is often hard to follow the system rules for psychological reasons. Depending on one’s character traits it is better to have automated or manual trading strategy.

Manual trading involves executing trades by a click of a mouse, and using the rules of the system no matter what happens. It is often hard to do this due to this because of psychological reasons. One of the biggest drawbacks of manual trading is the hope that a huge loss will turn around before long. In some cases, the trader will refuse to exit the trade, and a trade that may have lost only a small percentage of the initial investment will have lost a much higher percentage. However, not all manual traders are this way. Some manual traders have an innate sense for the market and can “feel it out” and bend their own rules to allow for maximum winnings. One example of bending the rules was told by Professor Hossein Hakim. He said “when you have a winner, let it run” (Prof. Hakim, Personal communication) This essentially means that if you have a high winning trade, keep your position in the market even if your exit rules are met and only exit the position if the asset starts to decline. Manual Trading can be learned, but again, one’s personal traits can have a very large effect on how one trades.

Technical trading, on the other hand, involves implementing an algorithm or computer code to execute trades. The author of the code can make the system do anything he or she wants. The trader can then put the code on, and let it trade the market without even looking at it. This takes out the human element of trading, and makes it solely based on the rules. One downfall to this is that writing code is not as easy as coming up with a system. One would need to learn how to code, and how to apply it to a trading platform, which, in itself, is an entirely different task to accomplish.
Market Orders/Order Types:

A market order is the most basic type of trade order. It instructs the broker to buy (or sell) at the best price that is currently available. There are different kinds of Order types that are used in various markets:

- A market order is an order to buy or sell an asset immediately. This type of order guarantees that the order will be executed, but does not guarantee the execution price. A market order generally will execute at or near the current bid (for a sell order) or ask (for a buy order) price. However, it is important for investors to remember that the last-traded price is not necessarily the price at which a market order will be executed.

- A limit order is an order to buy or sell a security at a specific price or better. A buy limit order can only be executed at the limit price or lower, and a sell limit order can only be executed at the limit price or higher. Example: An investor wants to purchase shares of ABC stock for no more than $10. The investor could submit a limit order for this amount and this order will only execute if the price of ABC stock is $10 or lower.

- A stop order, also referred to as a stop-loss order is an order to buy or sell a stock once the price of the stock reaches the specified price, known as the stop price. When the stop price is reached, a stop order becomes a market order.

- A buy stop order is entered at a stop price above the current market price. Investors generally use a buy stop order to limit a loss or protect a profit on a stock that they have sold short. A sell stop order is entered at a stop price below the current market price. Investors generally use a sell stop order to limit a loss or protect a profit on a stock they own.  

33 https://www.investor.gov/introduction-investing/basics/how-market-works/types-orders
Chapter 4: Optimization and Analyzing Systems:

Walk forward Analysis:

The automatic Walk forward test is a system design and validation technique in which you optimize the parameter values on a past segment of market data ("in-sample"), then verify the performance of the system by testing it forward in time on data following the optimization segment ("out-of-sample").

The amount of data used for a walk forward is very subjective. To do paper trading it is a great way to analyze how the system will behave.  

Monte Carlo Analysis

When analyzing a trading system especially an automated one, it is important for an investor to be able to state with some degree of certainty, the statistical probability that there trading system will produce the results they are looking for. In addition to this, in order to understand how efficient a system is, that same statistical probability question needs to be asked about a variety of different characteristics regarding the trading system and how likely it is to have undesirable results vs. desirable ones. This type of statistical probability study is called Monte Carlo Analysis and it is used by scientists and researchers in a variety of different fields. With regards to trading systems it is important to define the characteristics you are looking at in order to calculate the statistical probabilities your system will have. For example, automated systems may be pre-programmed with a maximum set amount of consecutive losing trades possible. For

34 https://www.amibroker.com/guide/h_walkforward.html
a system programmed in this manner it is possible to determine the statistical probability that loss will occur in day to day trading because there is only a certain amount of loss that can occur before a system quits all together and closes out position ultimately reducing loss for an investor. Additionally another characteristic looked at when conducting Monte Carlo Analysis is maximum possible drawdown. This parameter allows systems to allow for pre-set amount of decline in the value of an investment overtime before closing out the position to avoid loss. Characteristics like this allow for the things like the statistical probability that a system will make some amount (x) of profit to be determined. Additionally to produce this information accurately other factors like equity value, liquidity etc. would also need to be quantified and taken into consideration.

**Value of, and Managing a System of Systems**

In order for a system or a system of systems to have much value to an individual it must be managed accordingly. Furthermore in order to be a robust system capable of producing profits, the system should operate on a portfolio that is diversified which in theory should minimize loss and maximize profits when compared to a system operating on a portfolio much less so. The reason for this being that industries are somewhat interconnected which can cause a chain reactions when one industry leader performs poorly or if some disaster occurs etc. Systems of systems are better equipped to handle these scenarios I they operate of a diversified portfolio because they can activate different systems to compensate for industries performing better than others. The idea here is akin to that of a coach with a team full players. Some players (systems) may perform better some days when compared to others but ideally a coach or in this case investor would like to have their best performing systems active and handling the money. In order

---

35 http://www.investopedia.com/terms/d/drawdown.asp

to do this effectively systems of systems should have monitoring rules in place to decide when a system should be suspended (turned off for a period of time), reactivated (turned on and playing with real money), and at times suspended (disable for good by the system manager). Each of these scenarios requires different parameters to be looked at and analyzed in order to make the decisions described previously. For example if a parameter measuring the tech industry sounds an alarm warning of an impending decline in stocks for that sector, an active system will likely suspend (close all positions) all systems operating on the tech sector primarily. When that same parameter comes back within a given accepted level, the protocol to re-trigger the previously suspended system will be engaged. Additionally actively managed systems of systems will more than likely have some sort of money allocation policy allowing systems who perform better to use more capital than others. This active managing or money allows for profits and losses to be maximized and minimized respectively. In manual trading systems this money allocation logic is typically decided using some form of modern portfolio theory.

Analysis of Trading Systems:

After the developing a system the systems were analyzed with the following metrics to get a better understanding of how the system will do as time progresses. ³⁷

The metrics to analyze the systems are as follows:

- Expectancy
- Annualized Expectancy
- System Quality Number
- Profit factor

³⁷ * All the formulas are from Professor Radzicki’s example Excel file to analyze systems Expectancy, Expectunity
Expected Pay Off

Expectancy is the average amount of return for every dollar at risk. A positive expectancy of a system means the system will make money over time. Negative expectancy means the system will lose money overtime. The formula that used to calculate to expectancy is as follows:

\[
\text{Expectancy} = \frac{\sum \text{return per trade}}{\sum \text{Average Loss per trade}} \frac{\text{Average Loss per trade}}{\text{Number of Trades}}
\]

The higher the expectancy of a system the better it statistically performs.

Annualized Expectancy:

Annualized expectancy is the average amount of return annually for money risked annually.

\[
\text{Annualized Expectancy} = \text{Expectancy} \times \text{Opportunities}
\]

\[
\text{Opportunities} = \frac{\text{Number of Trades} \times 365}{\text{Number of Trading Calendar}}
\]

System Quality Number:³⁸

SQN measures the relationship between the mean (expectancy) and the standard deviation of the R-multiple distribution generated by a trading system. It also makes an adjustment for the number of trades involved. Dr. Tharp has determined that the better the SQN, the easier it is to use various position sizing strategies to meet one’s objectives.

\[
\text{System Quality} = \frac{\text{Exepectancy}}{\text{standard deviation of} \frac{\text{Return Per Trade}}{\text{Average Loss per Trade}}} \times \sqrt[2]{\text{Number of Trades}}
\]

³⁸ www.Vantharp.com
Standard interpretation of SQN is:

Score: 1.6 – 1.9 Below average, but trade-able

Score: 2.0 – 2.4 Average

Score: 2.5 – 2.9 Good

Score: 3.0 – 5.0 Excellent

Score: 5.1 – 6.9 Superb

Score: 7.0 - Keep this up, and you may have the Holy Grail.

SQN Score (System Quality Number Score)

Profit Factor:

Profit Factor is Gross Profit/Gross Loss.

Expected payoff:

Expected payoff is net profit per trade. The formula used to calculate profit factor is:

\[
\text{Expected Payoff} = \frac{\text{Net Profit}}{\text{Number of Trades}}
\]

Chapter 5: Literature Review

Ever since the Forex market has started to be widely used, there have been countless people to trade on it, and thousands of people who have come up with strategies to try to make a profit off currencies. Some simple ones including Simple Moving Average Crossover can be
used in any kind of market with success, but there are others that are specific to the Forex market that, if used correctly, are able to make a large profit.

The first strategy is called the Bollinger Band Bounce Trading System. This system is quite simple in that it trades the obvious trend, and is very straightforward. The Bollinger Band system is to be used in the times when the market has little volatility, and is said to be sideways. The system essentially uses the Bollinger bands as floors and ceilings for the price to bounce off of so traders can make a little money every time. Because this system uses a day trading and looks to only make a small profit, it is said to be a scalping trading strategy. This system works best in a quiet market with not a lot of volatility to disrupt the Bollinger Bands.

The Bollinger Band Bounce trade system is also able to be paired with other indicators, such as Stochastic Bands, Simple Moving Average, and Parabolic SAR to give the system a better chance of surviving in a more volatile market. This can be seen in Baby Pips.com description of their Forex trading system: Simple System 32.

Simple system 32 uses, a simple moving average system, paired with a Parabolic SAR, Bollinger bands, and stochastic. Parabolic SAR is a technical analysis indicator that is used to determine the direction of an asset’s momentum. System 32 first starts by using the Parabolic SAR to recognize a new trend. At the same time, the Bollinger Bands and Stochastic bands are used to see if the asset is over or under valued. The system enters the market when the Parabolic SAR is below the price of the asset, the 100 moving average is heading in the direction of the SAR, and the Stochastics must be below 20. Once the System is in, it puts in a stop loss of 50 pips from the entry price to minimize losses. It will then stay in the market until the exit conditions are met. The exit conditions include taking profit at 50 pips, 100 pips, and 200 pips from initial buy
price. In addition, the system looks for signals that show a change in momentum, in which the system will close the trade, and take the opposite side.  

Based on automated strategy the second trading system was built. The system used fundamental analysis in order to get into trading of a currency pair. Some of fundamental analysis techniques that this system was used was calculating the balance of payment for the nation and GDP of the nation to predict whether the currency would appreciate. After entering the market the system ran a automated swing trading strategy. 

The automated strategy consisted of a moving averages and RSI indicators the position sizing for the system was fixed. The strategy was to buy when the RSI is low (indicates overbought) and moving average is upward and sell when the complement of buy condition occurs. The strategy also used a money management technique that will be discussed extensively in the coming sections. The strategy combined both fundamental and technical trading strategies.

Chapter 6: Trading System #1

Misunderstanding of Objectives:

Due to some unexpected circumstances when I first started this project, I had some misunderstanding of the expectations from this project. Due to these misunderstandings, I went on studying the fundamentals that influence the Forex Market. After studying, I felt like the

---

39 https://www.authenticfx.com/free-forex-strategy.html

40

http://www.investopedia.com/articles/technical/02/042202.asp?ad=dirN&qo=investopediaSiteSearch&qsrc=0&o=40186

information that I getting out was not very useful. My realization confirmed with a meeting with Professor Michael Radzicki, which was almost at the end of term.

**Moving in Baby steps:**

Then, I went on trading with my system that I made with a RSI and moving average cross over strategy in Meta Trader. Unfortunately, at that time I was not a skilled in Meta Trader 4 programming. Therefore, I used an online tool named Forexadvisor.com to make an EA automatically for me.

I ran a back test of the strategy from November 2016 to April 2017 1 minute bars. I had an investment of $10,000 and made around $1500. These results initially made me very happy because you do not have a return of 10% in 4-5 months if you keep your money in the bank that is almost over 20% return in a year.

**Back tested Automated Strategy:**

**Buying Rules:**

1) When 5EMA crosses 12 EMA to upside it is an indication to buy as it is a uptrend.

2) RSI indicator if it is below 30 buy.

3) Place stop loss at 5 pips below crossover stick,

**Selling Rules:**

1) When 5EMA crosses 12 EMA to downside it is an indication to sell as it is a downtrend.

2) RSI indicator if it is above 70 sell.

3) Sell at 2 times the risked money or 10 pips above.

**Getting in touch with Reality:**

However, analyzing the trades of my system as advised by Professor Radzicki’s grading criteria sent to us made me skeptical of my system. The different metrics that I used to take an honest look at the system that I created and made some money. It was apparent that in long
term trading my system statistically would not make money I was just being lucky that I made
money in this system. One of my trades was as large as 1080$ profit.

System Analysis Metrics:
Expectancy: 0.64164
Annual Expectancy: 0.79352
System Quality: 1.2

The numbers did not seem to support my claim and my confidence that this system will
be make money overtime. This realization pushed me to do some research on why my system
was not working.

**Analysis of the apparently failed system:**

One of the mistakes made was not checking for the bars to update in the chart while
checking for trades. As the bar updates where not checked while trading my system used to trade
more than once while the system had the buy/sell condition occurred. This resulted in loosing
trades those were losing more than it should have all together violation of my exit strategies.
Therefore, I had to make a function that checked whether the chart had a new bar.
Beyond, fixing the issue I tried and understood what terms influences the System Analysis Metrics
(Profit Factor, Expectancy, Annual Expectancy and System Quality). Through my research, one
issue seemed to be apparent to have a system that makes money overtime, it was important to
have a good risk reward ratio and have a high percentage at least 45% of winning trades.

**Realization and Improvement:**

After realizing how to improve, the system I assigned myself the task of making an EA that
auto adjusts the Lots so the win loss ratio stays the same all the time. With this logic if I had auto
lot sized my trades all I have to do is find a trigger that produces a wining trade more than risk
reward ratio that I have in place. Keeping this aspect of Trading in mind I searched for a trigger
will give me a correct answer more than my risk reward ratio.
To approach auto lot sizing I first modified my order entry function so that it can modify the lot size automatically based on my fixed risk reward ratio.

**Adaptive Lot Sizing Algorithm:**

In the previous version of the algorithm, the risk reward ratio was fixed. I wanted to make the algorithm in such a way so that the lot sizing was adaptive based on different trading signals. Therefore, making a system that has multiple trade signals finding some signals that had statistically high probability of resulting in a winning trade was important.

In the search of multiple buy and sell trigger I looked at indicators that can give me an overall idea of the trends. So studying from BabyPips I found the Ichmoku Kinko Hyo indicator to be the best fit for my needs as I progressed.

With this Ichmoku Kinko Hyo indicator the indicator buy and sell rules were the following:

**Buying and Selling Rules:**

**Buy:**

When the conversion line or Tenkasen line moves above the base line or Kijun Sen line.

If the close price is above the cloud risk percent will increased 2 times.

**Sell:**

When the conversion line or Tenkasen line moves below the base line or Kijun Sen line.

If the close price is above the cloud risk percent will increased 2 times.

Then for further consistency of my trades, I added another logic to my trade so the Risk percent would increase based on taking long positions when the closing price was above the Cloud. The reasoning behind this strategy was the Kumo. The Kumo is a strong support/resistance area, so when a price is under the Kumo, it could quite easily rebound of it back down again.

I employed this strategy but it was done manually. The results could have been better if the strategy was automated.
Real time Trades:

Although the whole aspect of back testing results seemed to be depressing my system that was automated and manual seemed to perform well in weekly and daily charts. As the number of trades that my system did was not a lot I cannot say it will scientifically make money. But the exciting part of my system was it made around 0.725% profit in a month after I employed it. I realize I was lucky but more improvements should be made so I can be confident that the system that I developed will make money overtime statistically. Due to some bugs in the code that was generated by an automated EA generator online there were issues in my money management in the real time trades. So nothing can be said about the systems expectancy based on the trades.

Real Time Trade Records:

Closed Transactions:

<table>
<thead>
<tr>
<th>Ticket</th>
<th>Open Time</th>
<th>Type</th>
<th>Size</th>
<th>Item</th>
<th>Price</th>
<th>S / L</th>
<th>T / P</th>
<th>Close Time</th>
<th>Price</th>
<th>Commission</th>
<th>Taxes</th>
<th>Swap</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>10816</td>
<td>2017.04.09 23:12:24</td>
<td>buy</td>
<td>0</td>
<td>audus</td>
<td>1.05</td>
<td>806</td>
<td>0.965</td>
<td>2017.04.12 19:15:19</td>
<td>1.06</td>
<td>316</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>10854</td>
<td>2017.05.07 21:45:04</td>
<td>sell</td>
<td>0</td>
<td>audus</td>
<td>0.74</td>
<td>111</td>
<td>0.74</td>
<td>2017.05.08 08:12:57</td>
<td>0.74</td>
<td>212</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>10826</td>
<td>2017.04.17 21:12:34</td>
<td>sell</td>
<td>0</td>
<td>audus</td>
<td>0.75</td>
<td>903</td>
<td>0.75</td>
<td>2017.04.18 02:31:43</td>
<td>0.75</td>
<td>602</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>10825</td>
<td>2017.04.17 17:36:01</td>
<td>sell</td>
<td>0</td>
<td>audus</td>
<td>0.75</td>
<td>985</td>
<td>0.75</td>
<td>2017.04.17 21:12:27</td>
<td>0.75</td>
<td>947</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>10816</td>
<td>2017.05.07 23:28:27</td>
<td>buy</td>
<td>0</td>
<td>eurus</td>
<td>1.06</td>
<td>518</td>
<td>1.06</td>
<td>2017.04.18 15:22:52</td>
<td>1.07</td>
<td>018</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>10854</td>
<td>2017.05.07 21:44:54</td>
<td>buy</td>
<td>0</td>
<td>eurus</td>
<td>1.10</td>
<td>140</td>
<td>1.10</td>
<td>2017.05.07 23:56:24</td>
<td>1.09</td>
<td>640</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
</tbody>
</table>
Closed P/L: 72.50

### Open Trades:

<table>
<thead>
<tr>
<th>Ticket</th>
<th>Open Time</th>
<th>Type</th>
<th>Size</th>
<th>Item</th>
<th>Price</th>
<th>S/L</th>
<th>T/P</th>
<th>Price</th>
<th>Commission</th>
<th>Taxes</th>
<th>Swap</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>10879</td>
<td>2017.05.24</td>
<td>buy</td>
<td>1.00</td>
<td>audca</td>
<td>1.00</td>
<td>0.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>-667.83</td>
</tr>
<tr>
<td>9032</td>
<td>08:55:21</td>
<td></td>
<td>0.00</td>
<td>dpro</td>
<td>913</td>
<td>000</td>
<td>961</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Floating P/L: -649.21

### Working Orders:

<table>
<thead>
<tr>
<th>Ticket</th>
<th>Open Time</th>
<th>Type</th>
<th>Size</th>
<th>Item</th>
<th>Price</th>
<th>S/L</th>
<th>T/P</th>
<th>Market Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10881</td>
<td>2017.05.25</td>
<td>sell</td>
<td>1.00</td>
<td>audca</td>
<td>1.01</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>8358</td>
<td>03:09:43</td>
<td>limit</td>
<td>0.00</td>
<td>dpro</td>
<td>491</td>
<td>000</td>
<td>000</td>
<td>015</td>
</tr>
</tbody>
</table>

### Summary:

<table>
<thead>
<tr>
<th>Deposit/Withdrawal: 10000.00</th>
<th>Credit Facility: 0.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Trade P/L: 72.50</td>
<td>Floating P/L: -649.21</td>
</tr>
<tr>
<td>Balance: 10 072.50</td>
<td>Equity: 9 423.29</td>
</tr>
<tr>
<td></td>
<td>Free Margin: 7 182.20</td>
</tr>
</tbody>
</table>

Details:
### Financial Performance

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Profit:</td>
<td>132.60</td>
</tr>
<tr>
<td>Gross Loss:</td>
<td>60.10</td>
</tr>
<tr>
<td>Total Net Profit:</td>
<td>72.50</td>
</tr>
<tr>
<td>Profit Factor:</td>
<td>2.21</td>
</tr>
<tr>
<td>Expected Payoff:</td>
<td>12.08</td>
</tr>
<tr>
<td>Absolute Drawdown:</td>
<td>0.00</td>
</tr>
<tr>
<td>Maximal Drawdown:</td>
<td>60.10 (0.59%)</td>
</tr>
<tr>
<td>Relative Drawdown:</td>
<td>0.59% (60.10)</td>
</tr>
<tr>
<td>Total Trades:</td>
<td>6</td>
</tr>
<tr>
<td>Short Positions (won %):</td>
<td>3 (66.67%)</td>
</tr>
<tr>
<td>Long Positions (won %):</td>
<td>3 (66.67%)</td>
</tr>
<tr>
<td>Profit Trades (% of total):</td>
<td>4 (66.67%)</td>
</tr>
<tr>
<td>Loss trades (% of total):</td>
<td>2 (33.33%)</td>
</tr>
<tr>
<td>Largest profit trade:</td>
<td>51.00</td>
</tr>
<tr>
<td>Average profit trade:</td>
<td>33.15</td>
</tr>
<tr>
<td>Maximum consecutive wins ($)</td>
<td>4 (132.60)</td>
</tr>
<tr>
<td>Maximum consecutive profit (count):</td>
<td>132.60 (4)</td>
</tr>
<tr>
<td>Average consecutive wins:</td>
<td>4</td>
</tr>
<tr>
<td>Maximum consecutive losses ($)</td>
<td>2 (-60.10)</td>
</tr>
<tr>
<td>Average consecutive losses:</td>
<td>2</td>
</tr>
</tbody>
</table>

### Improvements to be made:

To be confident that my system will be profitable statistically I need to consider the risk reward ratio and a trigger or trading rule that is correct at least 45% of the times in any given situation as I plan to have a risk reward ratio of 2. I am yet to find a suitable trigger to achieve this.
goal of mine. So I am not confident to make money with my system although I made profit. Money management and finding a trigger still needs to be

Programming Projects in Meta trader 4:

Apart from moving averages and RSI cross over and I tried to make an expert to use the Ichimoku cloud. However, I did not employ it and the strategy lost money in back testing due to some coding error on my part so I am not including the results. However, as a lot of manual traders made money in the strategy I think it was something wrong with my code that I did not get expected results. Project codes are in the appendix.

After trading real-time and back testing I learned having trigger that is correct with a high probability and having an appropriate risk reward ratio will make one a successful trader. I plan to trade with both manually and automated after the improvements that I want to make are made. Other than that I am confident if the rules are followed and coding bugs are fixed the system will be able to generate around 7-8% profit a year.

Chapter 7: Trading System #2

The Second system that our team used was a manual Forex system implemented by David Zielinski through the Trade Station platform. This system was a short term day trading long only system that traded mainly on the EURUSD market. The system was designed to work by using the technical analysis indicators of Bollinger bands, Stochastic Index, Relative Strength Index, Slow, and Fast moving averages, and sometimes used fundamental analysis of the news via Wall Street Journal to find optimal and bad times to enter the market. The system traded standard orders of 10,000 pairs per order on 1 minute bars.

The setup, entry, and exit rules for this system are listed below:
Set up Rules:

1. Candlestick hits bottom Bollinger band;
2. Stochastic Bands are trending downward toward 20% mark;
3. Relative Strength trending downward toward the 20% mark.

These three indicators show that the currency is starting to become undervalued, or oversold, and thus a “good deal”, and show the general volatility of the market. When the Bollinger Bands start to widen, it shows a period of greater volatility, and thus more chance for profit. When the candlesticks are trending downward, the Bollinger bands tend to widen to show that there is a lot of volatility. However, when the price hits the bottom Bollinger Band, The Band acts as a floor and it will either ride the band for some time, or bounce off and start to trend the other way. The stochastics trending downward tell us that the supply is more than the demand, and thus there is essentially a drop in price, which, if the volatility is high, tells us that soon people will see that it is a good deal and start to buy, forcing the price back up. Finally, the Relative Strength Index tells us how many people are in the market at that time. Similar to Stochastic Bands, RSI generally gives us a sense of how oversold or overbought an asset is.
Entry Rules:

1. Candlestick rises above bottom Bollinger Band, and shows green;
2. Stochastic bands level out below the 20% mark;
3. RSI levels out below 20% mark.

These indicators for my entry rules essentially confirm or bust the trends that I start to recognize in my setup rules. Once the price of the currency pair bounces off the bottom bollinger band, it starts to move back up toward the simple moving average, showing that the price is starting to rise. When the Stochastics start to level out below the 20% mark, this shows that the demand and supply of the currency pair are starting to match each other, and that it will soon reverse direction on head back upward. Similarly, when the RSI levels out below 20%, it tells us

41 https://www.authenticfx.com/free-forex-strategy.html
that more people are starting to enter the market and buy the currency pair, which in turn will cause the price to go back up by the supply and demand rule.

Exit Rules:

1. The Candlestick hits the top Bollinger Band;
2. The Stochastic Bands cross above the 80% mark;
3. The Relative Strength Index crosses above the 80% mark.

These exit rules essentially work in the opposite way than the entry rules. When the candlesticks hit the top Bollinger Band, it acts as a ceiling in that the price will soon bounce off start to drop. When the Stochastic Bands cross above the 80% mark, this shows that the demand is way higher than the supply, and the currency pair is seen as overbought and the price is too high for the value of the pair. Similarly, when the RSI crosses above the 80% mark, it shows that there are too many people in the market, confirming that the currency pair is in fact overbought.

Figure 7.2: Example of a Winning Trade

The Figure above shows how the system was used to execute a winning trade. I bought into the market at the blue line at a limit price of 1.08891. When I bought in, the price had been
off of the bottom Bollinger band for one candlestick, the stochastic bands were below 20, and the RSI was also below 20. This told me that the currency was undervalued, and was going to go up in price very soon. Sure enough, after 15 minutes of being in the market, the price hit the top Bollinger band, and the stochastic bands crossed above 80. Even though the RSI did not cross above 80, it was much higher than it was when I bought in, and it was starting to level out, showing that people were starting to exit the market. I sold at a limit price of 1.08930, and made $3.90 of profit. I made the right decision to exit the market at this point because the currency pair did in face bounce of the top Bollinger band and start to trend downward.

Although these rules are quite simple to follow, it is hard to find time in which the volatility of the EURUSD market is high. The highest volatility in the EURUSD market occurs during the opening of the NYSE at 9AM EST. This is when the NYSE overlaps with the London Stock Exchange (LSE). However, I was not available to trade during this time due to having class during this time during the project. I did, in fact, notice when looking back that there was a very large drop in price of the EURUSD during the opening hours of the NYSE. After the price drop, the currency pair usually starts to trend back upward to where it started the day.

![EURUSD Chart](image.png)

*Figure 7.3: “Morning Drop” March 21 TradeStation.com*
Here, in figure 7.1, there is a steady drop just before 9AM in which the price of the EURUSD currency pair. We can see that just before the drop, the Stochastic Bands were just at 80%, and the RSI was relatively high. Once the drop occurred, the Stochastics fell well below the 20% mark, and the RSI leveled out below the 20% mark as well. This indicated that the currency was well undervalued, and that the price was going to go back up. This is in fact exactly what happened.

![Figure 7.3: “Morning Drop” May 1 Trade Staton.com](image)

In figure 7.2 again, you can see how the Stochastic Bands and RSI are high, near or above the 80% mark, indicating that the price will soon drop. This drop occurs between 10:05AM and 10:15AM before the volatility started to settle back down until later on in the day.
Below are a record of trades made using this system:

<table>
<thead>
<tr>
<th>Index</th>
<th>StoryID</th>
<th>Refindex</th>
<th>Date</th>
<th>Time</th>
<th>Size</th>
<th>Price</th>
<th>Type</th>
<th>Time</th>
<th>Size</th>
<th>Price</th>
<th>AvgPrice</th>
<th>Date</th>
<th>Time</th>
<th>Size</th>
<th>Price</th>
<th>AvgPrice</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>447282831</td>
<td>Filled</td>
<td>Buy</td>
<td>3/16/2017 10:54</td>
<td>3/16/2017 10:54</td>
<td>10000</td>
<td>10000</td>
<td>Market</td>
<td>1.07359</td>
<td>DAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>448520979</td>
<td>Filled</td>
<td>Buy</td>
<td>3/30/2017 12:35</td>
<td>3/30/2017 12:35</td>
<td>10000</td>
<td>10000</td>
<td>Market</td>
<td>1.07238</td>
<td>DAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>448790638</td>
<td>Filled</td>
<td>Sell</td>
<td>3/30/2017 12:35</td>
<td>3/30/2017 12:35</td>
<td>10000</td>
<td>10000</td>
<td>Market</td>
<td>1.07245</td>
<td>DAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7.1: System #2 Trade Records
The above graph shows the equity curve of my manual Forex system. It can be seen that the system started out with a very big loss. This was due to the fact that I was inexperienced in trading, and did not include a stop loss with this trade. Despite this, the trades made after this loss were making money and the equity in the account was becoming less negative. However, the second large loss of the system came when I was close to breaking even. This loss was solely due to the fact that when I had put on a trade, I had not recognized that my computer had very low battery, and in the course of watching the market, my computer died. When I was not watching the market, it ended up falling very far down leaving me with a huge loss. However, despite these two losses, when the rules of my system were followed, and the trades monitored, I was able to make a profit. The graph below shows how my system performed without the two biggest losses:
From the above graph, the equity without the huge losses is well above the equity with the losses. This shows that when I used my rules and traded those rules while managing risk, I was able to make a profit with my system.

After I had used my system, I did a series of Optimization calculations to find out the Expectancy and the Expectunity of my system. The equations of both of these Optimization tools are located below:

Expectancy = \[ \frac{\text{Sum Of} \ \{(\text{Profit} / \text{Loss on nth Trade}) / \text{Money Management stop loss on nth Trade}\}}{N \text{ Trades}} \]
Expectunity = Expectancy * N Trades

Taken from the previous spreadsheet of trades, and P/L, and using a stop loss margin of $10 for each trade, I have calculated that my system’s Expectancy over the 11 trades that I paced is -0.43454545R. This will give the system an overall Expectunity of -4.78R. Given that the system did have some flaws due to the element of human error, I have also calculated the expectancy and Expectunity given that the two major losses were 0, and I came out with an expectancy of 0.191818182R, and an Expectunity of 2.11R. However, given that the system can make more trades, say 100 trades per month, the Expectunity of the system would be 19.18181818R. Although it may not be as robust as some other systems, I believe that given more time, and more experience with my system, I would be able to generate a much more steady profit than I have done thus far.

Chapter 8: Trading System #3

Investing systems are quite different when compared to a traditional trading system. As stated previously in the report, investors look to buy and hold on to equities, believing that their investment will mature over time and produce steady returns or in some cases (dividend yielding equities) pure profit. This differs greatly from the approach of a trader using a trading system. In this case it is more likely that a trader would execute several trades a day and perform the required back testing to ensure the likelihood that their system will be able to return steady profits. My philosophy going into this project was that of an investor meaning that I believe in the buy and hold philosophy. For this reason there were no trades in my system and back testing was not possible because the philosophy I believe in does not require set-up and trigger parameters in the same sense. I originally had the goal of meeting at least a 7% return on investment given the time frame which I assumed to be just about one month. I began
looking at different stocks and executing test trades but quickly realized that as an investor it was necessary to spend more money, allocating the amount over a spread of assets rather than investing heavily in a few. Because of this I set my sights on theory and focused on creating an ideal portfolio, and in order to understand what is meant by ideal it is necessary to discuss the metrics used to gauge portfolio strength by investors, enter Modern Portfolio Theory. Modern Portfolio Theory (MPT) was pioneered by Henry Markowitz in 1952 as part of a paper he wrote titled Portfolio Selection. The theory is on the idea that it is possible for risk-averse investors to construct portfolios that optimize or maximize their expected return for a certain level of market risk. Markowitz also claimed that it was possible to create an efficient frontier of portfolios offering different levels of expected return vs. a given level of risk. This idea meant that less risk-averse investors could use the theory to create portfolios that would maximize their returns as much as possible given the risk they felt comfortable taking. Furthermore, MPT emphasized that investors look at stocks and their risk versus return not as individual assets, but as pieces of a bigger puzzle, a portfolio. This was one of the major insights of MPT because it pushed the focus of risk-averse investors toward the expected return and market risk of the entire portfolio as a function of the individual stocks within it. In theory this meant that (for a well-constructed portfolio) the day to day losses of some of the assets in the grand scheme of things would be offset by larger gains made by other assets in the portfolio and ultimately loss would be all together minimized again for a given level of risk and expected return. From this theory I was able to discern that the metrics used to gauge portfolio strength were risk and return in terms of just stocks. From a portfolio standpoint, the important metrics to look at were variance (statistically calculated spread between targeted goal and the actual value), correlation (relative behavior of stocks when compared to each other), and finally whether or not ones portfolio is on the efficient frontier (an upward sloping parabola connecting all of the most efficient portfolios possible given varying combinations of assets and capital allocation). In addition to this, my portfolio would have to be diversified in order to protect against unique or specific risk.
Figure 8.1 Graph visualizing portfolio risk vs number of stocks

This sort of risk is specific to companies, industries, and on large scale even countries. However according to www.Nasdaq.com, studies have proven that reasonable diversification can be had by holding as little as a dozen stocks and can be all together eliminated by holding around 50 stocks, bearing in mind of course that these assets need spread across different sectors (see figure 8.1). At this point I had my goal (creating the ideal portfolio), and I knew how to gauge the strength of my theoretical portfolio’s performance. I now needed a method for screening and selecting stocks adequate enough to be in my portfolio. From an investor point of view I very much enjoyed employing fundamental analysis when looking at different companies so I decided to start researching screening methods that used this tactic as well and before long I came across a method coined CAN SLIM.

Invented by noted stockbroker and author William J. O’Neil, the CAN SLIM method provides a system for selecting growth stocks. Each letter of the acronym represents a driving factor in determining whether or not a stock will show significant growth over time. Respectively, the driving factors as defined are C, Current quarterly earnings more over looking for sharp increase year over year. A, annual earnings increases over the last 5 years or for some of the stock I chose, as far back as data is available. N, new products or management, essentially screening for assets that will drive company profits. S, looks at the supply of a company’s stock relative to the demand available on the market, which could suggest future profitably. L, dictates that we
should look at leaders in a sector as opposed to the slower moving stocks. I, informs us that we should look for stock that have strong institutional sponsorship and M tells us to review market averages daily in order to determine the direction of the market. With this information I began screening for stocks that I considered CAN SLIM stocks based on the methodology outlined by O’Neil and I was able to generate a list of 25 suitable stocks for my portfolio. My original goal was to aim for a pool of 15 stocks simply because the difference in portfolio risk between 15 and 25 stocks was negligible according to figure 8.1. To narrow the group down further I also came up with a supplemental set of 3 parameters to use in the screening of different equities. Each stock I chose would have to fulfill at least 2 of the 3 parameters I created, they were the following:

1. Quarter to quarter revenue growth of at least 5% with year over year quarterly revenue growth at 10% or higher.
2. Annual earnings increases greater than or equal to 30% over the last two years.
3. Focus on companies making new acquisitions and producing or marketing new products (with special attention to product pre-orders if applicable).

Additionally I only allowed for 3 stocks to be from a similar sector with the idea that it would be unlikely for more than 2 sectors to take a hit significant enough to disturb the overall performance of the portfolio with time. Because of this I assumed that plugging in the returns from these assets would likely result in some correlation especially across similar sectors, however, it was my opinion that my parameters combined with CAN SLIM would result in stocks that would end up adding value overtime without much volatility. After careful analysis of stock performance, investor reports, and applying my own fundamental analysis, these were the 15 stocks I deemed suitable to place in my portfolio;

1. Cadence Design Systems (CDNS)
2. Facebook Inc. (FB)
3. United Technologies (UTX)
4. NVidia (NVDA)
5. Amazon Inc. (AMZN)
6. KLA-Tencor Corp (KLAC)
7. TAL Education Group (TAL)
8. ABIOMED Inc. (ABMD)
9. MKS Instruments Inc. (MKSI)
10. Adobe Systems Inc. (ABDE)
11. Tesla Inc. (TSLA)
12. Essent Group LTD (ESNT)
13. NVR Inc. (NVR)
14. Apple Inc. (APPL)
15. Coherent Inc. (COHR).

Plugging these into a portfolio and conducting modern portfolio analysis revealed interesting results and proved to further my understanding of portfolio management. In the next section I will share my findings and insights as well as thoughts on how to improve my portfolio and next steps.

Global Minimum Variance Portfolio

Markowitz’s Modern Portfolio Theory taught that risk adverse investors should consider the performance of the portfolio given the assets and weights among each of them. His idea of an efficient frontier stemmed from the fact that for a given level of risk every portfolio had a maximized level of expected return. A Global Minimum Variance (GMV) portfolio is one in which as much non-systematic risk has been removed as possible via the use of return, variance and
correlation. The end result is a portfolio that will in theory give an investor the highest possible return with the least amount of risk. In order to understand how well my parameters and decided methods worked I created one with the goal of exceeding 2% return per month with risk at 1% or within half a percentile of that figure. This would make for a theoretical portfolio with returns exceeding 24% annually while keeping risk at or below 10% on the year. In order to do this I acquired historical price data for each of the stocks in my portfolio from yahoo finance. I decided to use 5 years (60 months) as a suitable timeframe for my stock price data, specifically I acquired the adjusted monthly close prices (adjusted for splits/dividends) of each month going back 5 years. Using excel, first I listed each of the stock tickers at the top of its own column, and listed the historical price data starting with January 1st 2012 and listing until May 26th 2017 (for this reason some prices appeared twice as data was not yet available for the month close, see figure 8.2). The next step was to list each stock ticker out again over a spread of columns in order to begin calculating adjusted monthly returns.

<table>
<thead>
<tr>
<th>Adjusted Monthly Closing Price (3yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NVDA</td>
</tr>
<tr>
<td>12.43</td>
</tr>
<tr>
<td>13.82</td>
</tr>
<tr>
<td>13.54</td>
</tr>
<tr>
<td>14.03</td>
</tr>
<tr>
<td>13.34</td>
</tr>
<tr>
<td>11.98</td>
</tr>
</tbody>
</table>

**Figure 8.2 Adjusted Monthly Closing Prices first 6 months**

This process was quite simple, for each cell the equation would be the stock price for that equity one month ahead subtracted by the month prior then that value divided by the month prior. A depiction of this equation can be seen in figure 8.3. After this, it was necessary to determine the correlation between returns. High correlations among stocks (negative or positive) suggest that the same market pressures effect the equities in a portfolio. This situation is unfavorable because it suggests that the portfolio is not diversified however in some cases I believe it can be overlooked, particularly with CAN SLIM equities.
My reasoning for this being that because the projected over all trajectory of CAN SLIM stocks in theory is upward, they are likely to have some sort of correlation. However, in order to mitigate the effects of a non-diversified portfolio I would however advise that numerous portfolios be made in order to disperse stocks that are more closely correlated and mitigate overall risk. Continuing with the creation of the GMV portfolio, the next step was to calculate the standard deviation and average return of each stock in the portfolio. Both of these were accomplished using built in excel equations STD.DEV and AVERAGE. By selecting the right the data sets I came up with these values as well. Figure 8.4 depicts the correlation matrix which was also calculated using a built in excel formula. The last bit required was a covariance matrix. By using the built in transpose feature I was able to create this matrix using the formula depicted in figure 8.5. The next few steps involved tying various matrices together in order to produce the GMV portfolio’s risk and expected return. I have elected not to include the specifics in this
portion of the report however the instructions I followed can be found in a link in the appendix.

Figure 8.6 depicts my findings, and my results exceeded expectations.

```
<table>
<thead>
<tr>
<th>Matrix Name</th>
<th>Portfolio Expected Risk and Return VCOV Matrix</th>
<th>Matrix W</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.04506</td>
<td>0.01161 0.0019 0.0007 0.0013 0.0037 0.00086 0.00211 0.00084 0.00014 0.00033 0.00048 0.00018 0.00013 0.00033 0.000124</td>
<td>0.04457</td>
</tr>
<tr>
<td>0.03654</td>
<td>0.00019 0.00209 0.00025 0.00164 0.00248 0.02015 0.00031 0.00016 0.00114 0.00014 0.0029 0.00016 0.00016 0.000164</td>
<td>0.13469</td>
</tr>
<tr>
<td>0.01379</td>
<td>0.00047 0.00035 0.00108 0.00011 0.00155 0.00015 0.00047 0.00027 0.00025 0.00073 0.00015 0.00048 0.000082 0.000118</td>
<td>0.0107</td>
</tr>
<tr>
<td>0.00908</td>
<td>0.00013 0.000131 0.00015 0.00009 0.00009 0.00004 0.00004 0.00008 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009</td>
<td></td>
</tr>
<tr>
<td>0.02736</td>
<td>0.00013 0.000131 0.00015 0.00009 0.00009 0.00004 0.00004 0.00008 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009 0.00009</td>
<td></td>
</tr>
<tr>
<td>0.03502</td>
<td>0.0006 0.00156 0.0005 0.00169 0.00188 0.00035 0.00026 0.00019 0.00029 0.00018 0.00016 0.00023 0.000097 0.000244</td>
<td>0.0401</td>
</tr>
<tr>
<td>0.04729</td>
<td>0.0231 0.0003 0.0004 0.0001 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038</td>
<td></td>
</tr>
<tr>
<td>0.03317</td>
<td>0.0006 0.00015 0.00024 0.00015 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038</td>
<td></td>
</tr>
<tr>
<td>0.03884</td>
<td>0.0014 0.00134 0.0003 0.0004 0.00017 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038</td>
<td></td>
</tr>
<tr>
<td>0.06298</td>
<td>0.00013 0.000131 0.00025 0.00088 0.00047 0.00037 0.00037 0.00015 0.00035 0.00016 0.00034 0.00005 0.00013 0.000248</td>
<td>0.077</td>
</tr>
<tr>
<td>0.00114</td>
<td>0.0004 0.00024 0.00021 0.00015 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038</td>
<td></td>
</tr>
<tr>
<td>0.0318</td>
<td>0.00018 0.000169 0.00013 0.0002 0.00026 0.00023 0.00043 0.00028 0.00038 0.00017 0.0003 0.00037 0.000086 0.00007 0.00007 0.00007 0.00007 0.00007</td>
<td></td>
</tr>
<tr>
<td>0.079</td>
<td>0.00011 0.00013 0.00019 0.00021 0.00015 0.00012 0.00017 0.00012 0.00009 0.00003 0.00003 0.00003 0.00003 0.00003 0.00003 0.00003 0.00003</td>
<td></td>
</tr>
<tr>
<td>0.04574</td>
<td>0.00013 0.000131 0.00025 0.00088 0.00047 0.00037 0.00037 0.00015 0.00035 0.00016 0.00034 0.00005 0.00013 0.000248</td>
<td>0.077</td>
</tr>
<tr>
<td>0.033</td>
<td>0.0012 0.00014 0.00024 0.00021 0.00015 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038 0.00021 0.00015 0.00038</td>
<td></td>
</tr>
</tbody>
</table>
```

Figure 8.5 depicts variance covariance matrix

I was able to create a GMV portfolio reflecting a monthly average return of 2.8% with risk at 0.1% monthly. Annualized this reflects average returns upwards of 33% with minimal risk (less than 1.5%). These finding prove that a portfolio comprised of these stocks (weights considered) would be profitable however as depicted in figure 8.4 it is clear that many of the stocks are heavily correlated. Although my instinct contradicts the diversification philosophy on the subject of CAN SLIM stocks it would best to continue creating portfolios which reflect lower correlation and somewhat similar return given a level of certain risk. Furthermore less risk averse investors may additionally look to take on more risk with the hope of realizing more profit. Continuing my analysis, my next step would be to construct an efficient frontier, capital
allocation line and tangency portfolio and determine where on this graph I would like my portfolio would be, however as my goal had been reached I decided against doing the additional calculations (for reference I have included my raw data in figures 8.7-10).

Efficient Frontier

The efficient frontier is a combination of portfolios, plotting their average return vs. risk or standard deviation. Being on this frontier would prove that for a given level of risk one’s portfolio is providing an optimal level of return. Portfolio’s which lie below this frontier are sub-optimal because they fail to provide “adequate” return given the level of risk taken on. Portfolios above this frontier are too risky considering the level of return. In figure 8.7, a frontier is depicted based on a provided portfolio. For reference my portfolio’s performance relative the frontier depicted is shown. Although the data presented does not depict an accurate representation of my portfolio on its true efficient frontier, it gives insight as to the level of risk vs. return of my portfolio compared with another set of portfolios. The y axis can be taken as return while the x-axis should be interpreted as the risk.

Figure 8.7 My Portfolio depicted against a generic Efficient Frontier for Context
From figure 8.7 it is clear that when compared with the frontier of a generic portfolio my portfolio’s GMV is considered to be too risky considering the return.

Capital Allocation Line (CAL) & Tangency Portfolio

Depicted in figure 8.7 you may have noticed the terms Capital Allocation Line (CAL) & Tangency portfolio being used. The CAL is line used by investors to measure the risk of risky and risk-free assets. This is important to not because if used correctly it can help an investor by providing insight into the type of portfolio he or she has constructed. Looking back at figure 8.7 shows that my portfolio is on the riskier side of things in comparison to the generic portfolio this line is based off of. If I had elected to include a risk free asset (i.e. Bond) it would no doubt reduce the risk of my portfolio, potentially even bringing it align with the frontier plotted in figure 8.7. I did however, elect not to do this because the rate of return on a risk free asset is much less than that of an average stock. A tangency portfolio is one in which the ratio between expected return and risk is maximized. This ratio is called the Sharpe ratio, and if the GMV is the highest return with the lowest level of risk, than the Tangency portfolio can be considered its opposite. As with most portfolio’s adding a risk free asset should reduce risk as well as return causing the Tangency Portfolio and GMV to appear at different points along the CAL and efficient frontier. As an investor all this information is helpful when deciding how you want a portfolio to look, and in the next section I will discuss where I would like to be on the efficient frontier or CAL as well as provide a summary and next steps.
Figure 8.8 Data for Efficient Frontier

Figure 8.9 Data for Capital Allocation Line
Summary & Next Steps

In my opinion there are things to consider when taking acceptable risk into account. Some of these include capital and income, but perhaps not as evident is age. A younger person is more likely to have the ability to recover from excessive loss and I took this into account when deciding where I would like my portfolio to fall on the graph of figure 8.7. Assuming my raw data was used, I would like to fall in the space before the CAL meets the efficient frontier, in other words, just above the efficient frontier and just below the CAL. This area represents a section of the graph known as the risk premium. This section is called as such because it is usually indicative of the influx of return relative to risk that is added when a risk free asset is placed into one’s portfolio. It is my opinion that this would be the best place for a portfolio to be in, because although you are creating more profit for you while keeping risk at the same level. If I were to construct another, or improve upon my current portfolio there are a few things I would consider doing. First, I would create multiple portfolios including some with risk free assets such that I could find an acceptable return and risk that would place in and ideal spot within the risk.

<table>
<thead>
<tr>
<th>Tan ER</th>
<th>0.0454607</th>
<th>0.031428</th>
<th>0.032899</th>
<th>0.000753</th>
<th>0.027429</th>
<th>0.015621</th>
<th>0.047329</th>
<th>0.181739</th>
<th>0.188594</th>
<th>0.028239</th>
<th>0.051141</th>
<th>0.038083</th>
<th>0.139028</th>
<th>0.126594</th>
<th>0.023594</th>
</tr>
</thead>
<tbody>
<tr>
<td>S Ratio</td>
<td>0.00119</td>
<td>0.0019</td>
<td>0.0025</td>
<td>0.0016</td>
<td>0.0037</td>
<td>0.0064</td>
<td>0.0076</td>
<td>0.0082</td>
<td>0.0049</td>
<td>0.0035</td>
<td>0.0047</td>
<td>0.0048</td>
<td>0.0057</td>
<td>0.0033</td>
<td>0.0013</td>
</tr>
<tr>
<td>P risk</td>
<td>0.241745</td>
<td>0.011322</td>
<td>0.011327</td>
<td>0.010936</td>
<td>0.014903</td>
<td>0.012551</td>
<td>0.013452</td>
<td>0.013128</td>
<td>0.013128</td>
<td>0.013128</td>
<td>0.013128</td>
<td>0.013128</td>
<td>0.013128</td>
<td>0.013128</td>
<td>0.013128</td>
</tr>
</tbody>
</table>

![Table 8.10 Raw data for Tangency Portfolio](image)

Figure 8.10 Raw data for Tangency Portfolio

In my opinion there are things to consider when taking acceptable risk into account.
premium depicted in figure 8.11. Second, I would continue looking for stocks whose returns lowered correlation between the stocks in my portfolio. Although my philosophy on this subject with regards to growth stocks is that it is not as relevant, less correlation can never hurt a portfolio. Lastly I would look into purchasing commodities. Throughout this project I rarely looked into commodities as an asset and have yet to discover their effects on a portfolio. I believe that they would be considered not risk free, but similar to assets with that distinction. Overall I would say that I am pleased with the results of my project. I was able to create a portfolio that performed better than my goals, with minimal risk, I consider this ideal. In future projects, I would consider taking the time to construct the efficient frontier, CAL, and tangency portfolio using raw data in order to have a deeper understanding of my ideal portfolio.

Chapter 9: System of Systems

Hedge funds and investment funds creates their systems to work together and provide a source of income for the investor no matter what the economic conditions. The systems all put together are called a system of systems. The system of systems offsets losses from one system or market with winning trades from a different system. A good example of a system of systems may include long term investments in the stock market, combined with short term returns in the stock or Forex markets from day trading. The performance of a system of systems can be measured in many different ways. One of the simplest ways to analyze a system is through an equity curve. The equity curve is a graphical representation of the profit or loss of the system by data points of all the trades made with the system. With good system, the equity curve should have a positive slope, and, if there is correct position sizing rules, the curve should be exponential.

With our team’s three systems each performing much differently, we feel that after a short test run, more money should be allocated to system #3 for long term investment and
growth, and less money should be devoted to the short term trading so that the system of systems

Chapter 10:

After analyzing each of the systems individually, we looked at our system of systems as a whole and saw that some sectors performed better than others. For example, system #3 that used fundamental trading, and long term position holding was able to perform the best out of the three. This is because the system used the news to find a trend that might cause a breakout, and bought or sold based on this, and most of the time, it worked. Contrastingly, The automated Forex system used strictly technical analysis to trade currency pairs. This system also performed quite well, giving a consistent, short term profit margins. All in all, our team as a hedge fund was quite successful in generating a profit.

This being said, it would take a lot more than system analysis and knowing the jargon to actually invest our own money. The first problem is that to make money in the markets you need to first spend money. This is money that we do not have at this time. Sure, we can take out a loan or get investors, but there is a lot of pressure behind that as well. Maybe one day when we all have an income of our own we may take our systems out and see what they can do in the real world.

Some problems that our team did have with this project was that there was clearly a lack of communication at the beginning of the project, both among team members as well as with the advisors. It also did not help that our original advisor had to be taken off the IQP and replaced with only a handful of weeks remaining in the year. However, we did fix the communication problem by planning weekly meetings both as a team and with our advisor to straighten out some of the issues we were having with our systems and the writing.
Appendix

Strategy Tester: IQTest2

Strategy Tester Report
IQTest2
Forex.com-Demo 5 (Build 1065)

Symbol: EURUSDpco (Euro vs US Dollar)
Period: 1 Minute (HH: 2017.02.03 19:22 - 2017.02.03 20:59) (2016.11.01 - 2017.03.30)
Model: Every tick (the most precise method based on all available least timeframes)
Parameters: MAF: Number of MA filters; LotSize: lot size; StopLoss: stop loss; TakeProfit: take profit; TrailingStop: trailing stop; SLpage: 3;

Bars in test: 55561; Ticks modelled: 179925; Modelling quality: 24.96%

<table>
<thead>
<tr>
<th>Column1</th>
<th>Return</th>
<th>Average Loss</th>
<th>R mult 1</th>
<th>Column2</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>31.25</td>
<td>0.224</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.3</td>
<td>31.25</td>
<td>0.4576</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.6</td>
<td>31.25</td>
<td>0.1472</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-90</td>
<td>31.25</td>
<td>-2.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-90</td>
<td>31.25</td>
<td>-2.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-90</td>
<td>31.25</td>
<td>-2.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.1</td>
<td>31.25</td>
<td>0.5472</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1080</td>
<td>31.25</td>
<td>34.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade Count</td>
<td>Expectancy</td>
<td>System Quality Number</td>
<td>Annualized Expectancy</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>------------</td>
<td>-----------------------</td>
<td>-----------------------</td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>31.25</td>
<td>0.016</td>
<td></td>
<td></td>
</tr>
<tr>
<td>57.2</td>
<td>31.25</td>
<td>1.8304</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.7</td>
<td>31.25</td>
<td>0.2784</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39.2</td>
<td>31.25</td>
<td>1.2544</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td>31.25</td>
<td>0.0256</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.7</td>
<td>31.25</td>
<td>0.2464</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>31.25</td>
<td>4.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.6</td>
<td>31.25</td>
<td>0.3392</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.6</td>
<td>31.25</td>
<td>0.3712</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>31.25</td>
<td>0.0512</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>31.25</td>
<td>-0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.9</td>
<td>31.25</td>
<td>0.0608</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-30</td>
<td>31.25</td>
<td>-0.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-30</td>
<td>31.25</td>
<td>-0.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-30</td>
<td>31.25</td>
<td>-0.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-30</td>
<td>31.25</td>
<td>-0.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49.8</td>
<td>31.25</td>
<td>1.5936</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-180</td>
<td>31.25</td>
<td>-5.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-180</td>
<td>31.25</td>
<td>-5.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>540</td>
<td>31.25</td>
<td>17.28</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Code for Trading System #2:

```
#property copyright "Copyright 2017, MetaQuotes Software Corp."
#property link "https://www.mql5.com"
#property version "1.00"
#property strict
extern int FastMa = 5;
extern int MagicNumber = 76155;
extern int CandlesBack=5;
extern int RiskPercent=20;
extern int FastMaMethod=0;
extern int FastMaShift = 0;
extern int FastMaAppliedTo=0;
extern int SlowMa = 21;
extern int StopLoss = 25;
extern int SlowMaMethod=0;
extern int SlowMaShift=0;
extern int SlowMaAppliedTo=0;
extern int TakeProfit=50;
extern int PadAmount = 10;
extern double reward_ratio= 2.0;
int BarsOnChart=76155;
//extern int StopLoss = 25;
int OnInit()
{
    double ticksize = MarketInfo(Symbol(),MODE_TICKSIZE);
    if(ticksize == 0.00001 || ticksize == 0.001)
        pips = ticksize*10;
    else pips = ticksize;

    return(INIT_SUCCEEDED);
}
```
// Expert tick function

void OnTick()
{
    //
    if(IsNewCandle())
        CheckForIchoTrade();
    //

    void CheckForIchoTrade()
    {
        double T_0=ichimoku(NULL, 0, 9, 26, 52, MODE_TENKANSEN, 1);
        double T_1=ichimoku(NULL, 0, 9, 26, 52, MODE_TENKANSEN, 4);
        double K_0=ichimoku(NULL, 0, 9, 26, 52, MODE_KIJUNSEN, 1);
        double K_1=ichimoku(NULL, 0, 9, 26, 52, MODE_KIJUNSEN, 4);
        if (T_1 < K_1 && T_0 >= K_0) // Tenkan-sen crosses Kijun-sen upwards
            OrderEntry(1);
        else if (T_1 > K_1 && T_0 <= K_0) // Tenkan-sen crosses Kijun-sen downwards
            OrderEntry(0);
    }

    bool IsNewCandle()
    {
        static int BarsOnChart=0;
        if(Bars==BarsOnChart)
            return (false);
        BarsOnChart=Bars;
        return(true);
    }

    void OrderEntry(int direction) // direction = 0 buy ; direction == 1 sell /* direction is the signal
    {
        if(direction==0&&OrdersTotal()==0)
            OrderSend(Symbol(),OP_BUY, LotSize, Ask, 3, (Ask-(StopLoss*pips)), Ask+TakeProfit*pips, NULL, MagicNumber, 0, Green);
        if(direction==1&&OrdersTotal()==0)
            OrderSend(Symbol(), OP_SELL, LotSize, Bid, 3, (Bid+(StopLoss*pips)), Bid-TakeProfit*pips, NULL, MagicNumber, 0, Red);
    }
}
int OpenOrdersInPair(string pair)
{
    int total = 0;
    for(int i=OrdersTotal()-1; i>=0; i--)
    {
        OrderSelect(i, SELECT_BY_POS, MODE_TRADES);
        if(OrderSymbol() == pair) total++;
    }
    return total;
}

RSI and MA Cross System Code:
//+---------------------------------------------------------------------+
//  DO NOT DELETE THIS HEADER
//  DELETING THIS HEADER IS COPYRIGHT INFRINGEMENT
//
//  Copyright ©2011, ForexEAdvisor.com
//  ForexEAdvisor Strategy Builder version 0.2
//  http://www.ForexEAdvisor.com
//
//  THIS EA CODE HAS BEEN GENERATED USING FOREXEADVISOR STRATEGY BUILDER 0.2
//  on: 4/11/2017 12:04:55 AM
//  Disclaimer: This EA is provided to you "AS-IS", and ForexEAdvisor disclaims any warranty
//  or liability obligations to you of any kind.
//  UNDER NO CIRCUMSTANCES WILL FOREXEADVISOR BE LIABLE TO YOU, OR ANY OTHER PERSON OR
//  ENTITY,
//  FOR ANY LOSS OF USE, REVENUE OR PROFIT, LOST OR DAMAGED DATA, OR OTHER COMMERCIAL OR
//  ECONOMIC LOSS OR FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, STATUTORY, PUNITIVE,
//  EXEMPLARY OR CONSEQUENTIAL DAMAGES WHATSOEVER RELATED TO YOUR USE OF THIS EA OR
//  FOREXEADVISOR STRATEGY BUILDER
//  Because software is inherently complex and may not be completely free of errors, you are
//  advised to verify this EA. Before using this EA, please read the ForexEAdvisor Strategy Builder
//  license for a complete understanding of ForexEAdvisor' disclaimers.
//  USE THIS EA AT YOUR OWN RISK.
//
//  Before adding this expert advisor to a chart, make sure there are NO
//  open positions.
//  DO NOT DELETE THIS HEADER
//  DELETING THIS HEADER IS COPYRIGHT INFRINGEMENT
//+---------------------------------------------------------------------+

extern int MagicNumber = 5643211;
extern double Lots = 0.1;
extern double StopLoss = 5;
extern double TakeProfit = 30;
extern int TrailingStop = 5;
extern int Slippage = 3;
//+---------------------------------------------------------------------+
// expert start function
//+---------------------------------------------------------------------+
int start()
{
    double MyPoint=Point;
    if(Digits==3 || Digits==5) MyPoint=Point*10;

double TheStopLoss=0;
double TheTakeProfit=0;
if( TotalOrdersCount()==0 )
{
    int result=0;
    if((iRSI(NULL,PERIOD_M1,21,PRICE_CLOSE,1)>70)&&(iMA(NULL,PERIOD_M1,5,1,MODE_EMA,PRICE_CLOSE,1)>iMA(NULL,PERIOD_M1,12,1,MODE_EMA,PRICE_CLOSE,1))) // Here is your open buy rule
    {
        result=OrderSend(Symbol(),OP_BUY,AdvancedMM(),Ask,Slippage,0,0,"EA Generator www.ForexEAdvisor.com",MagicNumber,0,Blue);
        if(result>0)
        {
            TheStopLoss=0;
            TheTakeProfit=0;
            if(TakeProfit>0) TheTakeProfit=Ask+TakeProfit*MyPoint;
            if(StopLoss>0) TheStopLoss=Ask-StopLoss*MyPoint;
            OrderSelect(result,SELECT_BY_TICKET);
            OrderModify(OrderTicket(),OrderOpenPrice(),NormalizeDouble(TheStopLoss,Digits),NormalizeDouble(TheTakeProfit,Digits),0,Green);
        }
        return(0);
    }
    if((iRSI(NULL,PERIOD_M1,21,PRICE_CLOSE,0)<60)&&(iMA(NULL,PERIOD_M1,12,1,MODE_SMA,PRICE_CLOSE,1)>iMA(NULL,PERIOD_M1,5,1,MODE_EMA,PRICE_CLOSE,1))) // Here is your open Sell rule
    {
        result=OrderSend(Symbol(),OP_SELL,AdvancedMM(),Bid,Slippage,0,0,"EA Generator www.ForexEAdvisor.com",MagicNumber,0,Red);
        if(result>0)
        {
            TheStopLoss=0;
            TheTakeProfit=0;
            if(TakeProfit>0) TheTakeProfit=Bid-TakeProfit*MyPoint;
            if(StopLoss>0) TheStopLoss=Bid+StopLoss*MyPoint;
            OrderSelect(result,SELECT_BY_TICKET);
            OrderModify(OrderTicket(),OrderOpenPrice(),NormalizeDouble(TheStopLoss,Digits),NormalizeDouble(TheTakeProfit,Digits),0,Green);
        }
        return(0);
    }
}
for(int cnt=0;cnt<OrdersTotal();cnt++)
{
    OrderSelect(cnt, SELECT_BY_POS, MODE_TRADES);
    if(OrderType()<=OP_SELL &&
        OrderSymbol()==Symbol() &&
        OrderMagicNumber()==MagicNumber
    )
    {
        if(OrderType()==OP_BUY)
        {
            if(TrailingStop>0)
            {
                if(Bid-OrderOpenPrice()>MyPoint*TrailingStop)
                {
                    if(OrderStopLoss()<Bid-MyPoint*TrailingStop)
                    {
                        OrderModify(OrderTicket(),OrderOpenPrice(),Bid-
                                       TrailingStop*MyPoint,OrderTakeProfit(),0,Green);
                        return(0);
                    }
                }
            }
            else
            {
                if(TrailingStop>0)
                {
                    if((OrderOpenPrice()-Ask)>(MyPoint*TrailingStop))
                    {
                        if((OrderStopLoss()>(Ask+MyPoint*TrailingStop)) || (OrderStopLoss()==0))
                        {
                            OrderModify(OrderTicket(),OrderOpenPrice(),Ask+MyPoint*TrailingStop,OrderTakeProfit(),0,Red);
                            return(0);
                        }
                    }
                }
            }
        }
    }
    return(0);
}

int TotalOrdersCount()
{
    int result=0;
    for(int i=0;i<OrdersTotal();i++)
    {

OrderSelect(i, SELECT_BY_POS, MODE_TRADES);
if (OrderMagicNumber()==MagicNumber) result++;

}
return (result);
}
double AdvancedMM()
{
    int i;
    double AdvancedMMLots = 0;
    bool profit1=false;
    int SystemHistoryOrders=0;
    for( i=0;i<OrdersHistoryTotal();i++)
    {
        OrderSelect(i, SELECT_BY_POS, MODE_HISTORY);
        if (OrderMagicNumber()==MagicNumber) SystemHistoryOrders++;
    }
    bool profit2=false;
    int LO=0;
    if(SystemHistoryOrders<2) return(Lots);
    for( i=OrdersHistoryTotal()-1;i>=0;i--)
    {
        if(OrderSelect(i, SELECT_BY_POS, MODE_HISTORY))
            if (OrderMagicNumber()==MagicNumber)
                {
                    if(OrderProfit()>=0 && profit1) return(Lots);
                    if( LO==0)
                        {
                            if(OrderProfit()>=0) profit1=true;
                            if(OrderProfit()<0) return(OrderLots());
                            LO=1;
                        }
                    if(OrderProfit()>=0 && profit2) return(AdvancedMMLots);
                }
            else
                {
                    profit1=false;
                    profit2=false;
                    AdvancedMMLots+=OrderLots();
                }
    }
return(AdvancedMMLots);
}

Auto-Lot-Sizing Experiment
//+-------------------------------------------------------------+
//| Auto-Lot-Sizing.mq4 |
//| Copyright 2017, MetaQuotes Software Corp. |
//| https://www.mql5.com |
//+-------------------------------------------------------------+
double pips;
extern int FastMa = 5;
extern int MagicNumber = 76155;
extern int RiskPercent = 10;
extern int FastMaMethod = 0;
extern int FastMaShift = 0;
extern int FastMaAppliedTo = 0;
extern int SlowMa = 21;
extern int SlowMaMethod = 0;
extern int SlowMaShift = 0;
extern int SlowMaAppliedTo = 0;
extern int FastMaMeth
od = 0;
extern int FastMaShift = 0;
extern int SlowMaMethod = 0;
extern int SlowMaAppliedTo = 0;
extern int TakeProfit = 50;
extern double reward_ratio = 2;
//extern double LotSize = 0.01;
extern int StopLoss = 25;
int BarsOnChart = 76155;
int CandlesBack = 5;
double PadAmount = 0;
//+------------------------------------------------------------------+
//| Expert initialization function |                               |
//+------------------------------------------------------------------+

int OnInit()
{
    //---
double ticksize = MarketInfo(Symbol(), MODE_TICKSIZE);
    if (ticksize == 0.00001 || ticksize == 0.001)
        pips = ticksize * 10;
    else pips = ticksize;

    //---
    return(INIT_SUCCEEDED);
}
//| Expert deinitialization function |
//+------------------------------------------------------------------+
void OnDeinit(const int reason)
{
    //---

}
//+------------------------------------------------------------------+
//| Expert tick function |
//+------------------------------------------------------------------+
void OnTick()
{
    //---
    //if(IsNewCandle())
}
CheckForMaTrade();

}  
/// Checks if more than one order is open in the currency pair ///
int OpenOrdersInPair(string pair)
{
    int total = 0;
    for(int i=OrdersTotal()-1; i>=0;i--)
    {
        OrderSelect(i,SELECT_BY_POS,MODE_TRADES);
        if(OrderSymbol()==pair)total++;
    }
    return total;
}

bool IsNewCandle()
{
    static int BarsOnChart=0;
    if(Bars==BarsOnChart)
        return (false);
    BarsOnChart=Bars;
    return(true);
}

void CheckForMaTrade()
{
    double CurrentFast = iMA(NULL,0,FastMa,FastMaShift,FastMaMethod,FastMaAppliedTo,1);
    double CurrentSlow = iMA(NULL,0,SlowMa,SlowMaShift,SlowMaMethod,SlowMaAppliedTo,1);
    double PreviousFast =iMA(NULL,0,FastMa,FastMaShift,FastMaMethod,FastMaAppliedTo,2);
    double PreviousSlow =iMA(NULL,0,SlowMa,SlowMaShift,SlowMaMethod,SlowMaAppliedTo,2);
    if((PreviousFast<PreviousSlow)&&(CurrentFast>CurrentSlow))
    {  
        OrderEntry(0);
    }
    if((PreviousFast>PreviousSlow)&&(CurrentFast<CurrentSlow))
    {  
        OrderEntry(1);
    }
}

void OrderEntry(int direction)
{
    double Equity = AccountEquity();
    double RiskedAmount = Equity*RiskPercent*0.01;
int buyStopCandle = iLowest(NULL,0,1,CandlesBack,1); // Gives back the number of the candle where Lowest Value occurs
int sellStopCandle = iHighest(NULL,0,2,CandlesBack,1);
double buy_stop_price = Low[buyStopCandle]-PadAmount*pips; // Stop Price when buying stops
double pips_to_bsl = Ask -buy_stop_price;
    double buy_takeprofit_price = Ask + pips_to_bsl*reward_ratio;
double sell_stop_price = High[sellStopCandle]+PadAmount*pips;
double pips_to_ssl = sell_stop_price - Bid;
    double sell_takeprofit_price = Bid - pips_to_ssl*reward_ratio;
    double LotSize=0;
if(direction==0)
{
    double bsl = 0; //buy_stop_price;
    double btp = 0;//buy_takeprofit_price;
    LotSize = (RiskedAmount/(pips_to_bsl/pips))/10;
    if(OpenOrdersInPair(Symbol())==0)int buyticket = OrderSend(Symbol(),OP_BUY,LotSize,Ask,3,0,0,NULL);
    if(buyticket>0)OrderModify(buyticket,OrderOpenPrice(),bsl,btp,0,CLR_NONE);
}
if(direction==1)
{
    double ssl =0; //sell_stop_price;
    double stp =0; //sell_takeprofit_price;
    //int Lotsize = (RiskedAmount/(pips_to_ssl/pips))/10;
    if(OpenOrdersInPair(Symbol())==0)int sellticket = OrderSend(Symbol(),OP_SELL,LotSize,Bid,3,0,0,NULL);
    if(sellticket>0)OrderModify(sellticket,OrderOpenPrice(),ssl,stp,0,CLR_NONE);
}
References

Retrieved From
https://www.thebalance.com/what-is-the-business-cycle-3305912

Becker, David, 1 June 2016, *How to Enhance Your Moving Average Crossover Strategy*, The Money Show
Retrieved From

*Bolly Band Bounce Trade*, Authentic FX: Forex Strategies and Tools
Retrieved From
https://www.authenticfx.com/free-forex-strategy.html

Retrieved From
https://www.dailyfx.com/forex/education/learn_forex/the_basics/making_a_forex_trade/5/2009-10-14-0111-Forex_Market_Hours.html

Definition | Breadth of the Market
Retrieved From
http://www.investopedia.com/terms/b/breadthindicator.asp

Definition | Brokerage Account, Investopedia
Retrieved From
http://www.investopedia.com/terms/b/brokerageaccount.asp

Definition | Bollinger Bands, Investopedia
Retrieved From
http://www.investopedia.com/terms/b/bollingerbands.asp

Definition | Bond, Investopedia
Retrieved From
http://www.investopedia.com/terms/b/bond.asp?ad=dirN&qo=investopediaSiteSearch&qsrc=0&o=40186

Definition | Bull Market, Investopedia
Retrieved From
http://www.investopedia.com/terms/b/bull.asp

Definition | Business Cycle, Investopedia
Retrieved From
http://www.investopedia.com/terms/b/businesscycle.asp

Definition | Buy Stop Order, Investor.gov
Retrieved From
https://www.investor.gov/introduction-investing/basics/how-market-works/types-orders
Definition | Commodity, Investopedia

Definition | Currency, Investopedia
Retrieved From http://www.investopedia.com/terms/c/currency.asp?ad=dirN&qs=serpSearchTopBox&qs=1&o=40186

Definition | Day trader, Investopedia
Retrieved From http://www.investopedia.com/terms/d/daytrader.asp

Definition | Derivatives, Investopedia
Retrieved From http://www.investopedia.com/terms/d/derivative.asp

Definition | Drawdown, Investopedia
Retrieved From http://www.investopedia.com/terms/d/drawdown.asp

Definition | Equity, Investopedia
Retrieved From http://www.investopedia.com/terms/e/equity.asp?ad=dirN&qs=investopediaSiteSearch&qs=0&o=40186

Definition | Hedge Funds, Investopedia
Retrieved From http://www.investopedia.com/terms/h/hedgefund.asp

Definition | High Frequency Traders, Investopedia
Retrieved From http://www.investopedia.com/terms/h/high-frequency-trading.asp

Definition | Hypothecation, Investopedia
Retrieved From http://www.investopedia.com/terms/h/hypothecation.asp

Definition | In and Out Trading System, Investopedia
Retrieved From http://www.investopedia.com/terms/i/inandout.asp

Definition | Limit Order, Investor.gov
Retrieved From https://www.investor.gov/introduction-investing/basics/how-market-works/types-orders

Definition | Liquidity, Investopedia
Definition | Margin, Investopedia
Retrieved From
http://www.investopedia.com/terms/m/margin.asp

Definition | Market Order, Investor.gov
Retrieved From
https://www.investor.gov/introduction-investing/basics/how-market-works/types-orders

Definition | Options, Investopedia
Retrieved From
http://www.investopedia.com/terms/o/option.asp#ixzz4f5xZHf1F

Definition | Position Sizing, Investopedia
Retrieved From

Definition | Relative Strength Index (RSI), Investopedia,
Retrieved From
http://www.investopedia.com/terms/r/rsi.asp?ad=dirN&qo=investopediaSiteSearch&qsrc=0&o=40186

Definition | Self Employed, Investopedia
Retrieved From

Definition | Stop Order, Investor.gov
Retrieved From
https://www.investor.gov/introduction-investing/basics/how-market-works/types-orders

Definition | Swing Trading, Trade King
Retrieved From

Definition | Trading Platform, Investopedia
Retrieved From
http://www.investopedia.com/terms/t/trading-platform.asp

Definition | Trend, Investopedia
Retrieved From
http://www.investopedia.com/terms/t/trend.asp?ad=dirN&qo=investopediaSiteSearch&qsrrc=0&o=40186

Definition | Variance, Investopedia
Retrieved From
http://www.investopedia.com/terms/v/variance.asp

Retrieved From
Intermarket Analysis, Stock Charts.com
Retrieved From

Investopedia, Types of Brokerage Accounts, Investopedia
Retrieved From

London Forex Opening Hours, Rondownload,
Retrieved From
http://rondownload-computer.tk/voe/london-forex-opening-hours-2127.php

Mitchell, Cory, Intermarket Relationships: Following the Cycle, Investopedia
Retrieved From
http://www.investopedia.com/articles/fundamental-analysis/09/intermarket-relations.asp

Retrieved From
https://www.thebalance.com/minimum-capital-required-to-start-day-trading-stocks-1031142

Murphy, Case, Introduction to the Parabolic SAR, Investopedia,
Retrieved From
http://www.investopedia.com/articles/technical/02/042202.asp?ad=dirN&o=investopediaSiteSearch&qsrc=0&o=40186

Office for National Statistics. (2017) [Graph Illustration: BoP Current Account Balance, Line Graph, May, 2017] BoP Current Account Balances SA in £m,
Retrieved From
https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/timeseries/hbop/pnbp

Online Trading Concepts (2007) [Example of Simple Moving Average Crossover (2 SMAs)], Online trading concepts
Retrieved From
http://www.onlinetradingconcepts.com/TechnicalAnalysis/MASimple2.html

Perry, Brian, Popular Forex Currencies, Investopedia
Retrieved From
http://www.investopedia.com/university/forex-currencies/?ad=dirN&o=serpSearchTopBox&qsrc=1&o=40186

Pettinger, Tejvan, Inflation and Exchange Rates, 17 May 2012, Economics Help
Retrieved From
http://www.economicshelp.org/blog/1605/economics/higher-inflation-and-exchange-rates
Retrieved From

Retrieved From
http://www.traderplanet.com/articles/view/164104-how-currency-traders-can-reduce-their-taxes/

*RSI Forex Trading Strategy*, Swing Trading Strategies
Retrieved From

http://www.babypips.com/school/preschool/what-is-forex/what-is-traded.html

Retrieved From

Stone, Chris *Sector Rotation: The Essentials*, 30 January 2017, Investopedia
Retrieved From
http://www.investopedia.com/articles/trading/05/020305.asp

*Tax implications of Bonds and Bond Funds*, Fidelity Investments
Retrieved From

Trader Planet (2012) [Example of Bollinger Bands, Line Graph], Trader Planet,
Retrieved From

*Trading System Test: Simple System32*, Baby Pips.com
Retrieved From

Tun, Zaw Thihan, 15 August 2016, *Best Undergraduate Degrees for Day trader*, Investopedia
Retrieved From
Vonko, Dima, *Fundamental Analysis For Traders*, Investopedia
   Retrieved From
   http://www.investopedia.com/articles/trading/06/fundamentalapproach.asp

*Walk-Forward Testing*, Amibroker.com
   Retrieved From
   https://www.amibroker.com/guide/h_walkforward.html

X-Rates.com (2017) [GBPUSD Monthly Average for 2016, Bar Graph], X-Rates
   Retrieved From
   http://www.x-rates.com/

   Retrieved From
   https://www.sec.gov/reportspubs/investor-publications/investorpubsdaytipshtm.html