

Trading System Development

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Abstract

The purpose of this Interactive Qualifying Project is to develop a system of trading and investing strategies for the equity market that outperforms the major market indices. The strategies were developed individually, but each strategy was developed to perform in a specific set of market conditions to ensure that the strategies were not repetitive. Although not all individual strategies outperformed the market on a consistent basis, when combined to create a system of strategies, our group was able to develop a system of systems that regularly outperformed major market indices. The system of systems generated returns of 8.48% over a two-month period with real time trades while SPY, an ETF that tracks the S&P 500, returned just 0.3% over the same two month time period.

Chapter 1: Introduction

The purpose of this report is to outline the process of developing a system of trading and investing systems that can outperform major market indices. With a growing number of people looking to control their own finances, it is important to have a basic understanding of the financial markets. New sources of information have provided individual investors the information to make informed decisions on investments. Using basic knowledge of the financial markets, individual investors can begin to establish a supplemental source of income and to help take control of their own finances. With roughly 50% of Americans owning stocks, it is crucial to have a basic understanding of the financial markets and develop a system to maximize profits (Ingraham, 2017).

The system of systems outlined in this paper was developed with the intention of creating a system that can profit in all market conditions. For the purpose of the system, we categorized the market conditions based on overall market direction and volatility, resulting in four distinct market conditions; upward trending market and low volatility, downward trending market and low volatility, upward trending market and high volatility, downward trending market and high volatility. By creating individual systems that were successful in at least one of these market conditions, we were able to combine the individual systems into a system of systems that would be able to hold positions and profit at all times regardless of the market condition.

Chapters 2, 3, and 4 will provide a general background on the financial markets, trading and investing systems, as well as other background information that is needed to develop a successful system. Chapters 6, 7, 8, and 9 will then provide examples of trading and investing systems that we have developed, with chapter 10 outlining the process of combining the individual systems in to a system of systems to improve results.

Chapter 2: Overview of Financial Markets and Macroeconomics

This chapter will provide a general overview of the financial markets as well as macroeconomic theory.

2.1: Characteristics of Trading and Investing

Trading and investing can both be defined as purchasing an asset with the intent to sell later for a profit. The difference in the definition of trading and investing is that traders open a position with the intent to sell after a certain event occurs, such as an earnings release, while investors will hold their positions for a much longer time period.

Trading and investing are two very different approaches to profiting from the stock market. Individuals that choose to take an investing approach are typically more patient and prefer a less hands on strategy or are interested in long term gains rather than short term. A key factor that differentiates trading from investing is that individuals that partake in investing strategies construct very detailed portfolios containing various stocks. A portfolio can be defined as a grouping of assets. An asset is defined as, “a resource with economic value that an individual, corporation or country owns or controls with the expectation that it will provide future benefit” (Investopedia, 2016). An investor purchases various assets that are available such as stocks, bonds, and other funds. For our purposes, we will cover the stock portion of the asset classes. Stocks incorporated in portfolios are bought and held for extended periods. Typical holding periods for investors are years or even decades. Trades can be made in minutes, or even seconds. Trading is the active involvement in the financial markets with the ideology that the individual(s) will be able to outperform investing portfolios.

<u>Characteristic</u>	<u>Trading</u>	<u>Investing</u>
Time horizon	Short term	Long term
Valuation Technique	Technical	Fundamentals

Figure 1: Characteristics of Trading and Investing

Trading involves frequent buying and selling of stocks, bonds, and other assets. The goal of trading is to outperform the market indexes and investment portfolios using various technical and fundamental analysis. The phrase, “buy low, sell high” is a general principle of trading. Stocks purchased at a low price and then sold back at a higher price would be classified as a “long” position. When stocks are bought, the general idea is that the stock’s price will increase. However, there is another order position that can be considered. Unlike a long position, selling short is the idea that a stock's price will decrease.

The differences between traders and investors can be seen in Figure 1 above. The main difference is the time frame in which stocks are traded and held. As mentioned previously, investors hold on to the stocks they purchase, whereas a typical trader can be actively in and out of the markets within months,

weeks, days or even minutes. The other main difference is the type of analysis that is used. Traders tend to focus on technical analysis, an analysis technique that focuses on recent price movements to attempt to predict the future price, while investors tend to use fundamental analysis, an analysis technique that focuses on the financial statements of the company.

Depending on the individual, an investor's approach can be advantageous. Common perks such as dividends, stock splits and compounded interest are just some of the benefits to consider, to name a few.

When trading, there are very distinct advantages to capitalizing on the financial markets. Technical analysis provides traders with tools to identify how stocks are performing and can provide valuable information such as trends and patterns. Not only can traders benefit from technical analysis to monitor the markets, they are also able to utilize fundamental analysis of companies to help identify the top performing stocks from the weaker stocks. Traders are better suited to capitalize on short term price movements, due to their constant monitoring and hands-on analysis tools. Although traders can profit in the short-term, there are disadvantages to trading. For instance, the commission individuals must pay to purchase a stock, can negatively affect traders that do not actively track and their commission costs. Traders pay a higher commission compared to investors since a commission is charged whenever a trade is made. Small commissions can add up over time which can greatly decrease profits. In addition to commission, trading tends to be more volatile than investing since traders tend to have fewer open positions than investors at a given time, resulting in less diversification.

Whether investing or trading, success is typically based on performance compared to a particular index such as the Dow Jones Industrial Average or the S&P 500. If a trader or investor are not able to develop a system that can outperform these benchmarks, then it would be more profitable to invest in an index fund that tracks the overall market. Eugene Fama believed that in the long run it is impossible to outperform the overall market since the market is efficient and all stocks are valued correctly and developed the Efficient Market Hypothesis. The Efficient Market Hypothesis states that it is not possible to outperform the market since the equity market is an efficient market and all information has already been factored in to the price of stocks (Cochrane, 2018). The stock market is setup to reflect all relevant data and a stock always trades at price decided on by a buyer and a seller which makes it impossible to determine undervalued stocks. Active traders and investors disagree with Fama and attempt to outperform the market and maximize their profits. With this said, mistakes and losses occur from this idea. This may impact traders more often since they make numerous trades and often time may try to hold an already winning trade to maximize profits, which in turn can lead to these individuals losing money due to volatility in the financial markets.

The stock market provides individuals with countless opportunities to make money and to prepare financially for their futures (Radzicki, 2018). Luckily, individuals seeking to venture in to the world of the financial markets may do so depending on their own preferences and desires. Whether an investor or trader chooses to invest in index funds or attempts to develop their own system, it is important to monitor the overall economy to determine whether to enter or leave the market. When attempting to gain a clear picture about the overall economy it is very important to be familiar with the business cycles and the determinants of the macroeconomy.

2.2: Macroeconomics: Trends and Cycles

Macroeconomics is defined as the "branch of the economics field that studies how the aggregate economy behaves." This covers different aspects of the economy such as inflation, rate of growth, and change in unemployment (Investopedia, 2016). Traditionally, macroeconomics as it pertains to the financial markets focuses on GDP, unemployment, and inflation. Since macroeconomics is heavily

influenced by the business cycle, there is a trend and a cycle in the macroeconomic data. The trend is defined as the general direction, whether it is up or down over an extended period of time, while the cycle is a pattern within the trends over a shorter time period.

Macroeconomic has a very large impact on the financial markets. The two main macroeconomic indicators that are monitored by traders and investors are GDP and the employment situation. Sturdy growth and low unemployment instills confidence in investors, which typically results in an increase in equity prices, but high unemployment or lower than expected GDP growth tends to have a negative effect on equity prices.

The trend and the cycle of the macroeconomy can also be applied to equities. Understanding trends are important as they can help tell you predict which way an equity may be heading. A trend is the general direction that a stock is heading towards, whether the trend is going up or down. When the market is trending upwards it is considered a bull market while a downward trending market is referred to as a bear market. From using long term trends, as well as short term trends, a trader can see the qualities of an equity. Whether an equity is consistent in either trending up or down, or if it is very volatile and fluctuates greatly can often be told by understanding and seeing an equity's trend.

Seeing a pattern in the trends, called a cycle, of an equity can also be very informative in helping decide what to do with any given equity (Radzicki, 2018). One may be able to see a good, reliable cycle of an equity and predict what happens to the equity in the future. An equity may also be very unreliable in terms of cycles, resulting in uncertainty of future price movements.

2.3: Sectors and Sector Rotation

The 10 sectors of the stock market are Consumer Discretionary, Consumer Staples, Energy, Financials, Healthcare, Industrials, Information Technology, Materials, Telecommunications Systems, and Utilities. Each of these sectors are then split up into their own industries which altogether add up to 90 industries. Consumer Discretionary consists of retailers, media companies, and other consumer companies, which generally benefit consumer spending. Consumer Staples are made up of food, beverage, and other companies that consumers are unable to cut from their budget, which makes these companies better during “economic downturns”. Energy is made up of oil, gas and production companies, whose successes are normally correlated with the price of crude oil. Financials are made up of banks, investment funds and relating companies. This sector is normally linked to interest rate rise, which gains value from mortgages and loans. Healthcare consists of biotechnology companies as well as hospital management firms and other companies, because people continually require medical aid this is also considered a “defensive play” like Consumer Staples. Industrials come from aerospace, defense machinery and other manufacturing companies. The demand for construction and manufactured products drive this sector generally. Information Technology is made up of electronic manufactures, software and information technology companies. Upgrade cycles and the overall health of the company are normally correlated with this sector. Materials consist of mining, refining, and other companies based on discovering and developing materials, this sector is left vulnerable to the business cycle because it is considered to be the beginning of the supply chain. Internet and cable providers, along with other satellite and communication companies make up the Telecommunications Systems Sector. This sector normally generates recurring revenue from its consumer customers, although subsection sometimes face rapid change. Finally, Utilities which consist of electric, gas and water companies are the final sector, this sector also generates consistent income from its consumers.

Sector rotation is defined as “an investment strategy involving the movement of money from one industry sector to another in an attempt to beat the market” (Stone, 2017). The stock market is split up

into 10 different sectors, and the idea of sector rotation is to look at the different sectors and put money into the sectors that are doing well, and then short the sectors that are not doing well.

2.4: Asset Classes

There are four main asset classes of financial instruments. The four classes, equities, bonds, currencies, and commodities are all connected by the rotation of assets between sectors throughout the business cycle. Generally, commodity prices and the United States dollar trend in opposite directions, commodity prices and bond prices trend in opposite directions, and stock and bond prices trend in the same direction. Financial institutions use this knowledge to move large amounts of money between asset classes at varying points in the business cycle, an edge that can be used by individual investors if timed correctly.

<u>Asset Class</u>	<u>Advantages</u>	<u>Disadvantages</u>
Equities	Large amount of data on companies, easy to open a brokerage account, high liquidity	Strict government regulations, low leverage ratio, markets only open 6 and a half hours on weekdays, high commission costs
Currencies	Very high leverage ratio, markets open at all times, low commission costs	Strong knowledge of macroeconomy of multiple countries is needed
Bonds	Low risk	Low rate of return
Commodities	Wide range of goods, high leverage	Low liquidity

Figure 2: Advantages and Disadvantages of Asset Classes

Each asset class has advantages and disadvantages such as tax laws, margin rules, and liquidity, all of which can be seen in Figure 2 above. Equities, more commonly known as stocks, are a share of an individual company. When a share of stock is purchased, the buyer becomes a partial owner of the company. The liquidity of equities varies depending on the market capitalization and trading volume of the company. Companies with large market capitalizations and high trading volume, such as Amazon.com Inc. are highly liquid, but smaller companies with low trading volume, such as Greif Inc. are not very liquid and will take longer to convert to cash (Mueller, 2017). Since equities is one of the most popular asset classes, there are a large number of regulations in place. Gains that are made using equities are heavily taxed through taxes on both dividends and capital gains. Traders can apply for Trader Status, allowing them to deduct costs related to their office or any training that they undergo, but also increases the chance of audits from the IRS. When trading equities, there is a 50% leverage ratio, meaning that in order to purchase the equity, the buyer must have at least 50% of the money to make the trade

(Investopedia, 2017). Also, in order to day trade equities, there must be a minimum of \$25,000 in the account (FINRA, 2018). Despite all of these requirements, equities are one of the most widely traded asset classes and are often a key holding in retirement accounts along with bonds.

Bonds are generally thought of as loans. Bonds are mainly issued by large corporations and the federal government and are rated by third party rating agencies based on the risk of the issuing entity defaulting on the loan. The highest rating is AAA, which have very low risk but also very low rates of return. Bonds can also be traded on margin, with a margin rate of up to 100% depending on the rating of the bond. Similar to equities, the liquidity of bonds depends on the issuing entity. Bonds issued by the federal government are very liquid and can easily be converted to cash.

Unlike the large number of regulations regarding equities and bonds, currencies have very few regulations. There are no day trading requirements for currency trading and currency accounts have a margin requirement of just 2%, allowing currency traders to trade amounts that are 50 times as large as the amount of capital in their account. Unlike equities, currencies can be traded at any time, with markets being open all 24 hours of the day. There are also very low transaction costs for each trade. Currency traders must have a very strong understanding of macroeconomic events and the economy of each country that they are trading.

Finally, one of the least used asset classes for individual investors and traders are commodities. Commodities are physical goods such as grain, metals, and oil which are traded through futures contracts. The holder of the contract has the right to buy a set amount of the commodity on a certain date at a predetermined price. Traders do not purchase future contracts with the intent to receive the actual good, but to sell the contract at a higher price as it nears the expiration date. Commodity traders can take on a very high amount of leverage as they only need to pay the cost of the contract. The liquidity of commodities depends on the commodity, time until expiration, and price, but commodities are typically less liquid than the other asset classes (Investopedia, 2018).

2.5: Principles of Technical Analysis

Market breadth is a technique used in technical analysis that attempts to gauge the direction of the overall market by analyzing the number of companies advancing relative to the number declining. If more companies are doing better than worse than it is said that the market trend is controlled by the bull and vice versa. Since a stock's price is determined by the quantity of people buying and selling that stock it's important to look at the entire market before first evaluating an individual stock. The entire market is traded through stock exchanges all over the world. A stock exchange is a marketplace in which securities, commodities, derivatives and other financial instruments are traded. The New York Stock Exchange and the NASDAQ are two of the most popular exchanges in the world. As people trade on these stocks they continuously want to know how the market is doing before trading. Investors and traders want to see how certain aspects of the market are trending in order to make accurate decisions. The main indices used when evaluating the market are the Dow Jones, Nasdaq, and the S&P 500. These stocks are market trends for different types of stocks. The Dow Jones for example is one stock price that measures the 30 top industrial companies in the market. The S&P does the same for the top 500 companies and the NASDAQ does the same for the top technology companies. All these indices are important to look at because they measure the large drivers of the entire market and therefore can be a great guide to understanding overall market movements (Investopedia, 2006).

Chapter 3: Overview of Trading and Investing Systems

To succeed in the financial markets, whether trading or investing, it is extremely important to develop a system. A system is a set of rules that cover all aspects of trading and investing, such as exit and entry rules, allocation rules, and stock selection rules. This section will provide a general overview of both trading and investing systems.

3.1: Investing Systems

The differences between trading and investing result in a number of differences between trading systems and investing systems. There are two main components of an investing system; selection rules and allocation rules. Selection rules are rules that an investor uses to pick which companies to invest in. Selection rules provide an edge for investors and determine the investor's investing style. Two of the most common investing styles are growth investing and value investing. Growth investors will search for stocks that have shown strong earnings growth in recent years, with the hope that the earnings will continue to increase. Value investors, on the other hand, search for companies that the market is currently undervaluing using various fundamental analysis ratios. One of the most common ratios used by value investors is the price to earnings ratio, or P/E. The P/E ratio is used to determine the price an investor has to pay for a company's earnings. The higher the ratio, the more overvalued a company is. Both value and growth investing can be successful but are often successful at different points in the business cycle. Value investing is typically successful at the start of a bull market, while growth investing tends to be the most successful in the middle and later stages of a bull market. A common set of growth investing selection rules is the CANSLIM investing method (American Association of Individual Investors). William O'Neil developed the CANSLIM method which can be seen in Figure 3 below. If an investor follows the CANSLIM stock selection strategy, the investor will only invest in stocks that meet all of the criteria outlined in Figure 3.

Current Quarterly Earnings	Company has current earnings per share growth of at least 25% in the most recent quarter
Annual Earnings Growth	Company has annual earnings per share growth of at least 25% for the past three years
New Product	Company has recently released a new product or service, or have experienced a change in leadership
Supply	Price of the stock has increased recently and is trading at a high volume
Leader or Laggard	Company has a relative price strength of at least 70 compared to other

	companies in the same industry
Institutional Sponsorship	At least 3 large institutional owners that will provide support for the stock
Market Direction	Only invest in a company during a bull market

Figure 3: CANSLIM Investing Selection Criteria

The other type of rules in a successful investing system are allocation rules. Allocation rules are rules that determine what percent of the total amount of money in the portfolio to allocate for each individual stock. It is important for an investor to develop allocation rules that fit the risk profile of themselves and their clients. The most common allocation rule used by investors is Modern Portfolio Theory. Modern Portfolio Theory is a set of allocation rules developed by Harry Markowitz in 1952 and won a Nobel Prize in 1990 (Markowitz, 1952). Modern Portfolio Theory states that the risk of a portfolio can be defined as the standard deviation of the portfolio's returns. The goal of Modern Portfolio Theory is to determine the allocation that will minimize the portfolio's standard deviation, thus minimizing the risk of the portfolio. Other allocation rules, such as allocating an even amount of money for each stock in the portfolio can be used but must be defined in order to have a successful investing system.

There are other rules such as rules to determine when to enter and leave the market that can be implemented in investing systems, but selection and allocation rules are necessary for all investing systems, both active and passive.

3.1.1: Financial Ratios and Investing

Financial ratios are a valuable tool in evaluating the performance of a company. All publicly traded companies are required by law to release quarterly financial statements. These statements provide data for investors to determine various financial ratios that can be used to evaluate the performance of the company. Many of the ratios incorporate the earnings of the company, such as the price to earnings ratio. There are five main categories of financial ratios; profitability ratios, capital market ratios, efficiency ratios, solvency ratios, and liquidity ratios (Wilkins, 2016). Together these various financial ratios allow investors to evaluate the performance of a company. Different investing strategies rely on different ratios to select stocks, with each ratio providing different information (American Association of Individual Investors).

3.1.2: Active and Passive Investing

Active Investing is different than long-term investing in that instead of buying and holding a stock, an active investor may purchase a stock with the intention of holding for an extended period of time but will monitor the performance closely and be more likely to close the position. Active investing can be seen as almost a middle ground between trading and long-term investing. Active investors tend to trade individual stocks and monitor their performance closely, while passive investors tend to hold index

funds or mutual funds, two instruments that require less knowledge of the financial markets and monitoring by the investor.

3.2: Trading Systems

Trading systems generally contain more rules than investing systems, but the main rules are similar. In a trading system, a trader uses various parameters and rules for aspects such as position entry, exit, sizing, as well as rules to limit possible losses.

3.2.1: Manual vs. Automatic Trading Systems

When placing trades, one either uses the process of manual trading or automatic trading. The process of automatic trading is one where a trader will use different algorithms and computer codes to automatically place trades when a defined set of rules are met. Writing a computer program that will monitor the stock prices and will go in and out depending on which rules are met can help maximize profit and do the trading work for you. Some pros that come with using automatic trading is that when coding correctly, it can execute trades at the best possible times. These trades with the code are almost instant and very accurate so you are able to get stocks at the desired prices. Also, through the use of automatic human error can be avoided and emotion that is normally involved in stock trading, whether it is actual errors on making trades on stocks, or mental errors such as staying in a stock past the defined exit rules.

Some cons with automatic trading are that when the code is not properly put together it can minimize the stock profit, by either leaving the stock too early or leaving too late for example. Also automatic trading can neglect outside factors when it come to the stock market, like daily news in regards to different stocks.

Manual trading is the original trading method when entering and exiting trade is determined by the actual trader through their own decision making. They use different factors and indexes to better inform the trader of the stock, but the trader will ultimately decide when to go into and out of which stock. Although the trades are not executed by the computer, manual traders still must define a strict set of rules and be able to abide by these rules at all times (Domowitz, 2006).

3.2.2: Support and Resistance in Trading

One technique of analysis that works with the trends of a stock is support and resistance levels. Support and resistance is a technical analysis tool used mainly in trading systems for the stock market. A “support level” is where the stock price drops to a level that it is difficult to pass through, oftentimes referred to as the floor of the stock. The stock price is likely to rebound off a support level and move in an upward direction until it tries to challenge the resistance level. However, a stock price can also break through a support level, thus making the previous support a resistance level. A “resistance level” is where the price will likely find resistance as it rises. The price once again can either break through the resistance level or bounce off and continue downward. Support and resistance levels aren't precise levels that can be predicted but are rather determined based on previous stock price data. To identify support and resistance levels, specific areas in stock price data must be analyzed. These areas are locations where the stock price data is best “held”.

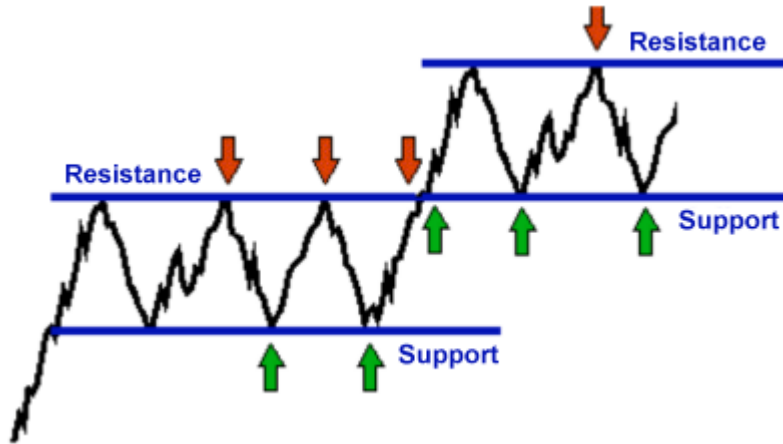


Figure 4: Support and Resistance via InvestTech

Common trends that occur from support and resistance are Breakouts and Breakdowns. Breakouts occur when a stock price challenges a level of resistance and rather than being held, the price breaks through the resistance. Once a breakout occurs the price is expected to climb higher based on previous breakout trends. A “breakdown” precisely occurs in the opposite direction of a breakout, however occurs in areas of support rather than resistance.

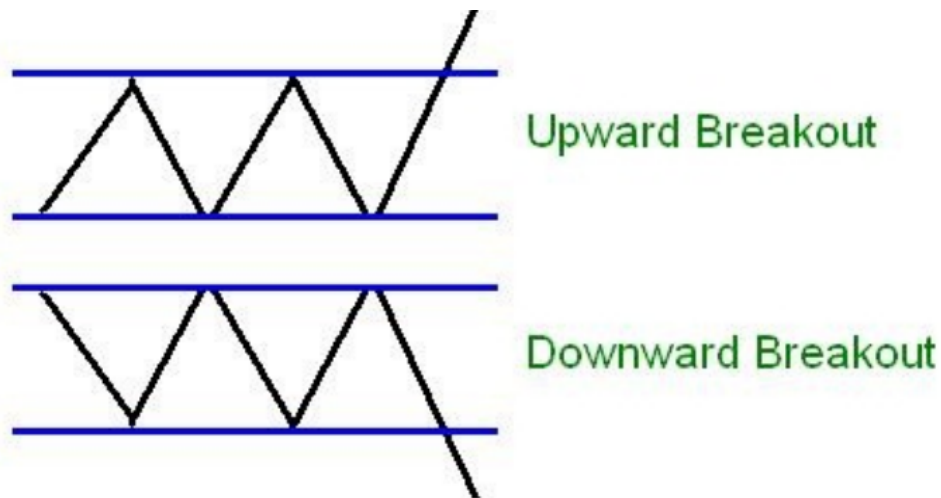


Figure 5: Breakout vs. Breakdown

3.2.3: Keltner Channels and Bollinger Bands in Trading

Keltner Channels are another important tool that is used in many systems. These channels are essentially indicators for trading that identify reversals with channel breakouts and channel direction (Evans, 2017). They are represented by two lines above and below the central moving average, these are the Keltner channels. Using these two channels it is possible to predict price movement using the average

true range and determine channel direction and channel movements. The average true range is a measure of a stock's volatility. When there is growth in the average true range a trader can identify that a stock's price will move up or down because of its volatility growth, then using the Keltner channel you can identify whether the stock will ride the channel line or break through the channel.

Bollinger bands work similarly. In this case however the measurement of volatility is based on standard deviation. If a stock price's standard deviation widens from the mean the bands will also expand insinuating that the stock's volatility is growing. The bands are then used the same way as Keltner channels except the bands also incorporate the stock's closing price in order to more accurately predict the stock's potential growth or decline (Investopedia, 2018).

The financial markets are prone to countless stock price reversals. Stop and Reverse strategies, which are integrated in Bollinger bands, minimize risk by reversing initial positions to follow the current trend of the market. This strategy uses the premise that traders can't predict the short-term direction of a stock price when intraday trading. Rather than riding out price movements, traders simply go with the flow of the price movement (Fidelity Investments, 2017).

3.2.4: Time Frames

Another important consideration on any trade system are time frames. Time frames are essentially the parameters of how long someone will hold a position. Each time frame describes a type of trader. Each time frame has its own advantages and disadvantages, and a trader must choose a time frame that suits their strategy. The first type is called scalping. This time frame is considered to be one of the faster versions of trading because the trader will buy and sell many stocks in anticipation of small and correct price movements. The theory is that a trader can collect many little winners over time in order to create larger profits. However, someone who scalps must also be aware that one large drop could mean that all the little profit that was made was for nothing. Essentially you need very strict exit strategies to ensure you don't have a major loss and to protect from the large commission costs generated by making so many trades. The next form of trading is day trading. Day trading is just what it sounds like, it is the process of trading throughout the day and pulling out regardless of what you think will happen tomorrow. The beauty of day trading is that not only can you sleep at night knowing you have no money on the line, but also you will know your exact profit margins once the day is over. Similarly, to scalping, day trading is a short time frame and therefore also demands a strong exit strategy. Just because you are day trading does not mean you have to hold for the entire day.

Swing trading is a strategy that could last anywhere from two days to several weeks. This strategy probably uses the best mix of the fundamental thought as well as a technical analysis and is really the main strategy used throughout in our trading systems. Swing trades are specifically helpful when there is anticipation of strong price movements over short periods of time. Swing trades have their downsides as well. When holding overnight a trader risks not knowing what might happen to their stock, and therefore missing a price drop could be detrimental to the stock. Holding overnight also requires a trader's undivided attention at all times. The last time frame does not require constant attention but is also much less likely to be used by your average trader.

Long-term position trading is the idea that a trader buys or sells a stock and will hold it for months or years in anticipation of long term growth. This type of investing is typically used by large companies and investment firms but can also be useful for individual investors. By using this strategy, traders can keep commission costs low, and don't have to worry about short term problems with the

stock. The disadvantages are that holding for long time means that a trader's funds remain in one position for an extended period and other positions cannot be opened.

3.2.5: Order Types

It is essential for market goers to have a proper understanding of each order in order to maximize their profits as well as to minimize errors when submitting an order. The 3 main order types relevant to this IQP are market orders, limit orders, and stop-loss orders. The most common order type is a market order.

When issuing a market order, the individual is buying or shorting an asset at the best available current price. It is important to note that the best available current price isn't always price that appears when initially placing the order. Secondly, limit orders are a slightly different order type. When issuing a limit order, the individual can purchase an asset at their own determined market price is the price they opt for is reached. Limit orders are often referred to as take-profit order because the individual is able to set their minimum and maximum of how much they are willing to purchase asset. However, it is important to realize that if the specified order price isn't met, the order will not be filled.

Stop-loss orders are seemingly similar to limit orders whereas the individual places an order to buy or sell an asset when the price increases past a particular point determined. The key difference is that stop-loss orders are turned to market orders once the assets price goes beyond the predetermined price (Security and Exchange Commission).

Chapter 4: Optimizing a Trading System

Optimizing a trading system is a critical step in developing your system into a consistent and profitable system. Through proper optimization and back testing, market goers are able to find the best parameters and guidelines for their personal trading system. In this Chapter, we will explain all the different techniques to optimize trading systems.

4.1: Aspects of Optimization

When attempting to optimize the parameters of a trading system, it is necessary to have an objective function and constraints the parameters that need to be optimized. The objective function is defined as the function that the user is attempting to minimize or maximize, and the constraints parameters are the variables that are changed in an attempt to change the objective function. An example of an objective function would be the portfolio variance in Modern Portfolio Theory, and in this example the constraints parameters would be the weights of the individual stocks.

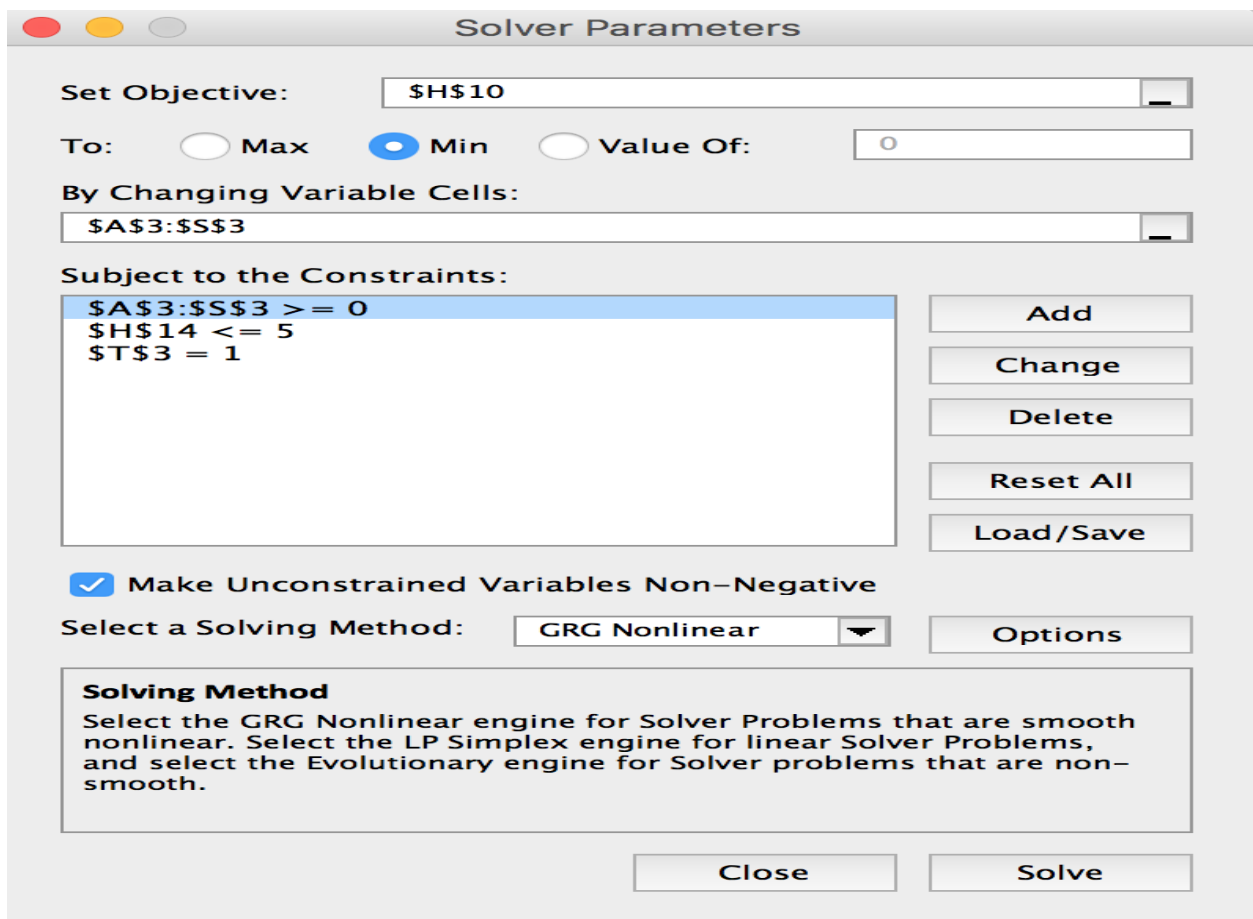


Figure 6: Excel Optimization Software

Figure 6 above is an example of the optimization software Solver that can be used in Microsoft Excel. In this example, it is very easy to see the various aspects that are necessary to use optimization techniques. First, the objective function must be determined, which is to minimize the cell H10, which is the portfolio variance. The value of H10 is changed by changing the cells A3-S3, which are the weights of the individual stocks in the portfolio. Finally, constraints parameters can be set to limit the cells that are changed. After everything is set, the tool runs through all feasible options, and the variables that minimize the objective function are returned (Radzicki, Optimization 2012).

4.1.1: Backtesting and Data Usage

One factor that is crucial for the optimization of a strategy is the correct analysis of back testing information and data usage. There are various sources of data available to individual traders and investors that allow improvements in back testing, but it is important to use the data correctly to accurately back test a trading or investing system. When back testing a strategy, the data must be divided into training data and testing data. This timeframe of the data is ultimately determined by the type of strategy that is being developed. For a long-term investing system, it is necessary to use roughly 10 years of training data in order to train the system in various stages of the market cycle, but for short term trading systems, the training data may be on a lower timeframe depending on the strategies short term goals. Once the divide between this training and testing data has been determined, the training data is used to determine the various parameters of the strategy, and the testing data is used to determine the effectiveness of the parameters that were established with the training data (Radzicki, Optimization 2012).

4.1.2: Walk-Forward Analysis

One tool which utilizes this back-trading strategy for the optimization of parameters is the Walk Forward Analysis. Walk Forward Analysis is the process of putting your trading system through a series of tests to determine the best possible parameters for your trading system. These tests consist of splitting up a sample of data from a stock into several blocks. In these blocks, which can be seen in figure 6, the sample data is further split up into in sample and out of sample data. The in-sample data is what is used to determine the best possible parameters of your system for that specific sample of data, and the out of sample data is what the trading system is tested on with the new parameters. This out of sample data is used to simulate real time trading, as the optimization did not take this portion of the data into account when finding the best parameters. The results from this out of sample data is recorded and the same process continues with the next block which is shifted forward, as shown in figure 7, until the analysis has been performed through all of the blocks of data as shown in the figures below. The numbers from the entire out of sample data results are then used to help determine the best possible parameters for your system (AmiBroker).

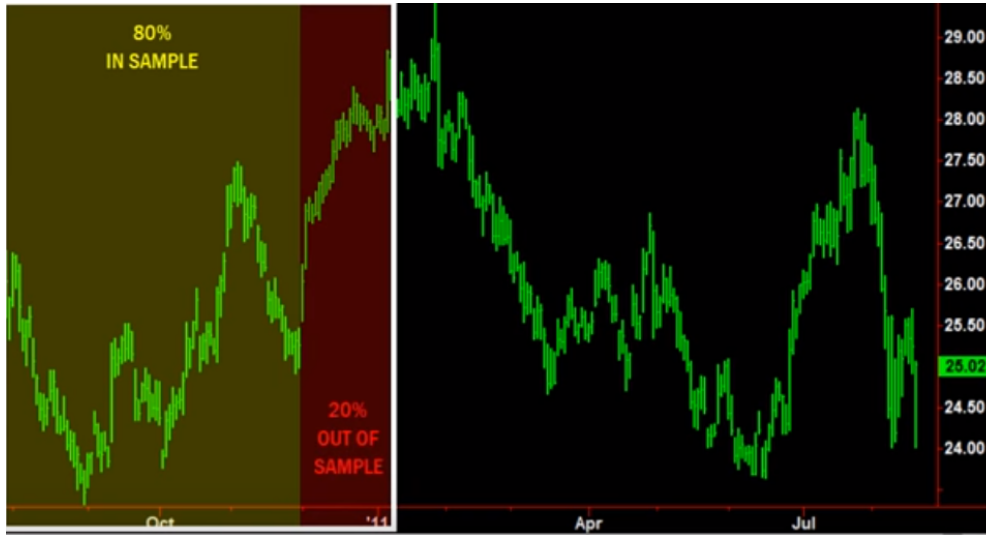


Figure 7: Example Block Walk 1 Forward Analysis



Figure 8: Example Block 2 Walk Forward Analysis

4.1.3: Monte Carlo Simulations

Monte Carlo simulations are an effective technique to model probabilistic systems. The Monte Carlo simulation technique generates a large sample of data, allowing more accurate predictions to be made from the data. Monte Carlo simulations are very effective at determining the effectiveness of trading or investing systems due to the randomness involved in these systems.

Using data from actual trades, Monte Carlo simulations generate a much larger sample of data through probabilistic simulations. This data can then be analyzed to determine various statistics about the system. For example, using the larger data sample, it is possible to determine more accurately the longest streak of losing trades or the maximum expected drawdown before the system should be reanalyzed (Dizikes, 2010).

Chapter 5 - Literature Review

This chapter provides a background on previous research that pertains to each system that our group developed.

5.1: Downside Risk Minimization Investing Strategy Background

The main point of reference for this system was Modern Portfolio Theory, a theory developed by Harry Markowitz in 1952 that subsequently won a Nobel Prize in Economics. In Markowitz's paper, *Portfolio Selection*, he states that investors consider variance as undesirable, and therefore seeks to develop portfolio allocation rules that minimize portfolio variance, thus minimizing the risk of the portfolio (Markowitz, 1952).

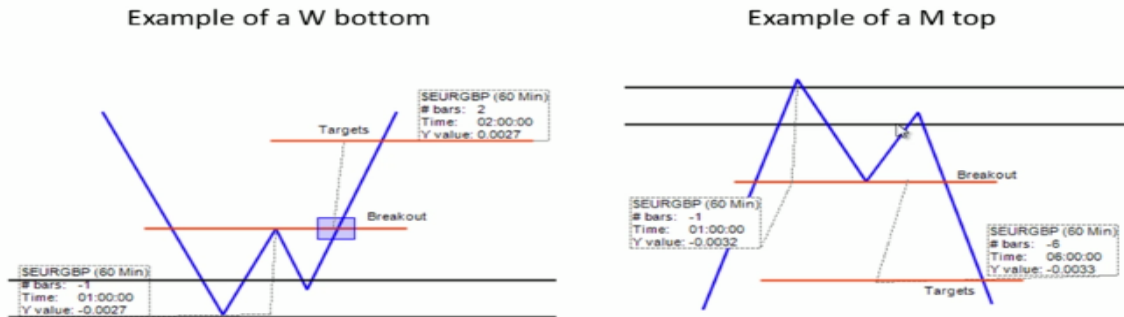
The Sortino Ratio was also a crucial part of developing the investing strategy. The Sortino Ratio is calculated as the expected returns divided by the downside deviation. The Sortino Ratio had traditionally been used as a performance measure, used after the allocation was already determined, rather than a statistic used to optimize the allocation of funds in a portfolio (Johnson, 2008).

The final aspect of prior research that was used to develop the Downside Risk Minimization Strategy was a study conducted by Richard Cohn and Wilbur Lewellen that examined the allocation methods of individual investors. This study, *Individual Investor Risk Aversion and Portfolio Composition* was used to determine the preferences of individual investors with a portfolio of approximately \$100,000, as most research conducted in this area focuses on risk preferences of large financial institutions. The risk preferences and definition of risk differ greatly between individual investors and large financial institutions as large institutions have the capital to recover from large losses, while individual investors may not have the capital or the risk capacity to recover from similar losses (Cohn, 1974).

5.2: M-Top System Background

One system used as a reference in the development of our system was the use of "M Top and W Bottoms" in the Forex Market. In this system, the trader utilizes the different support and resistance lines that he sees in the market and will trade accordingly when they see either a "M" shape or a "W" shape in a certain equity.

M tops and W bottoms



investoo.com
TRADING FOR BEGINNERS

Figure 9: M-Top W-Bottom Visual via investoo

The idea behind this strategy is that as an equity is on an up or down trend, if it hits a certain support or resistance line twice and then swings in the opposite direction, it is indicating a rise or drop in the opposite direction.

Unlike Double Tops and Double Bottoms which may take days for the equity to swing, this strategy is utilized more on an intraday basis on a lower time frame chart. When determining the M Tops and W Bottoms, there are different methods in trading with this strategy. The main method, and the method that was used in this strategy was one which looked took the difference in the upper resistance line and subtracted that from the lower support line, this value would give us our target profit, and the difference in the two pivots in the “M” or “W” would give us the stop loss that we wanted to take. After the “M” or “W” is formed and the equity crosses the support and resistance line, then that is when the trades would be made.

In this example, the traders suggested trading on lower time frames, such as one hour to 5-15 min bars, this would enable the trades to be more frequent in their trades and get a higher volume of trades on the stocks and a potential higher possibility of profit. This idea was utilized in the M-Top automatic trading strategy. Through this reference, the M-Top Strategy was based off the M-Top ideology as well as the use of lower minute bars, which in our personal system was 5 min bars.

5.3: Gap System Background

Searching through other gap trading systems I came across one that incorporated some interesting ideas. This systems objective was to minimize and limit the time commitment needed to trade in the

market. The creator of the system eliminated the detailed entry aspect of trading by simply entering a trade on the market open. The exit aspect of the trading system was also simplified to just closing all trades at the end of the trading day. This system also incorporated the use of gap filling. Gap filling is an interesting concept to use because it is a strong signal that the stock's price will continue in the direction in which the gap was filled.



Figure 10: Example of Filled Upward Gap

Chapter 6: Downside Risk Minimization Investing Strategy (Developed by Riley Doherty)

6.1: Background

When looking at the high commission costs as well as time available, individuals tend to gravitate towards long term investing rather than trading to minimize costs. Once an investor has decided to focus on investing rather than trading, they must also decide whether they believe they can outperform the market. This school of thought is in line with Eugene Fama's Efficient Market Hypothesis (Fama, 1998). If an investor believes that it is not possible to outperform the market, there is no strategy needed and instead the investor should invest in index funds that will track the market. If an investor believes they can outperform the market, there is a wide range of investing strategies that can be implemented. Although long term investing tends to carry lower levels of risk than active trading, it is still possible for an investor to lose a sizable percentage of their portfolio if they enter the market without a strong strategy in place.

Investing strategies are composed of two aspects, stock selection and portfolio allocation. An investor must first choose what stocks to include in their portfolio, and then once selected must choose the percentage of the portfolio allocated to each stock in the portfolio. Depending on the investor's preferences, such as risk tolerance and time frame, the investor's rules for selection and allocation will differ. The traditional method of portfolio allocation among investors is Modern Portfolio Theory, a theory developed by Harry Markowitz in 1952. The purpose of Modern Portfolio Theory is to minimize the overall portfolio variance of a portfolio, thus decreasing the total level of risk involved with holding the portfolio (Markowitz, 1952).

The following investing strategy aims to point out the flaws that are contained in Modern Portfolio Theory as well as observe possible remedies for these flaws. This strategy is focused on improving the portfolio allocation aspect of investing strategies but will also outline general improvements to stock selection strategies.

6.2: Limits of Modern Portfolio Theory

To understand the limits of Modern Portfolio Theory, it is important to first have a strong understanding of the goals of Modern Portfolio Theory. Modern Portfolio Theory is a portfolio allocation method that is aimed at creating a minimum risk portfolio. Modern Portfolio Theory accomplishes this by optimizing the portfolio allocations to minimize the overall portfolio variance, which is determined by the covariances of the stocks in the portfolio (Markowitz, 1952). It is helpful to see the limits in this definition of risk when looking at a graph of the returns of two different securities.

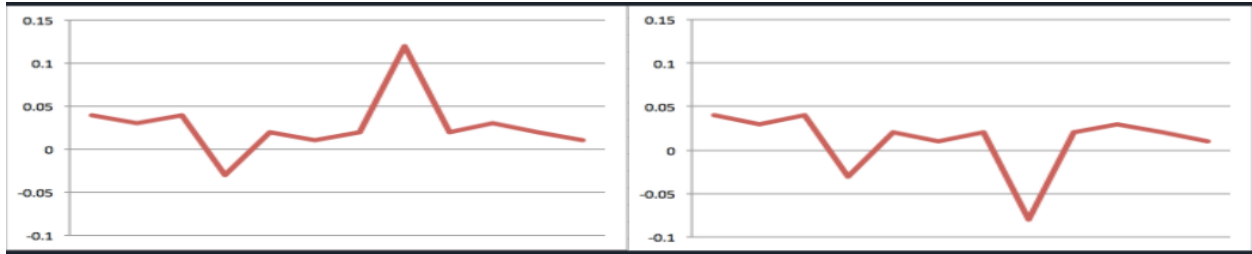


Figure 11: Risk Analysis of Two Securities (Hypothetical Data)

The problem in defining risk as the standard deviation of a security is outlined in Figure 11 above. Following traditional definitions of risk, the two securities are equally as risky, both with a standard deviation of returns of .034, but many individual investors would disagree with this assessment. The two securities have identical returns except for one month, where the security on the right has returns that exceed the average and the security on the left has returns that are far below the average, resulting in the same standard deviation.

Modern Portfolio Theory uses the same definition of risk when determining the allocation for the minimum risk portfolio. By minimizing the variance of a portfolio, Modern Portfolio Theory minimizes both upwards and downwards deviations from the average. The issue is that individual investors do not see upward deviations from the mean as risky returns, but rather celebrate these returns as they are returns that greatly exceed expectations. By minimizing the overall variance, the potential for excess returns is also decreased.

Another issue with Modern Portfolio Theory is the blind use of correlation of past prices to make predictions of future returns. After gathering historical price data, the first step in Modern Portfolio Theory is to develop a correlation matrix. This correlation matrix is then used to determine the covariance of the various securities in the portfolio, but there is no regard for theory included in this process. Modern Portfolio Theory is strictly a portfolio allocation theory and does not cover stock selection theories, but investors believe that any stocks can be used with Modern Portfolio Theory since the correlation of the stocks will be minimized.

These flaws in Modern Portfolio Theory can be remedied fairly easily in order to develop an investing strategy that is far more beneficial for individual investors in developing a minimum risk long term investing approach.

6.3: Issues with the Traditional Stock Selection

Other problems tend to arise during the stock selection process. Many popular stock screeners for individual investors use the same screening criteria for the entire market, rather than tailoring screening criteria for individual sectors of the market. Various sectors of the stock market tend to trade at varying financial ratios, and by screening the entire market with the same criteria, investors are decreasing the correlation of the stocks that are selected since the screen will tend to return stocks from the same sector.

Sector	Average Shiller P/E Ratio
Consumer Discretionary	37.71
Consumer Staples	25.52
Energy	18.14
Financials	23.79
Health Care	26.53
Industrials	21.87
Technology	32.61
Materials	32.21
Telecoms	38.64
Utilities	26.06

Figure 12: Average Shiller P/E Ratio by Sector

Figure 12 shows that different sectors tend to trade at different ratios. In traditional screeners, there is a threshold that is typically used for the entire market. In this scenario, if the Shiller P/E ratio of a stock was one of the criteria used in the screener, and the threshold was set at a Shiller P/E ratio of under 20, the stocks that are returned by the screener would be dominated by stocks in the energy sector, leading to a high correlation of stocks that are held in the portfolio (Siblis Research, 2018).

6.4: Improvements to Stock Selection Methods

Rather than screening the entire market using the same criteria, it is more beneficial to develop individual screeners for each sector. By doing this, individual investors can select leading companies from each sector, ensuring sector diversification in their portfolio. By using this method of stock selection, individual investors are no longer relying solely on historical prices to determine the correlation of stocks in their portfolio but can leverage the theory of sector diversification, which is the idea that due to sector rotation, sector returns will differ (NASDAQ, 2018).

This method also makes it easier for investors to implement other strategies based on sector rotation. Based on personal preference, investors can use various economic indicators or technical indicators to attempt to predict sector rotation patterns. By screening by sector, individual investors can easily leave entire sectors out of their portfolio if they believe that these sectors will perform poorly in the near future. It would be far more difficult to implement these sector rotation strategies if the investor used a full market screener.

6.5: Improvements to Asset Allocation

As previously stated, Modern Portfolio Theory is one of the most popular asset allocation techniques for individual investors, but it does not accurately portray the investor's definition of risk, and reduces portfolio returns. Rather than using optimization tools to minimize overall portfolio variance, it seems more effective for individual investors to optimize their portfolio to minimize downside deviation, as illustrated in Figure 12 below.

Downside deviation differs from overall portfolio variance since it only captures the deviations below a certain threshold that is defined by the investor, called the minimal acceptable return (MAR) (Nawrocki, 2000). Any value that is greater than the MAR receives a value of 0, while the values below the MAR receive a value of the difference between the MAR and actual value. Once these values are assigned, the standard deviation is calculated using these values.

Month	Monthly Portfolio Return	Excess Return	Lesser of 0 or Negative Return
1/1/08	-0.017018073	-0.017018073	-0.017018073
2/1/08	-0.035677557	-0.035677557	-0.035677557
3/1/08	0.259435503	0.259435503	0
4/1/08	0.005017057	0.005017057	0
5/1/08	-0.05162628	-0.05162628	-0.05162628
6/1/08	0.021589535	0.021589535	0
7/1/08	0.012588475	0.012588475	0

Figure 13: Example of Downside Deviation Calculations

Figure 13 shows the process of assigning values for the downside deviation calculation with a MAR of 0. The rightmost column is the column that contains the values used to calculate downside deviation. In the figure, all values with a return greater than 0 receive a value of 0, while all negative returns are included in the calculation. By using this method, the only volatility that is measured is the volatility of returns below an investor's established threshold, a more accurate definition of risk for the individual investor (Baccman, 2003).

6.6: Testing Downside Deviation Portfolio Allocation Strategy

To accurately determine the effectiveness of the downside deviation allocation method, I tested the strategy using various portfolios across various investing strategies. To do this, I selected seven stock screeners from the American Association of Individual Investors website. The seven screeners were selected to encompass all major stock screening strategies, value, growth, momentum, and a combination of all three.

Once the seven portfolios were established, I collected 15 years of monthly price data for each stock. Using this monthly price data, 10 years of data was used as training data, and 5 years was used for

testing data. Using the data, I determined the optimal allocation for the portfolio using traditional Modern Portfolio Theory and minimizing overall portfolio variance, as well as the optimal allocation to minimize downside deviation. Once these portfolios were developed, the 5 years of testing data was used to determine the average annual return as well as percentage of losing months for all fourteen portfolios. The results from these tests can be seen below in Figure 14.

Portfolio	MPT Return	Downside Return	% Losing Months MPT	% Losing Months Downside
Buffetology	0.1778	0.2367	33.6	28.6
Lakonishok	0.1392	0.1493	37.2	21.8
Greenblatt	0.2219	0.2015	39.8	32.3
ROE	0.2423	0.3123	36.9	33.1
O'Shaughnessy	0.2654	0.3411	41.2	36.3
Lynch	0.1899	0.2476	39.4	29.3
CANSLIM	0.1871	0.2341	36.6	27.2

Figure 14: Results of Backtesting Downside Deviation Allocation Strategy

I then conducted a paired t-test to determine if there was a statistical difference between both the returns of MPT and downside deviation as well as between the percentage of losing months of the two different allocation strategies. From the paired t-test, I determined that the difference in average annual returns of the two strategies was significant at the 5% significance level, with the downside deviation allocation strategy outperforming traditional MPT by 1%-7.5% on an annual basis based on the 95% confidence interval. The results were similar for the paired t-test for percentage of losing months, with the difference being significant at the .05 significance level, and a 95% confidence interval of 2-7 more losing months over a 5-year period for traditional MPT.

These tests suggest that optimizing a portfolio's allocation in order to minimize downside deviation rather than portfolio variance is more effective in both increasing returns, as well as decreasing the number of losing months.

6.7: Optimal Portfolio Using Lakonishok Screening Criteria

Using the findings regarding screening criteria and portfolio allocation, I developed the optimal portfolio using the Lakonishok investing theory. Any investing theory can be used to suit the investor's preferences, but the process for developing the optimal minimal risk portfolio would remain the same, except for changes to the screening criteria to match the preferred investing strategy. I selected the Lakonishok investing strategy for this example due to both the proven record of outperforming the S&P 500 as well as the substantial number of companies that pass the screening criteria at this time.

The Lakonishok investing strategy is a value investing approach with aspects of momentum investing included. The screening criteria for the strategy can be found below (American Association of Individual Investors).

1. Market capitalization is greater than \$500 million
2. PE is less than the sector median
3. Price to book value is less than the sector median
4. Relative price strength over the past 26 weeks is greater than 0
5. The relative price strength over the last 13 weeks is greater than the relative price strength over the last 26 weeks
6. There have been no downward revisions in estimated earnings in the past month
7. There has been at least one upward revision in estimated earnings in the past month

Based on this screening criteria, I selected the following stocks for the portfolio, with two stocks from each sector. The selected stocks can be seen in Figure 15 below.

Sector	Symbol	Company
Consumer Discretionary	EBAY	eBay Inc.
	BC	Brunswick Corporation
Consumer Staples	ABG	Asbury Automotive Group
	CENT	Central Garden & Pet Company
Energy	WTI	W&T Offshore Inc.
	SGY	Stone Energy Corporation
Financials	FDEF	First Defiance Financial
	OCN	Ocwen Financial Group
Health Care	IMGN	Immunogen Inc.
	DGX	Quest Diagnostics
Industrials	DXPE	DXP Enterprises
	HCCI	Heritage Crystal Clean Inc.
Materials	EMN	Eastman Chemical Corporation
	SXCP	Suncoke Energy Corporation
Technology	ATVI	Activision Blizzard Inc.
	AMAT	Applied Materials Inc.
Utilities	MRTN	Marten Transport Ltd.
	CMTL	Comtech Telecommunications

Figure 15: Selected Stocks from Each Sector from Lakonishok Screen

After selecting the companies from each sector, I collected five years of monthly price data for each stock to determine the returns of the portfolio. Using optimization techniques, I then minimized the downside deviation by changing the weights of each holding. I also used a constraint that all weights in the portfolio were greater than or equal to 2% of the total portfolio funds to ensure that all 18 stocks are held in the portfolio and that sector diversification is maintained. Figure 16 shows the results of the optimization below.

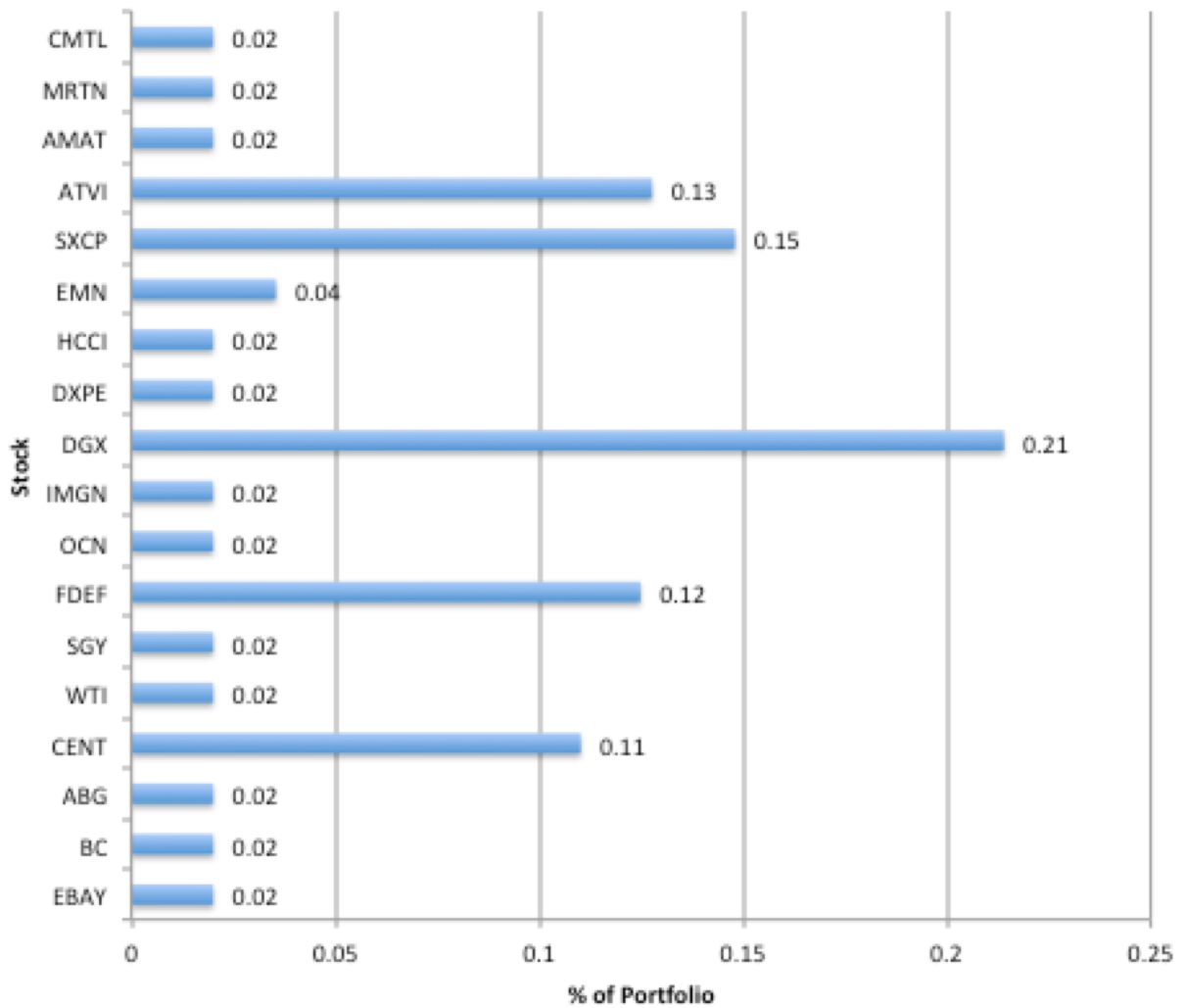


Figure 16: Portfolio Allocation for Lakonishok Portfolio Using Downside Deviation Minimization

Figure 16 shows that 12 of the 18 stocks receive the minimum of 2% allocation, while other stocks receive an allocation of up to 21% to minimize the downside deviation.

6.8: Monte Carlo Analysis

Using the model portfolio that I developed, I ran a Monte Carlo simulation of 500 months to analyze the effectiveness of the investing strategy. The results appear in Figure 16 and Figure 17 below.

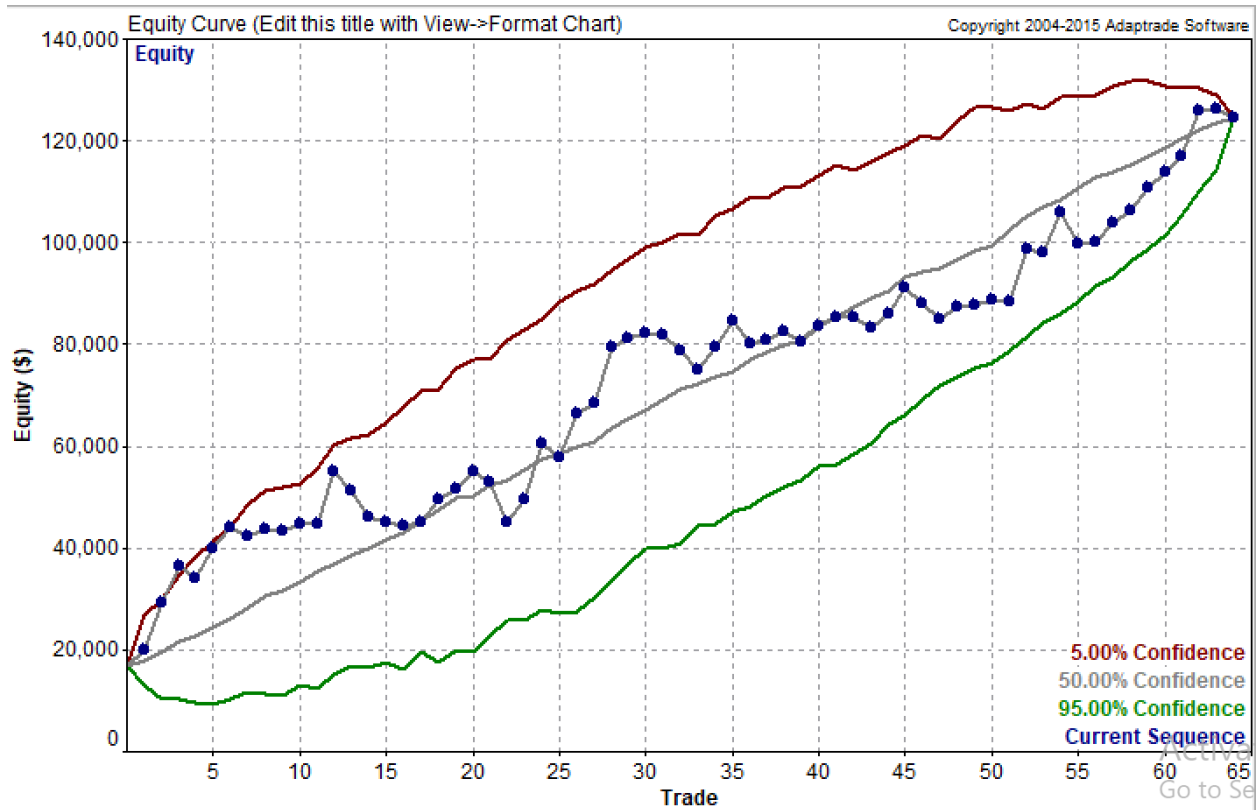


Figure 17: Monte Carlo Simulation of Equity Curve

The red and green lines in Figure 17 are a 95% confidence interval for the equity curve after running 1,000 simulations of the portfolio, while the gray line is the actual equity curve. From the simulation it can be determined that the actual returns were consistent with statistical expectations.

Monte Carlo Results at 95.00% Confidence

Total Net Profit: \$107,830.72	Max Number of Contracts: 1
Final Account Equity: \$124,586.72	Minimum Number of Contracts: 1
Return on Starting Equity: 643.5%	Average Number of Contracts: 1
Profit Factor: 2.839	
Largest Winning Trade: \$11,189.07	Largest Losing Trade: -\$7,858.63
Largest Winning Trade (%): 29.98%	Largest Losing Trade (%): -46.94%
Average Winning Trade: \$4,161.98	Average Losing Trade: -\$2,443.69
Average Winning Trade (%): 7.228%	Average Losing Trade (%): -9.446%
Average Trade: \$1,684.85	Win/Loss Ratio: 1.703
Average Trade (%): 3.458%	Win/Loss Ratio (%/%) : 1.448
Trade Standard Deviation: \$4,293.18	Max Consecutive Wins: 5
Trade Standard Deviation (%): 22.16%	Max Consecutive Losses: 5
Worst Case Drawdown: -\$20,253.93	Return/Drawdown Ratio: 9.240
Worst Case Drawdown (%): 69.65%	Modified Sharpe Ratio: 0.2356
Average Drawdown: -\$6,384.05	
Average Drawdown (%): 15.39%	

Figure 18: Monte Carlo Simulation Statistics

All the results in Figure 18 are the results of a 95% confidence interval. The major conclusions from the Monte Carlo simulation are that there can be five consecutive losing months as well as a drawdown of up to 70% in the portfolio before the results differ from statistical expectations.

6.9: Conclusions

The historical returns of this portfolio should not be expected due to the time period that this portfolio was back tested during, but there is statistically significant evidence to suggest that allocating the portfolio based on minimizing downside deviation rather than minimizing portfolio variance will lead to fewer losing months as well as higher expected annual returns regardless of the investing strategy that is used.

Chapter 7: Auto-M Strategy (Developed by Brian Mahan)

7.1: System Summary

In my personal system, I developed an automatic trading system which utilizes the M-Top strategy as previously mentioned. This strategy works through TradeStation's EasyLanguage and is mainly based off of a built in EasyLanguage function called "pivot". This function is used to tell the user when the direction of the stock is changing, which can be set up to different pivot strengths. To have the code look for the "M" formations, a series of if statements are set up to look for the top and bottom points of the "M". If these top and bottom points are met, and the top points are within a certain range of each other to ensure that the M-Top points are not too far from each other, the code will wait for the stock to drop below the bottom point. Once the stocks drop below the bottom point, also known as the breakout point, the program will short 100 shares at the market. As mentioned, when the stock drops below this point after the "M" formation is formed, it indicated that the stock is likely to continue falling. When shorting these trades, stop losses and profit targets are input based off the values given from the "pivot" functions. The difference between the two tops "M" point value gives the code the stop loss value. The profit target is calculated from subtracting the difference between the top and the bottom points of the "M" by the bottom breakout point price.



Figure 19: Visualization of Profit Calculations

7.2: System Screening

When screening for stocks to use this automatic trading strategy on, I focused on volatile stocks that would fit this M-top and W-bottom pattern. To do this I would screen for stocks that have a beta over 1.5, a volume over 400,000 and a price in between the price of \$10-\$150. These parameters have been set because these lower priced stocks tend to be more volatile, and a beta of 1.5 also ensures high volatility. The high volume is used for assurance that these stocks that are constantly being traded in. Once I screen for stocks that match these parameters and I am given a list of stocks, I will go through the stocks and look for frequent M-Top and W-Bottom patterns in the stocks then choose my final stocks.

Although I found that AAI was mostly focused on investing in stocks long term, and mostly not focused on shorting stocks, I was still able to utilize the AAI software. In AAI, I found that screeners that were based on targeting out of favor stocks were useful in the idea that these stocks would not stay out of favor and were due to rise. Although it is not ideal to look at shorting long term with these stocks, I was able to utilize these screeners by using them to see which stocks were currently out of favor and not doing well. I would use these out of favor stocks to trade with in the short term and continue to check these screeners to update my stock portfolio. From these screeners I would look at stocks that fit my initial screeners to choose the stocks.

7.3: Initial Analysis

When backtesting with these stocks I have seen a profitable system, one which depending on the stock would have a profit factor in the range of 3-7 when tested within a short-term range. I found through backtesting that it is important to consistently screen stocks and look for stocks that are currently showing M-Tops and W-Bottoms. When the system is back tested for extended periods of time, it can be shown to be less efficient as in the short-term stocks. This is because when backtested longer term this system will continue to trade in periods of time when the stock may not be as volatile with frequent M-Tops and W-Bottoms. This emphasized the importance of constantly looking for new stocks and keeping track of how all your stocks are doing, as some stocks may not be as profitable at certain times than others.

TradeStation Performance Summary

Collapse

	All Trades	Long Trades	Short Trades
Total Net Profit	\$154.00	\$0.00	\$154.00
Gross Profit	\$1,663.00	\$0.00	\$1,663.00
Gross Loss	(\$1,509.00)	\$0.00	(\$1,509.00)
Profit Factor	1.10	n/a	1.10
Roll Over Credit	\$0.00	\$0.00	\$0.00
Open Position P/L	\$0.00	\$0.00	\$0.00
Select Total Net Profit	\$96.00	\$0.00	\$96.00
Select Gross Profit	\$1,605.00	\$0.00	\$1,605.00
Select Gross Loss	(\$1,509.00)	\$0.00	(\$1,509.00)
Select Profit Factor	1.06	n/a	1.06
Adjusted Total Net Profit	(\$248.92)	\$0.00	(\$248.92)
Adjusted Gross Profit	\$1,473.48	\$0.00	\$1,473.48
Adjusted Gross Loss	(\$1,722.40)	\$0.00	(\$1,722.40)
Adjusted Profit Factor	0.86	n/a	0.86

Figure 20: NAV Performance Report 1 Year Pre-Optimization

Through performing my initial Monte Carlo Analysis on the stocks, I have found that there were many occasions when looking at my top 8 traded stocks in my portfolio that the equity curve strayed from the Monte Carlo predictions. In these 8 stocks, there were 6 occasions where the equity ran outside of the predictions. This data shows that the Monte Carlo Analysis was not doing a great job predicting the growth of my strategy, meaning that my system may not be as consistent as I would like. Another key finding in the analysis is that there are two occasions where the worst-case scenario of a stock loses all of the money allocated, showing that my strategy can be volatile and risky at times when not executed correctly.

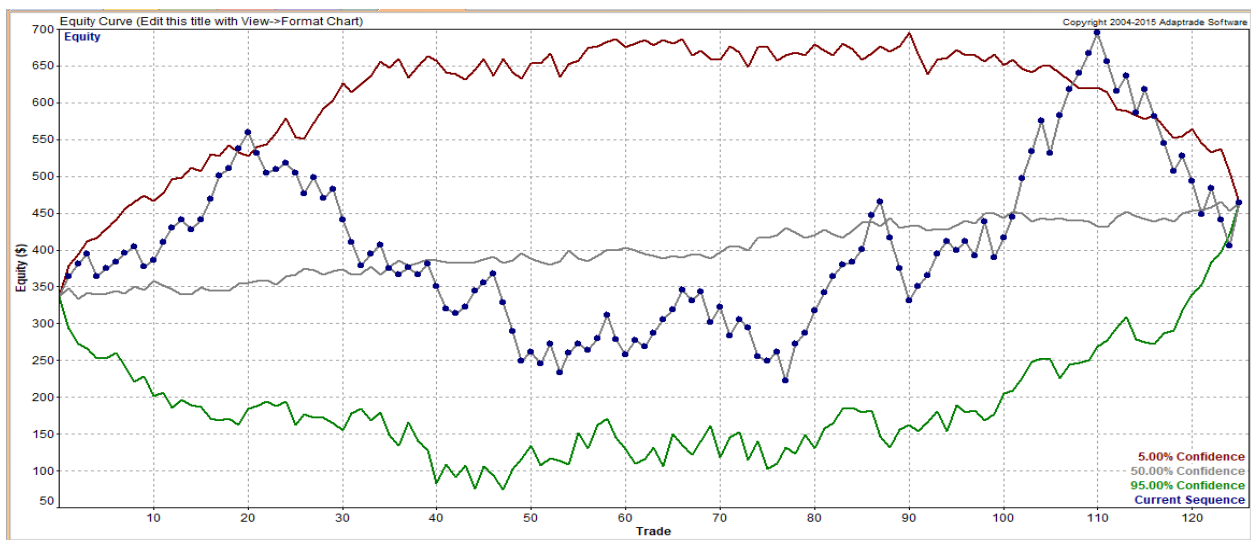


Figure 21: NAV Initial Monte Carlo Analysis

Looking at an example of the status of my NAV stock through this analysis. It can be seen in Figure 21 that the Monte Carlo Analysis shows the stock to be rather volatile and have a large area in between the best and worst-case scenario that the analysis came up with. This can show that the stock system is not performing as consistently as I would like. This analysis also shows how the trend of this equity it not as profitable as I would like. Moving forward from this analysis along with my other stocks, I saw that I needed to create a system that is more consistent and less risky in terms of equity gain. Performing a Walk Forward Analysis on my system to optimize my system parameters in my auto trading system would be able to create a more robust and efficient system.

7.4: Initial Optimization

To optimize my system, I focused on the main part of my trading algorithm which was the pivot function. This function, which provides the user information of when the stock changes from bullish to bearish, or vice versa, is used to help my code look for the M-Tops that I base my strategy on. With this pivot point function, it comes with several parameters which include length, left strength right strength and can be seen below on Figure 22. It calculates this pivot point by looking at a certain range of stocks, given through the length value, and looking for a pivot point based on the left a right strengths. The left and right strengths look for whether the bars before or after are either higher or lower than the potential pivot point depending on whether one is looking for a high or low pivot. For example if this function was looking for a high pivot with the left a right strength of 3, Tradestation will see if there are 3 bars below the right and left of the potential pivot bar.

Parameters

Name	Type	Description
Price	Numeric	Specifies which bar value (price, function, or formula) to be considered.
Length	Numeric	Sets the number of bars to consider for the pivot.
LeftStrength	Numeric	Sets the required number of bars on the left side of the pivot bar.
RightStrength	Numeric	Sets the required number of bars on the right side of the pivot bar.
Instance	Numeric	Sets which occurrence (that is, 1 = most recent, 2 = 2nd most recent, and so on) to return.
HiLo	Numeric	Sets which pivot values to return, 1 = High, -1 = Low.
oPivotPrice	Numeric	Outputs the specified bar value at the pivot point.
oPivotBar	Numeric	Outputs the number of bars ago the pivot point occurred.

Figure 22: Pivot Function Parameters

Since these parameters given to this function factor into determining whether the code will define a point as a pivot or not, different parameter values given to the pivot function can lead to the code recognizing or not recognizing certain M-Tops. To help find the best values for this pivot function and to help the code choose the best M-Tops at a frequent rate, I went to Tradestations Walk Forward Analyzer to look for the best parameters for my system. To do this I went through the various stocks in my portfolio and ran this walk-through analyzer with my M-Top Strategy. With the setup, I differed to the

recommended values for the different parameters given to me by Tradestation: The length being 3-7 incrementing the value by one, and the left and right strengths being 2-6 incrementing by one, as seen in Figure 23. I would run this walk-through analyzer with the data dating back one year for each of the stocks so I would be able to get a sufficient amount of trades to analyze in each option.

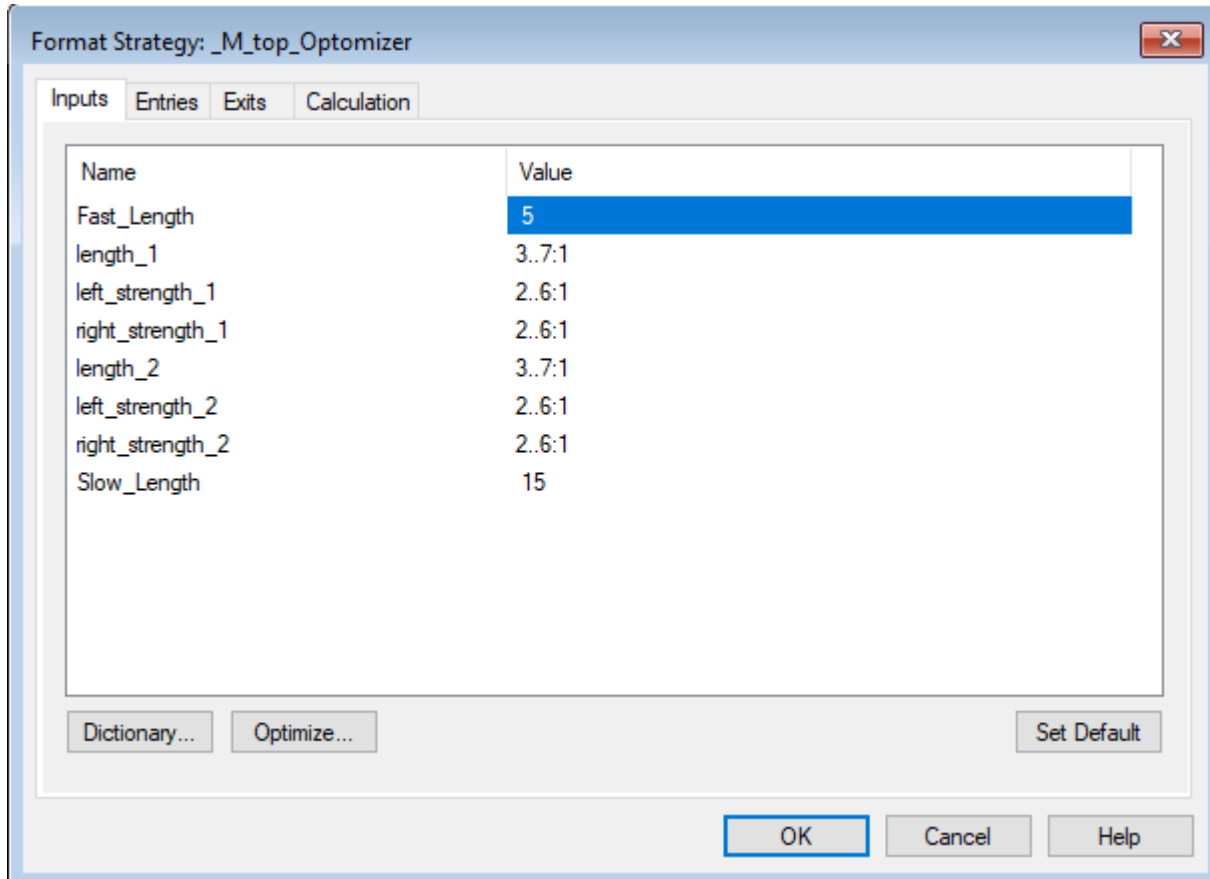


Figure 23: Optimization Setup

From looking at the optimized parameters, although the parameter values varied from stock to stock, it could be seen that most of the preferred values were based around the same values. For the top pivot points, a length of 5 and a strength of 4 were preferred and for the bottom pivot a length of 7 and strength 6 were the most effective. It can be seen in Figure 23 below how the Strategy Optimization report that comes from this walk forward analysis shows all the different parameter options that give the most profit. From looking at this report along with the other reports, it could be seen how the 5-length paired with 4 strengths were constantly in the upper region of the optimization. For each individual stock, after performing the Walk Forward Analysis, I began to use the preferred parameters for each the individual stocks independently, as my hope was to give each stock the best chance to succeed under their own parameters

	top_Optim length_1	top_Optim ft_strength	top_Optim ht_strength	top_Optim length_2	top_Optim ft_strength	top_Optim ht_strength	Test	All Net Profit	All Gross Profit	All Gross Loss	All Total Trades	All % Profitable	All Winning Trades	All Losing Trades	All Max Winning Trade	All Max Losing Trade	All Avg Winning Trade	All Avg Losing Trade	All Win/Loss Ratio	All Avg Trade	All Max Consecutive Winners	All Max Consecutive Losers
1	6	6	2	6	2	3	3,524	997.00	3,104.00	-2,107.00	204	64.22	131	72	134.00	-50.00	23.69	-29.26	0.81	4.89	10	5
2	5	6	2	6	2	3	3,523	942.00	2,993.00	-2,051.00	192	64.06	123	68	134.00	-50.00	24.33	-30.16	0.81	4.91	14	4
3	7	4	2	3	2	2	15	743.00	2,920.00	-2,177.00	208	64.42	134	74	72.00	-57.00	21.79	-29.42	0.74	3.57	8	4
4	7	6	2	6	2	3	3,525	896.00	3,130.00	-2,434.00	215	61.86	133	81	134.00	-67.00	23.53	-30.05	0.78	3.24	10	5
5	7	6	2	3	2	2	25	884.00	3,135.00	-2,451.00	231	61.90	143	87	72.00	-57.00	21.92	-28.17	0.78	2.96	8	5
6	6	6	2	5	4	2	1,524	880.00	2,589.00	-1,889.00	177	61.02	108	69	70.00	-55.00	23.79	-27.38	0.87	3.84	8	4
7	4	3	3	7	2	3	3,657	877.00	2,228.00	-1,551.00	156	64.74	101	54	70.00	-50.00	22.06	-28.72	0.77	4.34	11	3
8	7	6	2	3	6	2	2,525	854.00	2,075.00	-1,421.00	136	64.71	88	48	72.00	-67.00	23.58	-29.60	0.80	4.81	8	3
9	7	6	2	5	6	2	2,775	850.00	2,431.00	-1,781.00	164	62.20	102	62	78.00	-57.00	23.83	-28.73	0.83	3.96	7	4
10	6	4	2	3	2	2	14	850.00	2,592.00	-1,942.00	191	65.45	125	66	65.00	-50.00	20.74	-29.42	0.70	3.40	8	4
11	4	6	2	6	2	2	397	846.00	3,051.00	-2,405.00	218	61.01	133	84	134.00	-50.00	22.94	-28.63	0.80	2.96	11	4
12	7	6	2	4	2	3	3,275	827.00	2,557.00	-1,930.00	183	62.30	114	69	70.00	-67.00	22.43	-27.97	0.80	3.43	11	5
13	4	4	3	7	2	3	3,662	824.00	2,158.00	-1,534.00	152	63.16	96	56	70.00	-50.00	22.48	-27.39	0.82	4.11	20	5
14	4	5	3	7	2	3	3,667	820.00	2,183.00	-1,563.00	155	63.23	98	57	70.00	-50.00	22.28	-27.42	0.81	4.00	10	5
15	5	4	3	6	2	2	413	803.00	3,049.00	-2,446.00	220	61.82	136	83	134.00	-50.00	22.42	-29.47	0.76	2.74	12	5
16	4	2	3	7	2	3	3,652	597.00	2,421.00	-1,824.00	166	63.96	106	60	134.00	-67.00	22.84	-30.40	0.75	3.60	7	3
17	7	4	3	6	2	2	415	591.00	3,672.00	-3,081.00	258	59.91	152	106	134.00	-57.00	24.16	-29.07	0.83	2.29	6	6
18	7	3	3	7	2	2	535	591.00	3,578.00	-2,887.00	260	60.38	157	102	134.00	-59.00	22.79	-29.28	0.78	2.27	9	6
19	7	6	3	6	6	2	2,925	584.00	2,587.00	-2,003.00	183	60.11	110	72	92.00	-57.00	23.52	-27.82	0.85	3.19	7	5
20	4	2	3	6	2	3	3,527	581.00	2,185.00	-1,604.00	151	65.56	99	52	134.00	-49.00	22.07	-30.85	0.72	3.85	10	3
21	6	6	2	5	6	2	2,774	578.00	2,123.00	-1,545.00	143	63.84	91	52	61.00	-50.00	23.33	-29.71	0.79	4.04	7	3
22	7	5	2	3	2	2	20	578.00	3,034.00	-2,456.00	222	61.71	137	84	81.00	-57.00	22.15	-29.24	0.76	2.60	8	5
23	6	6	2	4	4	2	1,399	564.00	2,382.00	-1,798.00	166	60.84	101	65	70.00	-55.00	23.39	-27.66	0.85	3.40	7	4
24	7	6	3	4	6	2	2,675	558.00	2,413.00	-1,855.00	171	60.23	103	67	92.00	-57.00	23.43	-27.69	0.85	3.26	6	4
25	7	6	2	5	4	3	4,650	557.00	2,288.00	-1,711.00	155	60.85	94	61	70.00	-50.00	24.13	-28.05	0.86	3.59	7	4
26	7	6	3	3	6	2	2,550	555.00	2,229.00	-1,674.00	155	60.85	94	61	92.00	-57.00	23.71	-27.44	0.86	3.58	7	4
27	7	3	3	6	2	2	410	545.00	3,321.00	-2,776.00	244	61.07	149	94	134.00	-59.00	22.29	-29.53	0.75	2.23	7	5
28	5	4	3	7	2	2	538	542.00	3,385.00	-2,823.00	241	59.34	143	97	134.00	-50.00	23.53	-29.10	0.81	2.25	9	5
29	7	3	6	3	3	2	735	536.00	1,756.00	-1,220.00	123	57.72	71	52	92.00	-97.00	24.73	-23.46	1.05	4.38	7	4
30	7	4	2	5	2	2	265	529.00	3,008.00	-2,479.00	221	62.44	138	83	134.00	-57.00	21.80	-29.87	0.73	2.39	8	4
31	7	6	3	5	6	2	2,800	528.00	2,414.00	-1,886.00	173	60.12	104	68	92.00	-57.00	23.21	-27.74	0.84	3.05	6	4
32	7	4	3	6	4	2	1,665	528.00	2,332.00	-2,704.00	225	58.22	131	94	111.00	-57.00	24.67	-28.77	0.86	2.35	6	5
33	5	3	3	6	2	3	3,533	523.00	2,332.00	-1,809.00	174	63.79	111	62	134.00	-50.00	21.01	-29.18	0.72	3.01	7	4
34	7	6	2	4	6	2	2,650	516.00	2,247.00	-1,731.00	153	61.44	94	59	78.00	-57.00	23.90	-29.34	0.81	3.37	7	4

Figure 24: NAV Optimization Report

	Top Length	Top Left Strength	Top Right Strength	Bottom Length	Bottom Left Strength	Bottom Right Strength
ABBV	5	2	3	7	6	3
CMG	7	3	2	7	2	5
CSCO	7	6	3	5	6	2
DECK	6	6	5	7	2	2
DIS	4	2	3	7	4	3
HAS	7	3	6	7	2	3
NAV	6	6	2	6	2	3
PCAR	7	6	4	7	2	3

Table 1: Individual Stock Parameters

7.5: Secondary Analysis

To view the success of this optimization strategy, I backtested the stocks over the same period of time with the optimized parameters. As seen in Figure 25, the system can be seen to be much more profitable and consistent.


TradeStation Performance Summary Collapse 			
	All Trades	Long Trades	Short Trades
Total Net Profit	\$1,006.00	\$0.00	\$1,006.00
Gross Profit	\$3,066.00	\$0.00	\$3,066.00
Gross Loss	(\$2,060.00)	\$0.00	(\$2,060.00)
Profit Factor	1.49	n/a	1.49
Roll Over Credit	\$0.00	\$0.00	\$0.00
Open Position P/L	\$0.00	\$0.00	\$0.00
Select Total Net Profit	\$745.00	\$0.00	\$745.00
Select Gross Profit	\$2,805.00	\$0.00	\$2,805.00
Select Gross Loss	(\$2,060.00)	\$0.00	(\$2,060.00)
Select Profit Factor	1.36	n/a	1.36
Adjusted Total Net Profit	\$492.62	\$0.00	\$492.62
Adjusted Gross Profit	\$2,797.09	\$0.00	\$2,797.09
Adjusted Gross Loss	(\$2,304.48)	\$0.00	(\$2,304.48)
Adjusted Profit Factor	1.21	n/a	1.21

Figure 25: NAV Optimization Report Post Optimization

I ran the stocks through a Monte Carlo Analysis for a second time with the optimized parameters. I kept all of the stocks selected, as well as the duration the same to simply view the difference in performance from my original strategy to the one with the optimized parameters.

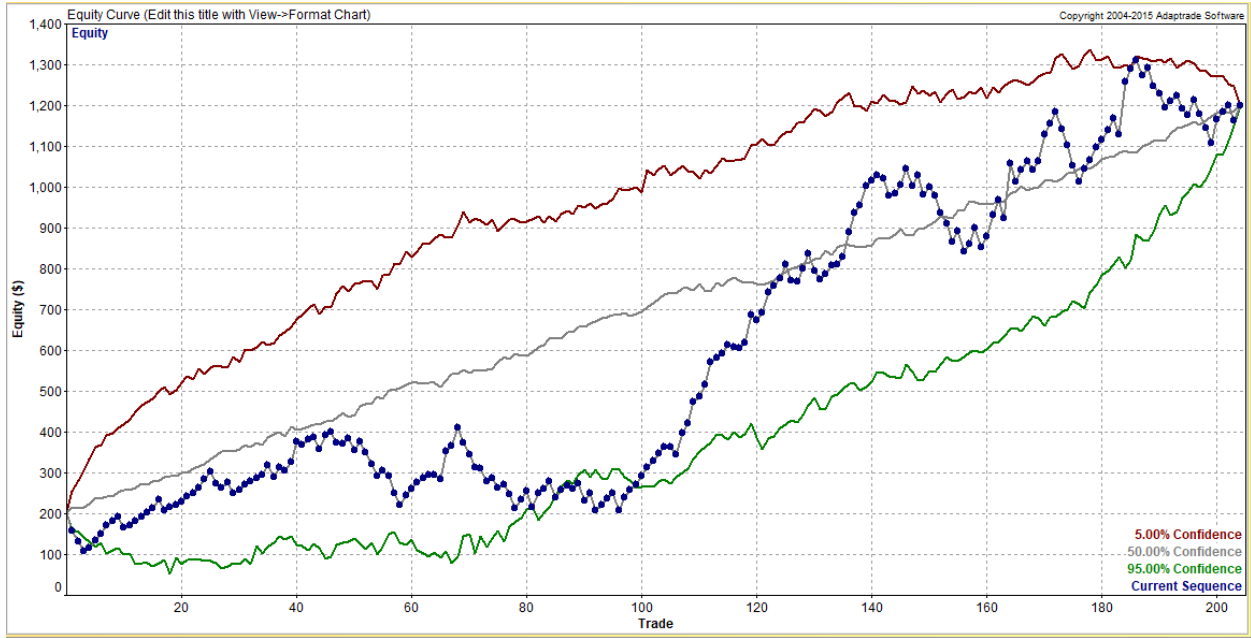


Figure 26: NAV Secondary Monte Carlo Analysis

As Seen through Figure 26, this analysis of my trading system for the NAV stock is much more successful than the initial analysis. The trend of equity in this stock is much more positive than the initial one, and confidence lines are not as spread apart as in the initial analysis. Through my walk forward optimization of parameters, I was able to create a more consistent and profitable system, which was able to lower the risk of my strategy and create a more robust system.

	Total Trades	Total Net Profit	Gross Profit	Gross Loss	Profit Factor
Pre-Parameter Optimization	125	\$154.00	\$1663.00	\$1509.00	1.10
Post Parameter Optimization	210	\$1006.00	\$3066.00	\$2060.00	1.49

Table 2: Parameter Optimization Comparison

Through looking at the above table to see the changes in system efficiency and profitability, it can be seen how the initial optimization greatly helped in the backtesting data. The net profit increased by around \$852 and the profit factor increased by .39. With the new parameters it can also be seen that there was a

higher volume of trades, which paired with the increased profit factor is what leads to the higher net profit.

7.6: Secondary Optimization

To further the optimization of my trading strategy, I went into the different stocks and looked at the patterns of my losing trades. With my system being a short only system, my losing trades came from when the stock increased in price, and I found that typically with the volatile stocks that constantly go up and down in price I would lose most of my money on the days where the stock rises in value. As shown in Figure 27, on the lower priced days when the stock is trending to go up, I will lose money more often than when the price of the stock is higher than normal and falls down.



Figure 27: CSCO Win/Loss Visualization

To help combat this analysis of my losing trades, instead of simply inserting my strategy on all of my stocks and letting the code run, I would look at the patterns of the different stocks and strategically insert my strategy based on whether or not I believed the stock was trending up or down for the certain day/ period of time. To help with my decisions, I would look at the fast and slow-moving averages of the stocks, as well as look at where the stock price was at relative to the maximum and minimum prices of the stock throughout the past couple days. I found that when using this strategy, I was able to minimize my losing trades and lower the risk of my overall system.



Figure 28: Visualization of Selecting Stocks

7.7: Real Time Trading

Through the end of March to beginning of April, I began testing my fully optimized system in real time trading. During this month, I would start the day by looking at the portfolio of stocks and choosing a handful of my selected stocks that I believe are more likely to drop in price that day as mentioned in the second optimization. Since this system is a short only system, I do not gain anything from putting my system into a stock that I believe will rise for the day, and I will only increase my risk of losing money on that given day. After choosing these stocks I would apply the personal optimized parameters of each stock as shown in table 1 to maximize the potential profit of each trade. When trading with the optimized strategies I was able to find more success in my real time trading.

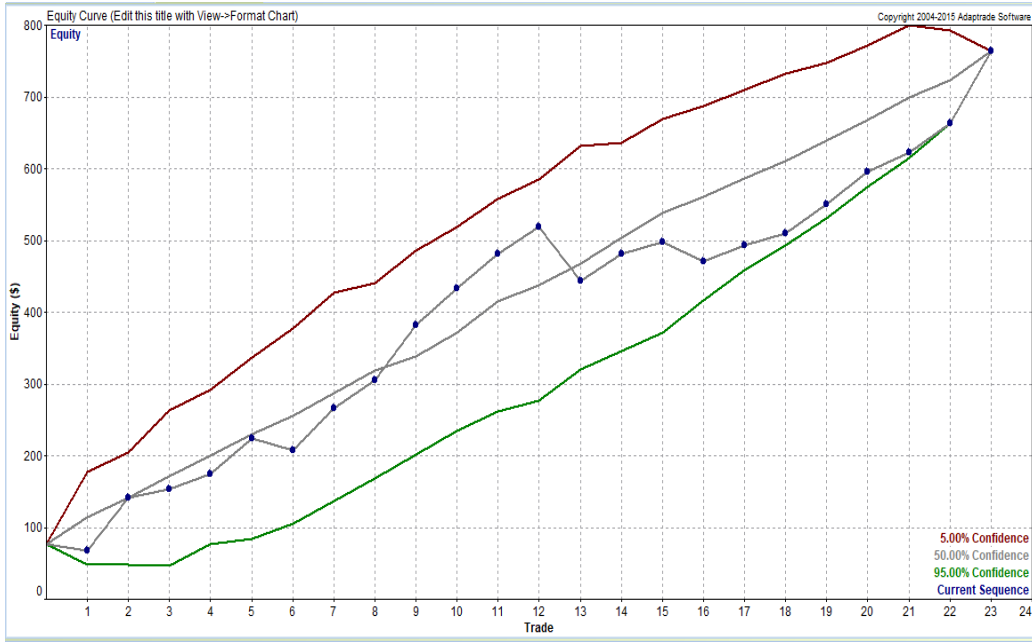


Figure 29: Optimized Monte Carlo Simulation

Looking at the analysis from the real time trades in figure 29, the real time trading has been much more efficient and less risky than the previously, un-optimized trades. Although the volume of trades are not as high as the back tested data it is clear that the newly optimized system is a more efficient system. The Monte Carlo Analysis shows that the real time trades have been much less risky compared to the back tested trades, as the confidence levels are closer together, and the system equity has been moving in a consistent profitable trend.

With my initial capital of \$50,000 USD, through the month of April I was able to increase the total money by \$756 USD, equating to a 1.3% increase in my portfolio. Through these optimization strategies along with the correct stocks, I found great success in my strategy and I believe it gave our system a solid and consistent source of profit.

Chapter 8: Gapping Trading System (Developed by Romelle Jack)

8.1.1: System Background

I have developed a personalized trading system that has shown potential with a manual trading method. The system of strategies utilizes morning stock price gaps as a main trading determinant. Utilizing the after-market activity as well as the morning price gaps, I developed methods in which I have proven successful when done correctly. The basis of this system stems from varying variables. A crucial factor that I consider when executing trades is company news leading up to price gaps. News surrounding companies are an efficient way to get a general idea of current events for a company. Earnings Estimates (EPS) play important roles in this system. Earnings Estimates for example, are key times for companies because it informs stockholders on how the company is expected to perform and how they have performed in the past (Investopedia, 2018). This information is vital have before using this system. The main reason for gapping in my observation, are the release of company quarterly and yearly earnings. These announcements lead to a rocketing increase of trading volume leading up to the opening of the stock markets.

A simple explanation for this is something that I called the “bandwagon effect”. As defined by Merriam-Webster Dictionary, a bandwagon is “a current or fashionable trend”. When companies post higher than expected quarterly or yearly earnings, traders and investors usually try to get in on the success of the company to increase their own profits. The same goes for companies that don’t perform well, which leads to investors and traders alike, simply dumping the stock from their portfolios. The scrambling of market capitalists leads to the stock’s price gapping up and down with respect to expectations revolving around companies’ earnings.

This strategy uses the price gap momentum of the stock to make profits. A gap is a sharp movement of prices in which no trading occurs in between (Investopedia, 2018). To execute this strategy, I indicate the highest and lowest points between the two gapping candlesticks.



Figure 30: Lockheed Martin Corporation Morning Gap-Down Sample

Using technical analysis, a gap up is essentially the inverse of a gap down. However, it is important to note that the behaviors between the two aren’t perfectly correlated.



Figure 31: Amazon.com Inc Morning Gap-Up Sample

Once a morning gap is identified, the next step to placing a trade is to identify the high and low between the price gap candlesticks as shown in the figures above. The high point is identified as the highest candlestick price between the previous day close candlestick bar and the current opening candlestick bar.

The optimal market time in which I execute trades are between 11:00 -11:10 am. Trades are only placed and executed during this time frame without exception. I have tested this time frame to be ideal. This is because, the markets opening time from 9:30am – 10:30am is an extremely volatile period. This is because this is the time where the major money management firms are executing many of their pending trades. At the opening of the markets, there is also an increase in market volume which inflated and go long or short depending on if the current price is either above the gap high or take a short position if the current price is below the gap low. Once the initial trade is placed it is important to observe the price movements to maximize potential profits. Prior to placing a trade using my gapping setup, it is important to analyze the Average Volume being traded. Volume can be a vital analysis tool to help look for price reversals and signals as well as get a better understanding of how much activity the stock is trading with.

If the stock's price is above the gap high level at 11:00am, I would take a long position. Inversely, if the stock price is below the gap low level at 11:00am, I would take a short position. Refer to Figure X. Lockheed Martin Corporation for an average trade setup.

8.1.2: System Screening

Stock screening is a useful tool to help build portfolios and to identify strong performing stocks. Using the AAI database and provided screeners I was able to utilize the Price to earnings screeners. These screeners identified companies with high P/E ratios as well as the companies upcoming earnings estimates. The P/E relative earnings stock screener, provided by AAI, essentially compares the general market's expectations of the company's future performance to the company's actual recent earnings performance. Stocks with higher P/E ratios and earnings estimates are considered to be growth stocks (American Association of Individual Investors). This means that they are expected to continuously perform well which will also lead to a rise in their stock price.

Company name	Ticker	Exchange	Price	Price as % of 52 Week High	EPS-Diluted Continuing 12m	EPS Est Y0	EPS Growth Est	PE	Ind. PE	PE Relative Avg-5 year
Sinclair Broadcast Group Inc	SBLI	Nasdaq	31.3	76	8.311	3.36	-15.61	3.8	21.2	0.86
Express Scripts Holding Co	ESRX	Nasdaq	69.08	81	10.261	9.346	11.188	6.7	15.8	1.05
Western Digital Corp	WDC	Nasdaq	92.27	86	6.522	14.077	31.1	14.1	26.3	1.62
H&E Equipment Services, Inc.	HEES	Nasdaq	38.49	87	4.931	1.849	17.4	7.8	19.9	0.81

Figure 32: AII P/E Relative Screener Featuring Earnings Estimates Sample

This stock screener was useful, in that it shows the willingness of market goers to purchase stocks with the expectations of high future earnings. A company's earnings or their earnings reports to be more exact, are a major contributor to price gaps occurring within a stock. Using the market speculation to my advantage, I can identify companies that are expected to grow which can often time lead to gapping since companies are reaching higher highs in terms of their stock's price.

Secondly, a more immediate approach to screening for price gaps in the market is to screen for companies that have currently gapped in price on the opening of the regular session day in which you are trading. Searching for characteristics such as the gap price, trading volume, price change since the gap occurred, and the symbols of the companies.

All US Exchanges Price Gaps Up

Fri, Apr 20th, 2018

GAP UP GAP DOWN

All US Exchanges Main View

[screen](#) [flipcharts](#) [download](#)

Ranks stocks by the highest Gap Up (difference between the current session's open and the previous session's high price).

Symbol	Name	Last	Change	Gap Up <input type="button" value="v"/>	High	Low	Volume	Time	Links
+ CHE	Chemed Inc	302.85	+10.76	+5.21	313.25	301.00	161,846	04/20/18	<input type="button" value="v"/>
+ PF	Pinnacle Foods Inc	60.58	+5.38	+4.35	61.97	59.48	6,999,501	04/20/18	<input type="button" value="v"/>
+ ATOS	Atossa Genetics Inc	3.52	+3.16	+3.90	4.29	3.40	403,099	04/20/18	<input type="button" value="v"/>
+ IONS	Ionis Pharmaceutical	48.51	+2.66	+3.88	50.44	46.77	4,731,724	04/20/18	<input type="button" value="v"/>
+ FFKT	Farmers Capital BA	49.20	+6.95	+3.75	49.25	46.65	356,638	04/20/18	<input type="button" value="v"/>
+ TRU	Transunion	66.84	+6.29	+3.25	67.32	64.01	3,771,657	04/20/18	<input type="button" value="v"/>
+ ASB	Associated Banc-Corp	26.50	+1.95	+2.10	27.10	25.85	4,747,254	04/20/18	<input type="button" value="v"/>

Figure 33: BarChart.com Gap Screener Sample

8.1.3: System Analysis

Using my gap system, I was able to get decent returns. When trading my system, I attempted to minimize my losses using trailing stop losses. Trades were placed using a total account equity of \$100,000 and each trade position value was a maximum of 5% - 10% of my total account equity depending on the stock's price.

TradeStation Performance Summary Collapse >			
	All Trades	Long Trades	Short Trades
Total Net Profit	\$6,804.00	\$9,001.00	(\$2,197.00)
Gross Profit	\$21,723.00	\$15,895.00	\$5,828.00
Gross Loss	(\$14,919.00)	(\$6,894.00)	(\$8,025.00)
Profit Factor	1.46	2.31	0.73
Roll Over Credit	\$0.00	\$0.00	\$0.00
Open Position P/L	\$0.00	\$0.00	\$0.00
Select Total Net Profit	\$4,939.00	\$4,381.00	\$558.00
Select Gross Profit	\$17,103.00	\$11,275.00	\$5,828.00
Select Gross Loss	(\$12,164.00)	(\$6,894.00)	(\$5,270.00)
Select Profit Factor	1.41	1.64	1.11
Adjusted Total Net Profit	\$2,347.99	\$5,579.62	(\$4,971.98)
Adjusted Gross Profit	\$19,420.37	\$13,825.65	\$4,763.96
Adjusted Gross Loss	(\$17,072.37)	(\$8,246.02)	(\$9,735.94)
Adjusted Profit Factor	1.14	1.68	0.49
Total Number of Trades	137	85	52
Percent Profitable	64.96%	69.41%	57.69%
Winning Trades	89	59	30
Losing Trades	48	26	22
Even Trades	0	0	0
Avg. Trade Net Profit	\$49.66	\$105.89	(\$42.25)
Avg. Winning Trade	\$244.08	\$269.41	\$194.27
Avg. Losing Trade	(\$310.81)	(\$265.15)	(\$364.77)
Ratio Avg. Win:Avg. Loss	0.79	1.02	0.53
Largest Winning Trade	\$2,174.00	\$2,174.00	\$200.00
Largest Losing Trade	(\$1,534.00)	(\$300.00)	(\$1,534.00)
Largest Winner as % of Gross Profit	10.01%	13.68%	3.43%
Largest Loser as % of Gross Loss	10.28%	4.35%	19.12%
Net Profit as % of Largest Loss	443.55%	3,000.33%	-143.22%
Select Net Profit as % of Largest Loss	321.97%	1,460.33%	36.38%
Adjusted Net Profit as % of Largest Loss	153.06%	1,859.87%	-324.12%
Max. Consecutive Winning Trades	10	8	7
Max. Consecutive Losing Trades	4	4	3
Avg. Bars in Total Trades	2.09	2.08	2.10
Avg. Bars in Winning Trades	2.04	2.03	2.07
Avg. Bars in Losing Trades	2.17	2.19	2.14
Avg. Bars in Even Trades	0.00	0.00	0.00

Figure 34: TradeStation Performance Analysis (No Commission or Slippage)

As seen in the figure above, my system was profitable overall. However, the system struggled when taking short positions. The losing trades although less in number, outweighed the winning trades when taking short positions. The total net profit is \$6,804 with an average win – average loss ratio of 0.79.

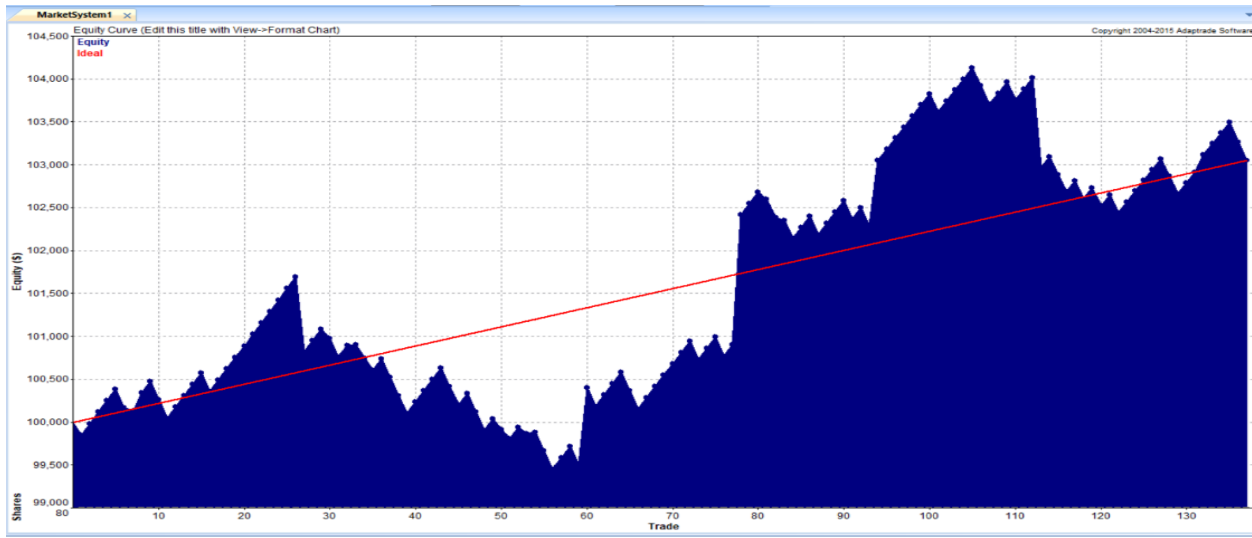


Figure 35: Market System Analyzer Equity Curve

The market system analyzer equity curve shows the performance of my trades. Equity is plotted as a function of trades. The red, linear-curve represents the average equity growth. My trades performed well below the equity curve from trade 30 to 80. This means that my trades were not profitable for these trades. After trade 80, my trades began to grow more profitable.

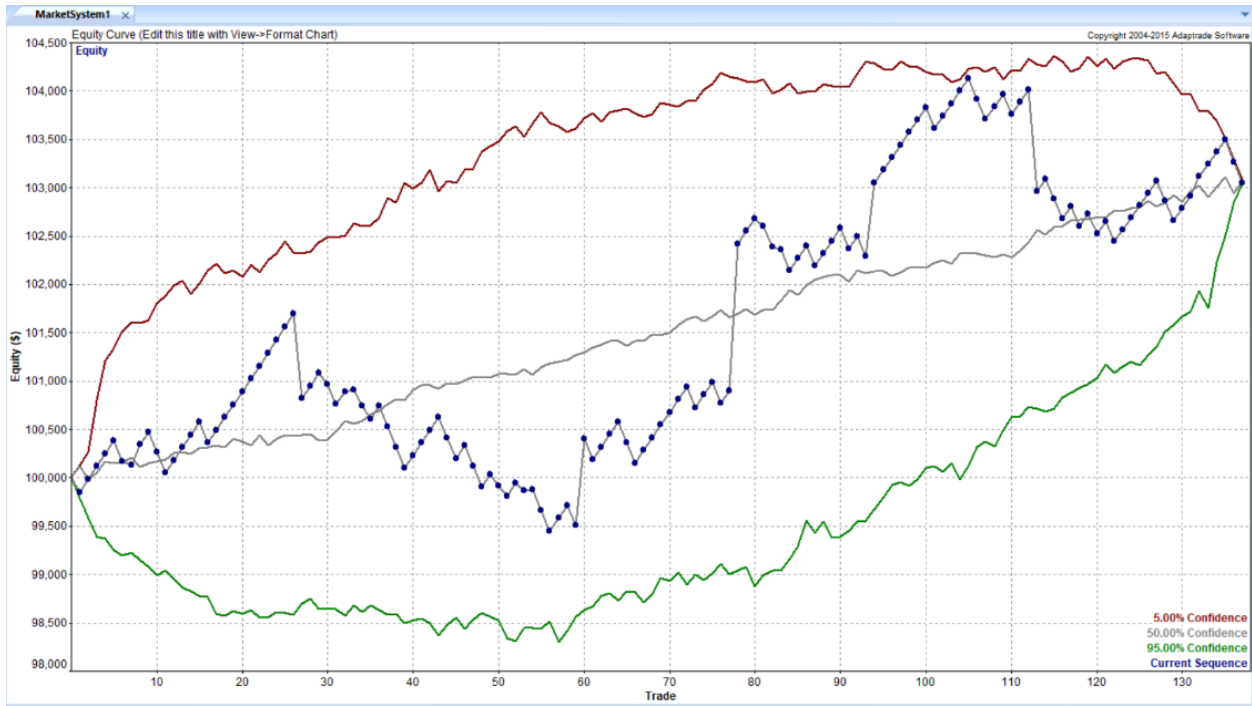


Figure 36: Monte Carlo Analysis

The Monte Carlo Analysis shows the ranges of best and worst-case scenarios from my trades. The blue line shows the current performance of my trades. Based on this analysis, it is evident that my system

has room for improvement. Using a total equity of \$100,000, the net profit from using the Monte Carlo analysis was \$3,052.12. The win – loss ratio was 0.7345 with a profit factor of 1.278.

Chapter 9: Sweet Spot Strategy (Developed by Matthew Nicholson)

9.1: System Background

This system is based on the idea that the market is 'beatable', that active equity trading can provide superior performance when compared against passive equity index investing. The efficient market hypothesis (EMH) states that it is impossible to "beat the market" because stock market efficiency ensures all existing share prices always incorporate and reflect all relevant information (Fama, 1998). If this theory is true then the way everyone should invest is by putting money in an index investment, which matches S&P 500 and Dow Jones performance. My trading system is designed to prove that this theory is false by exploiting flaws in the EMH to "beat the market" with a strategy that takes advantage of volatility in the market.

Levels of volatility are different for each stock price. Price volatility reflects the amount and quality of information available to investors about a stock. My strategy concept is that highly volatile stocks' price movements are impacted by other factors than the available information and attempt to accurately predict their price movements. By only focusing on the larger price movements, the strategy eliminates wasted time holding stock and creates maximum profits.

The level of success of this system is based on the manual trader's ability to comprehend and assess volatility. Trading with high volatility means risk levels are higher than usual. Any prediction that is made will normally result in a large percent change in the stock price. In order to mitigate risk, the strategy will select for inclusion in the portfolio stocks with a beta between 1.2 and 1.8. Beta is a representation of a company's volatility and therefore a solid metric to limit risk in determining which stocks to focus on (Investopedia, 2017). Although beta is an excellent risk indicator 'higher is not always better'. Beta analysis can be tricky and is therefore not the only evaluation metric that is used. If beta is below 1.2 the stocks are not risky enough and are therefore not creating the profits to "beat the market". If the portfolio is above 1.8 then the stocks are too risky and can't be accurately predicted. The 'Sweet Spot' beta, is between 1.2 and 1.8, as maintaining a portfolio in this range gives the strategy the best chance to outperform the market.

9.2: System Summary

This system takes volatile stocks and aims to predict their movements. The system aims to capitalize on three major stock elements. Number one is the fear of using stocks with high volatility. Most major market strategies aim to minimize volatility or use a minimal risk strategy to plan for long-term growth. This strategy aims to play with the "high risk" stocks that most strategies would never look at. The second major element that the strategy takes advantage of is, true range. True range is described in three separate ways. It is either current high less the current low, the current high less the previous close (absolute value) or the current low less the previous close (absolute value). Finding the average of these true ranges is called the Average True Range (ATR), which is a measure of volatility (Stock Charts, 2017). The ATR is an average of the differences in high and low and therefore is a measure of strong

price movements will be. By identifying the average distance, the price moves the strategy can get an understanding of how much a given price will move.

The third market element that it will take advantage of is support and resistance. Since this strategy is only interested in the larger price movements it will avoid stocks with limited movement and range. The strategy focuses on the stock prices hitting support bars and reversing up or hitting resistance bars and going back down. Accurately predicting when a stock will change direction will be the focus of the system.

Most strategies avoid high levels of volatility, but this strategy will identify ways to exploit that volatility and use it as an advantage. For day traders, volatility can price suddenly and result in making (or losing) money quickly. However, with the right parameters and overall market understanding this strategy will prove that not only is volatility predictable but also that it can be exploited for profit.

9.3: System Screener

The screener was created by combining my own ideas for an innovative trading strategy and from strategies that have been proven to work in markets with high volatility. The screener has five major purposes. They are to:

Screener:

1. Find stocks with a price change in either direction that total to 4.5% or higher over the last 7 days.
2. Find stocks with a beta between 1.2 – 1.8.
3. Find stocks with an average true range between .1 - .8
4. Find stocks with a market cap between 250K and 2.5Billion
5. Stock price is above 10\$.

9.4: Why these Metrics?

The use of these metrics will give identify stocks that best fit the system. The purpose of the screener is not to immediately give me the stocks to use, but to rather recommend the stocks that can fit the system. For example, screener metrics 1 and 2 are attempting to find specific types of stocks that have high levels of volatility. The first one is trying to find stocks with current levels of price volatility while the second uses beta to find stocks that have a history of volatility. By combining these metrics, the screener eliminates low volatility stocks and finds stocks that have consistent volatility, specifically over the most recent week. The third metric uses average true range to ensure price changes don't happen too slow or too rapidly. Since average true range is a representation of how distant open and closes can be using any stock with an average true range higher than .8 would considered too volatile and therefore

unusable. This works the opposite with true ranges below 0.1. If the ATR is too low, then stock price will not move enough to produce high returns.

The 4th and 5th metrics are borrowed from other volatility of trading strategies. The small cap metric was discovered through looking at the Foolish Small Cap 8 screen on AAI website. The screener has a few major features, but what was most useful for incorporating in this strategy was volatility in small cap stocks. The attraction of small caps is their growth potential to become large cap companies, with their share price growing in the process. However, the risk increases because they are also more likely to fail (American Association of Individual Investors). Small-cap companies also do not garner the attention of the financial media or analysts that larger firms do. However, the small-cap Foolish 8 strategy is partly based upon the premise that the lack of coverage and interest in small-cap companies presents a better opportunity to locate undiscovered, attractive investment candidates. I applied this idea to the trading strategy because it boosted its ability to identify stocks with higher risk levels. The 5th metric I also learned from a screener on AAI. Another high volatility trading strategy known as the Kilpatrick growth strategy uses the metric that states “the share price of the stock must be above \$10” (American Association of Individual Investors). It also identifies stocks with a small market cap but wants the share price’s to be above \$10 to help find stocks that have already started their growth process. Although this metric isn’t necessary it does provide another way to identify stock prices with large price movements.

9.5: Flaws in the Screener and How to Circumvent those Flaws

This screener is a fantastic way to identify the right types of stock that fit the system.

However, it doesn’t identify the perfect stocks. The stocks identified using the screener require further analysis and are broken down using fiscal measures and analysis of company statistics. This is the first major flaw in the screener. The screener will sometimes provide a stock with the right overall metrics but wrong financial figures. For example, certain companies in the biopharmaceutical sector have high volatility because one of their products recently passed a test conducted by the FDA. This type of volatility is too temporary to sustain the model.

This leads into the second major flaw in the screener. The screener will find stocks that have volatility which is inconsistent. Earnings reports, new product approval, prominent investor holdings changing, and many other factors can be false leads for volatility. That volatility is only short-term and is less predictable. It is therefore of the utmost importance to do in-depth research after the screener identifies stocks.

These flaws are a problem but are easily fixed with more research. I use these five metrics of the screener through FinViz.com, which is a website that gives in depth financial data and analysis for the stocks screened (FINVIZ). Once the screener is run correctly, I identify the right stocks to use for the strategy. Then I do an in-depth company analysis and uncover all the risk factors that are associated with trading that stock. That includes, but is not limited to, earnings report reviews, analysis of price to earnings ratio, debt to equity ratio, quick ratio, profit margins and changes in volume. If anything comes up during my research that proves the stock price has inconsistent volatility, it is then removed from the

list. It's also important to note that volatility can be closely associated to gapping so it is therefore important to keep an eye on gap percentage which is a representation of how likely the stock is to gap up or down.

9.6: System Studies

This system uses multiple studies to best predict volatility. Volatility stocks move in two ways. Either they go one direction for an extended period of time (3 hours or more) or they bounce between they support and resistance. The only way to determine whether the stock price will go one way or bounce is to examine the history of the stock price. Usually, the historical pattern will indicate how a stock will move in the future. If the trades track up and down consistently then the strategy requires Bollinger Bands. If the price is moving in one direction up or down, then Keltner channels are required. The Bands and Channels are meant to show entry and exit points for the stock.

Bollinger Bands create two simple moving averages approximately two standard deviations away from the mean of the stock price. As you can see below the stock has Bollinger bands helping indicate when to buy and sell (Investopedia, 2018). When the price crosses either line the strategy says to put an opposite position from the line that was crossed. For example, if the top Bollinger bands is broken (the support) then a short should be placed assuming the stock will return back toward its bottom Bollinger band (the resistance).

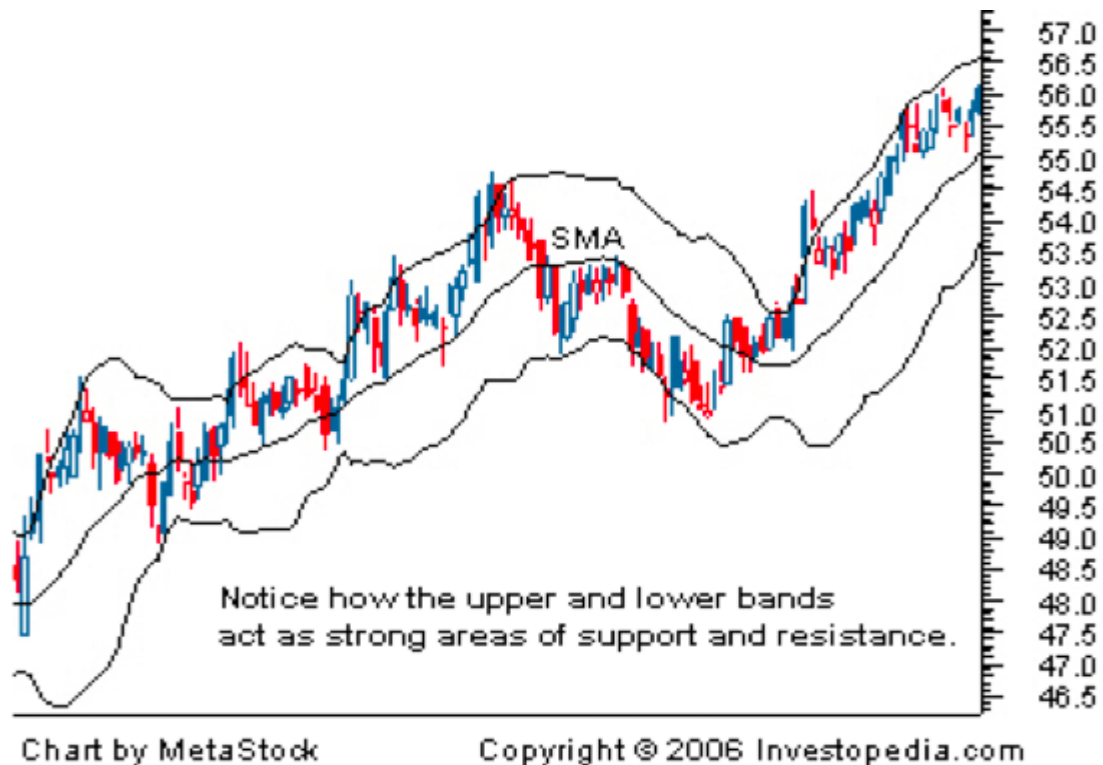


Figure 37: Bar Chart with Bollinger Bands

Keltner Channels on the other hand follow the opposite strategy. Since the channels are a trend following indicator it is more important to use financial figures and other indicators to help predict which direction and how long the stock will move in one direction for. The channels act as guidelines as opposed to how bands act more as entry and exit points. When looking at the graph below the stock price “rides” the top channel. If the channel’s slope changes direction that is usually a good indicator to enter or exit (Stock Charts, 2017).



Figure 38: Bar Chart with Keltner Channels

The other studies used are for helping predict the strength and direction of the price movements. The first study to look at is the average true range. This metric will show if volatility is strong or weak. If the average true range increases that would mean volatility is strengthening and therefore creating larger price movements. Naturally this will also expand the standard deviation of Bollinger bands and Keltner Channels. This works the opposite way if average true range is decreasing.

The second and third studies measure the direction of a stock price. Using the MACD study and Stochastic Slow combined is popular way traders attempt predict direction. This team of statistics works because the stochastic is comparing a stock's closing price to its price range over a certain period of time, while the MACD is the formation of two moving averages diverging from and converging with each other. This dynamic combination is highly effective if used to its fullest potential. Separately, the stochastic oscillator and MACD function on different technical premises and work alone. Compared to

the stochastic, which ignores market jolts, the MACD is a more reliable option as a sole trading indicator (Dowie, 2018). Although different mechanisms, they essentially predict the direction of the stock price by crossing over and staying ahead of the direction it anticipates the stock price to continue to move in. Specifically, in the MACD I'm looking for the two lines of the graph to crossover, which can indicate a reversal in stock price movement. In the Stochastic slow I'm looking for crossovers of .8 and .2. If the line on the chart crosses .8 or .2 that would indicate that the stock prices directional movement will slow down soon and maybe even reverse.

9.7: The System in Action



Figure 39: Keltner Channel Analysis of Overstock

This graph here is a strong example of a few things I highlighted earlier. Here is Overstock (OSTK), an online marketplace, which liquidated the inventories of at least 18 failed dot-com companies at below-wholesale prices. The company continues to sell home decor, furniture, bedding, and many other goods that are closeout merchandise. The company's volatility has recently risen because of highly anticipated earnings reports, small cap growth status and the CEO's ventures into new businesses.

In this situation I used Keltner channels for a mid-day entry at 11:55am. After growing in the morning hours, the stock price hit its support channel at around 10:30 AM. When the MACD and Stochastic Slow crossover I will want to enter a short position to capitalize on price movement. There is a crossover in both at 11:15am, however the MACD trend lines are so close together it's no guarantee that the price will reverse. When the second double crossover occurs at 11:54am, I know to enter because the stock price is decreasing and the trend lines of the MACD and Stochastic Slow are separating and

decreasing. Average True Range is relatively consistent, and the channels are now negatively sloping. To prepare for the exit I must watch for changes in volatility, changes in slope of channels, and crossovers in the indicators. The indication to exit is when the crossovers occur, and the indicators begin to change direction. The MACD going above .2 is also a good indication to exit.



Figure 40: Bollinger Band Analysis of Roku Inc.

Bollinger Bands will follow the same strategy, but the bands will be stronger indicators for entry and exit. Here is Roku (ROKU), it is an electronics company that focuses on streaming technology and creating an easier and more convenient way to watch TV. The company has high levels of volatility because of its growth potential, small cap status and anticipated earnings reports.

In this scenario the indicators are not following the stock price very well. The Stochastic Slow is the most important indicator for entry here because the MACD is delayed. The stochastic slow here is below .2 and crossing over, which would indicate the price would reverse soon. The bottom resistance band is being broken at the same time as the Stochastic Slows first crossover therefore the entry of a long was placed. This is where the MACD comes into play. If my analysis was correct, the MACD would soon crossover and change in direction along with the stock price. This is exactly what happens approximately one hour from the entry. Now exiting here was difficult because there was never a clear downturn indicator. However, with the strength of the MACD slowing and the Stochastic Slow finally dipping below .8, they make a strong case to finally exit.

9.8: System Performance and Implementation

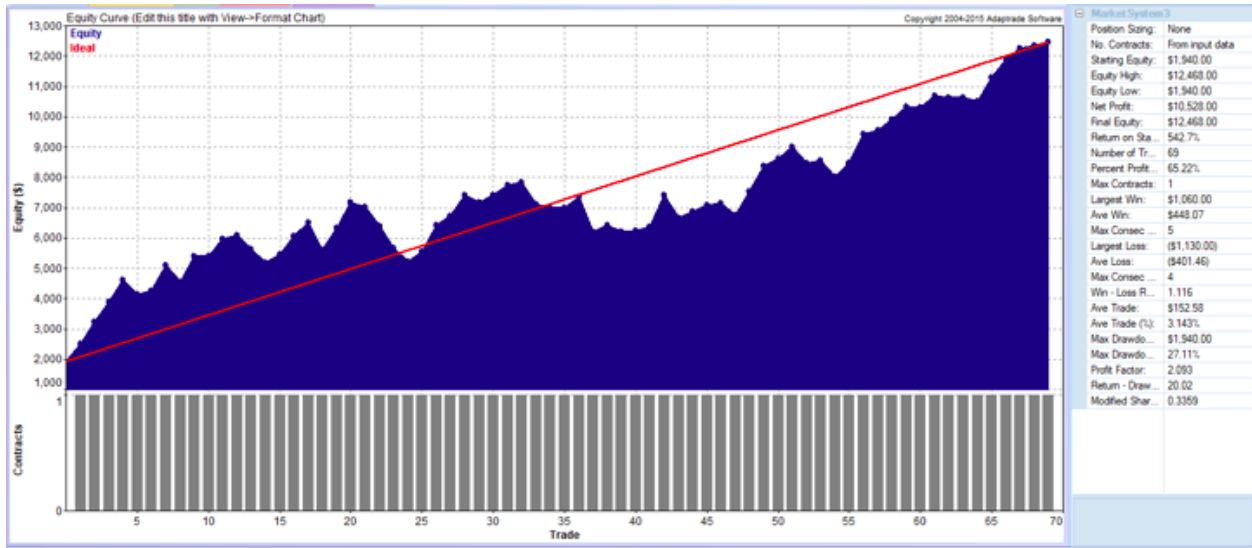


Figure 41: Ideal vs. Actual Equity Curve

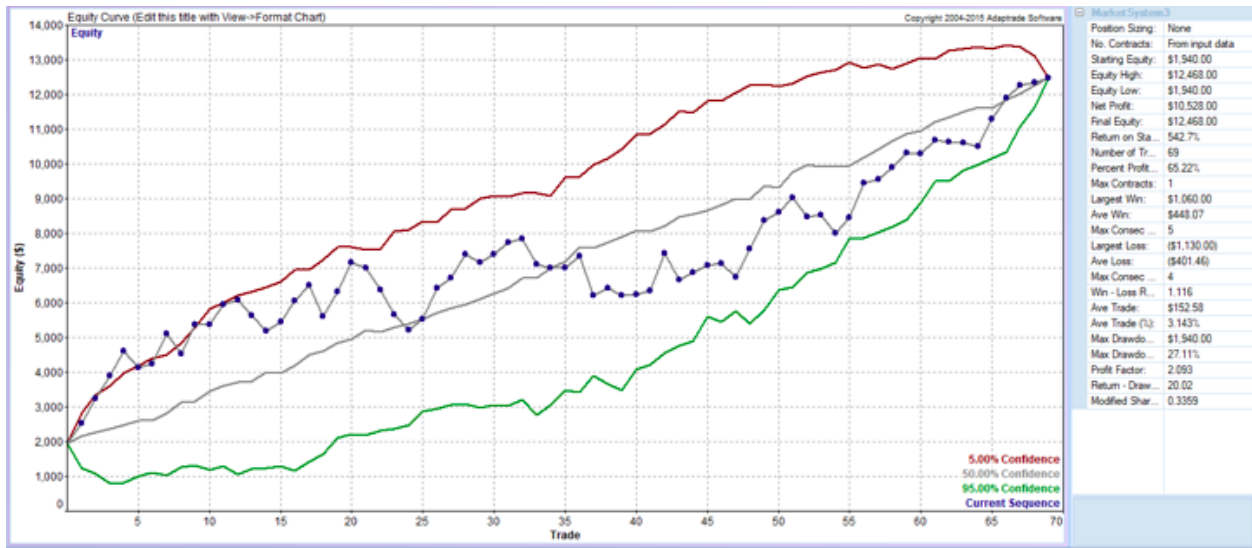


Figure 42: Monte Carlo Analysis of Strategy

The results of the system are solid but not as great as I thought they would be. By trading by my rules, I have limited my losses and maximized profits even slightly outperforming the Monte Carlo at times. With a positive win ratio of 1.116 and profit factor 2.096 I would say overall this a solid system. Although the bottom line is never touched it's important to realize that this system plays with volatility but is not considered risky. Looking at the bottom line of the Monte Carlo we see limited risk since the difference is not large and no trades ever cross or touch the bottom line. My assumption is that to increase the profits, I would need to increase the risk.

9.9: Key Statistics

Win Ratio: 1.116

Profit Factor: 2.06

Sharpe Ratio: .3359

Percent Profit: 65.22%

9.10: Conclusion and Final Remarks

When I initially began creating my system I wanted to do develop something that eliminated downside risks. Although I eliminate major downside risk while producing large profits, I feel there is more downside risk that can still be removed. In addition, I believe the system can also produce higher profits when more consistencies are found within the movement of the stock price. The system is not perfect and can be improved but it is a very solid foundation that can easily be improved through proper data analysis.

Chapter 10: System of Systems

While developing our systems, each of us was able to identify market conditions where our individual system was able to succeed and conditions when our individual system was not as effective. After discussing the market conditions where each individual system was successful, our group was able to identify two important indicators to determine when each system would be successful. These two indicators were overall market volatility and the overall market direction. For example, the Auto-M Strategy is far more effective than the Downside Risk Minimization Strategy during a bear market since it is a short only system and the bear market creates more opportunities for trades. Our group used the VIX and the S&P500 to quantify the overall market volatility and market direction to develop allocation rules for our system of system.

The Downside Risk Minimization Investing strategy is intended to slightly outperform the overall market and minimize risk of the overall portfolio. In the system of systems, the long-term investing strategy is used primarily during the early stages of a bull market, as well as during periods of low overall market volatility, as other systems in the system of systems rely heavily on market volatility. The Downside Risk Minimization Investing Strategy is initially allocated \$100,000, but this allocation varies depending on overall market conditions as well as recent performance of the short-term trading systems.

In the Auto-M System, this strategy is proposed to provide a small consistent profit in the hedge fund. As this system is initially allocated \$50,000 USD, the trades this system makes generally is not large leading to the profits it makes not large either. As this system is based off only trading when there is a high change of the selected stocks shorting, we expect the system to maintain a high percentage of winning trades. This strategy is directly connected with the Downside Risk Minimization Strategy in terms of money allocation. As this strategy is a short only system and Downside Risk is a buy only system. There is a movement of money between the two strategies depending on market rise or fall. For this strategy, market rise will cause the hedge fund to lower money allocation from this strategy and move the money into the Downside Risk Minimization Strategy, and inversely a market drop will lead to more money being allocated to this strategy.

The gap system utilizes the morning gap price momentum to incur profits. Since this system utilizes morning price gaps, this is the main parameter needed to find stocks. The gap system utilizes the idea of breakouts due to high trading volume. The system uses a mixture of long and short trades depending on the price level being above or below the gap high and low levels respectively. With an equity allocation of \$100,000 USD this system best operates using mid cap stocks. Mid cap stock prices enable the user to purchase more shares with respect to overall system equity. A downfall for this system is that it is only designed to maximize on breakouts. This means that if the price begins to move in the opposite direction of the initial trade, then the system will begin to lose money. To combat this, trailing stop losses are assessed to the orders.

Overall the Sweet Spot Strategy will attempt to capitalize on the larger changes in equities. By evaluating a company's beta and average true range you can get a good understanding of how immense the average price movement is. The higher the beta and true range, the higher the risk. By keeping the portfolio in a "sweet spot" (1.2 - 1.8 for beta, .2 - .8 for average true range) the strategy will be able to effectively predict risk. If the portfolio is outside of either beta or average true range, then predictions will be less accurate. Finally, to predict the direction of an equity the strategy uses the MACD and Stochastic

slow charts. Using these charts and either Bollinger bands or Keltner channels the strategy will consistently predict the strength and direction of “sweet spot” equities.

The S&P500 is an index of the top 500 stocks with market capitalizations of at least 6.1 billion. This indicator is one of the top indicators for US equities and can often be looked at to see how the overall market is doing (Investopedia, 2017). We decided to this indicator in our system for money allocation regarding the Downside Risk Strategy as well as the Auto-M strategy.

With the S&P500, we look at this indicator as an overall view of how well or poorly the market is doing. This is able to assist us in money allocation with our buy only and short only systems. When the S&P shows a high market rise, we move money out of the short only Auto-M Strategy and into the buy only Downside Risk Strategy. In Terms of the S&P showing a market drop, it is not recommended to move money out of a buy and hold strategy when the market is dropping. Instead we use the S&P 500 to anticipate when the market will be dropping, in that instance we would take some of the money out of the Downside Risk Strategy and move the money into the Auto-M Strategy.

Our system uses the VIX to track the overall volatility of the entire market. The VIX is calculated using the change in price of options to determine the market expectation for 30-day volatility. Multiple trading systems within our system of systems rely heavily on volatility, and therefore it is important for our system of systems to be able to determine the overall volatility of the market to know when these systems have the best chance of success (Chicago Board of Options Exchange).

During periods of above average volatility, determined by above average levels of the VIX, our system of systems increases allocation to the Sweet Spot Strategy and Gapping Strategy by removing money from the Auto-M Strategy, since these systems rely heavily on volatility to succeed. During periods of low volatility, money is moved from the Sweet Spot Strategy and Gapping Strategy to the Auto-M Strategy. If the low volatility period persists for an extended period of time, more money is transitioned from the Sweet Spot Strategy and Gapping Strategy to the Downside Risk Minimization Strategy as long-term investing strategies tend to be more successful than short term trading systems during periods of low volatility.

From the S&P 500 and the VIX, our group is able to determine the current state as well as the expected volatility of the overall market. With this knowledge, our group follows strict money allocation rules to allocate money to the systems with the highest expected profits based on the market condition and volatility.

When utilizing this complete system, our overall system has been very successful. Throughout the past two and a half months, our system has sported an overall profit of \$16,965. This comes out to an 8.48% increase in our portfolio, which can all be seen in the combined equity figure below.

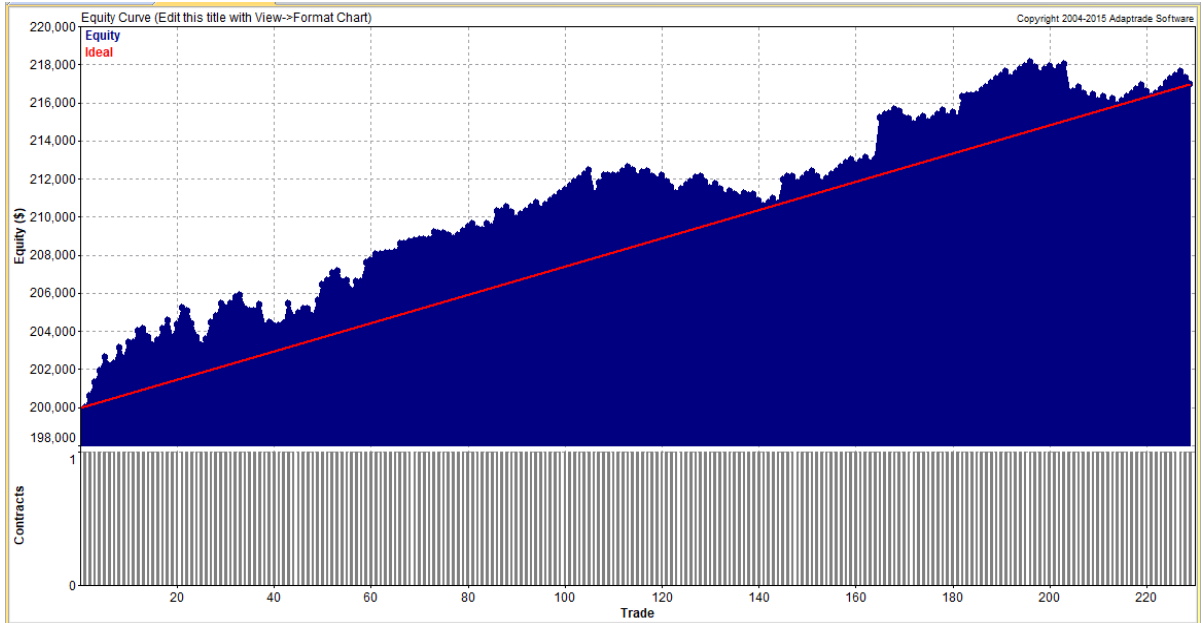


Figure 43: Equity Curve of Combined System

As seen in the Monte Carlo Analysis Figure below, through the rules that we have in place in our system, we can successfully control our system to maintain a steady and profitable system. Due to our Gap and Sweet Spot Strategy focusing mainly on volatility of the market, the overall system has an initial risk of losing money, but through the information that we can gather from the various indicators in the market we are able to successfully keep our system in the upper confidence level for the majority of the time.

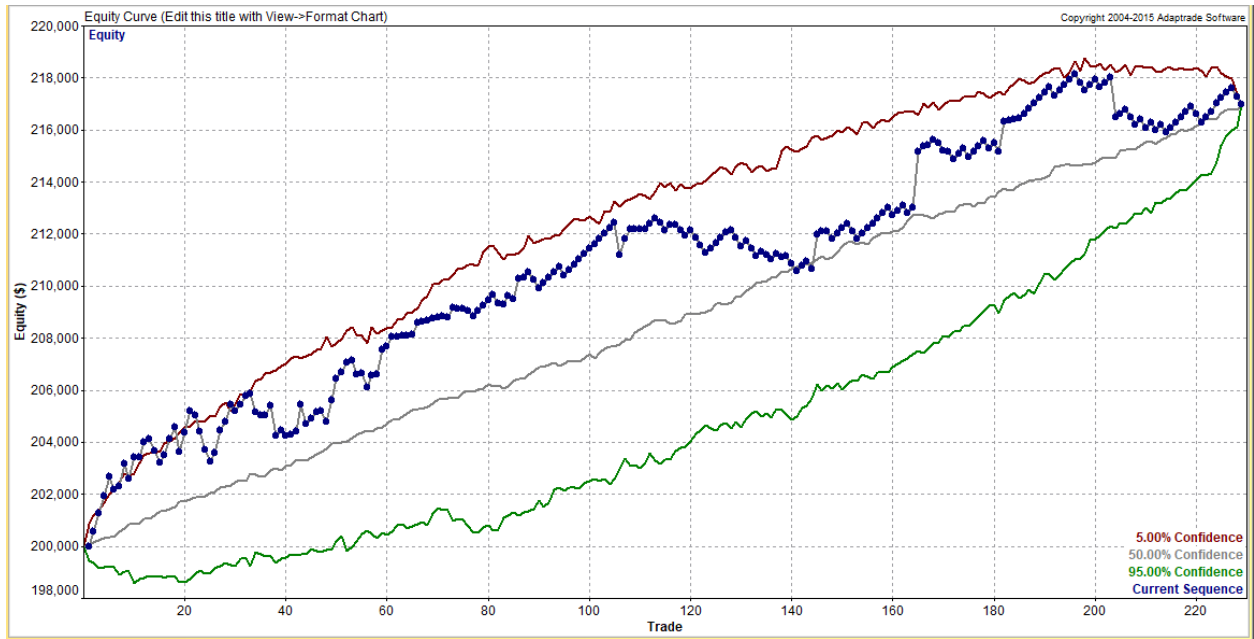


Figure 44: Monte Carlo of Combined System

Chapter 11: Conclusions

Each strategy, based on either backtesting or trades with a simulated account, appear that they would be profitable strategies if used correctly. The system of systems that our group developed further increases the expected profit but would require far more time and knowledge of the stock market to implement correctly. Based on the testing results of each individual strategy as well as tests of the system of systems, our group is confident that we would be successful in using this system of systems with actual funds rather than a simulated account but would likely begin with a very small amount of capital to ensure that we are able to continue to trade each system properly when the emotion of using real funds is involved.

The system of systems is not perfect and has its limits. It only consists of trading equities. The system doesn't trade commodities, bonds, Forex, etc. In other words, the system heavily relies on the stock market success. Although the system is protected against risk within the market, a market crash would leave the system of systems very vulnerable. Trading only equities has left the system completely reliant on the stock market never crashing. The only outlier here is the automatic system. The automatic system, within the system of systems, will stop trading when the stocks stop acting accordingly. To protect further against this the flaw the system of systems must add another asset class.

In terms of future research, our group would advise future groups to look to expand the system of systems to include strategies that traded other asset classes. Our current system of systems can succeed in nearly any state of the equity market due to a diverse set of individual strategies, but we lack asset class diversification. By implementing strategies for other asset classes, such as the foreign exchange market, future groups would see more success in the overall system. The system of system would be able to trade more frequently, and potentially increase profitability if the correct strategies were implemented.

Works Cited

- 1) American Association of Individual Investors. (n.d.). Financial Ratios. Retrieved March 14, 2018, from <http://www.aaii.com/journal/article/16-financial-ratios-for-analyzing-a-companys-strengths-and-weaknesses>
- 2) American Association of Individual Investors. (n.d.). Foolish Small Cap 8 Screener. Retrieved April 7, 2018, from <http://www.aaii.com/stockideas/screendata/Foolish8>
- 3) American Association of Individual Investors. (n.d.). Kirkpatrick Value Screener. Retrieved April 7, 2018, from <http://www.aaii.com/stockideas/screendata/KirkpatrickValue>
- 4) American Association of Individual Investors. (n.d.). Lakonishok Screener. Retrieved April 4, 2018, from <http://www.aaii.com/stockideas/screendata/Lakonishok>
- 5) American Association of Individual Investors. (n.d.). O'Neil CAN SLIM Screen. Retrieved January 25, 2018, from <http://www.aaii.com/stock-screens/screendata/CANSLIM>
- 6) American Association of Individual Investors. (n.d.). P/E Relative Screener. Retrieved April 5, 2018, from <http://www.aaii.com/stockideas/screendata/PERelative>
- 7) Amibroker. (n.d.). Walk Forward Testing and Optimization. Retrieved March 25, 2018, from https://www.amibroker.com/guide/h_walkforward.html
- 8) Baccman, J., & Scholz, S. (2003). Alternative Performance Measures for Hedge Funds. *The Alternative Investment Management Association Journal*. Retrieved April 2, 2018, from <https://pdfs.semanticscholar.org/7864/ffa6ba64dc47ebf07f04fd5a88fde335fb17.pdf>.
- 9) Investopedia. (2018, March 18). Bollinger Bands. Retrieved January 22, 2018, from <https://www.investopedia.com/terms/b/bollingerbands.asp>
- 10) Cochrane, J. (2018, January 14). Eugene Fama, Efficient Markets, and the Nobel Prize. Retrieved from <http://review.chicagobooth.edu/magazine/winter-2013/eugene-fama-efficient-markets-and-the-nobel-prize>
- 11) Cohn, R., & Lewellen, W. (1974). Individual Investor Risk Aversion and Investment Portfolio Composition. *The Journal of Finance*, 30(2), 605-620. Retrieved March 28, 2018, from <https://www.jstor.org/stable/pdf/2978738.pdf?refreqid=excelsior:4d20f84aeb6dd17e29f8fe324ccd8d44>.
- 12) Dizikes, P. (2010, May 17). Explained: Monte Carlo Simulations. Retrieved March 27, 2018, from <http://news.mit.edu/2010/exp-monte-carlo-0517>
- 13) Domowitz, I. (2006). The Cost of Algorithmic Trading. *The Journal of Trading*, 1-24. Retrieved January 29, 2018.

- 14) Dowie, G. (2018, February 28). MACD Stochastic Double Cross. Retrieved April 8, 2018, from <https://www.investopedia.com/articles/trading/08/macd-stochastic-double-cross.asp>
- 15) Investopedia. (2018, January 20). Earnings Estimate. Retrieved April 4, 2018, from <https://www.investopedia.com/terms/e/earningsestimate.asp>
- 16) Evans, S. (2017, December 20). Keltner Channels. Retrieved January 19, 2018, from http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:keltner_channels
- 17) Fama, E. (1998). Market Efficiency, Long-Term Returns, and Behavioral Finance. *Journal of Financial Economics*, 49(3), 283-306. Retrieved March 29, 2018.
- 18) Fidelity Investments. (2017, March 14). Understanding Bollinger Bands. Retrieved from <https://www.fidelity.com/viewpoints/active-investor/understanding-bollinger-bands>
- 19) FINRA. (2018, March 29). Day Trading Margin Requirements. Retrieved January 14, 2018, from <http://www.finra.org/investors/day-trading-margin-requirements-know-rules>
- 20) Investopedia. (2016, April 01). Assets. Retrieved January 14, 2018, from <https://www.investopedia.com/terms/a/asset.asp>
- 21) Investopedia. (2017, November 09). Beta. Retrieved April 6, 2018, from <https://www.investopedia.com/terms/b/beta.asp>
- 22) Investopedia. (2018, April 23). Commodity. Retrieved January 18, 2018, from <https://www.investopedia.com/terms/c/commodity.asp>
- 23) Investopedia. (2003, November 19). Gap. Retrieved April 5, 2018, from <https://www.investopedia.com/terms/g/gap.asp>
- 24) Investopedia.(2017, October 17). Leverage. Retrieved January 14, 2018, from <https://www.investopedia.com/terms/l/leverage.asp>
- 25) Investopedia. (2016, September 07). Macroeconomics. Retrieved December 15, 2017, from <https://www.investopedia.com/terms/m/macroeconomics.asp>
- 26) Investopedia. (2006, December 20). Market Breadth. Retrieved January 22, 2018, from https://www.investopedia.com/terms/m/market_breadth.asp#ixzz54vOvII2f
- 27) Investopedia. (2017, November 15). Standard & Poor's 500 Index. Retrieved April 14, 2018, from <https://www.investopedia.com/terms/s/sp500.asp>
- 28) Johnson, H. (2008). The Efficacy of the Sortino Ratio. Retrieved April 2, 2018, from <http://journals.sagepub.com/doi/abs/10.1177/031289620803200306>
- 29) Markowitz, H. (1952). Portfolio Selection. *Journal of Finance*, 7(1), 77-91. Retrieved January 28, 2018, from https://www.math.ust.hk/~maykwok/courses/ma362/07F/markowitz_JF.pdf.
- 30) Mueller, J. (2017, October 18). Understanding Financial Liquidity. Retrieved January 17, 2018, from <https://www.investopedia.com/articles/basics/07/liquidity.asp>
- 31) NASDAQ. (n.d.). Sector Diversification. Retrieved April 3, 2018, from <https://www.nasdaq.com/investing/glossary/s/sector-diversification>
- 32) Nawrocki, D. (2000). A Brief History of Downside Risk Measures. *Journal of Investing*, 8(3). Retrieved April 2, 2018.

- 33) Radzicki, M. (n.d.). *Basic Macroeconomics*. Lecture presented in Worcester Polytechnic Institute, Worcester.
- 34) Radzicki, M. (n.d.). *Optimization*. Lecture presented in Worcester Polytechnic Institute, Worcester.
- 35) Security and Exchange Commission. (n.d.). Types of Orders. Retrieved January 26, 2018, from <https://www.investor.gov/introduction-investing/basics/how-market-works/types-orders>
- 36) Sibilis Research. (2018, April 08). P/E Ratios by Sector. Retrieved March 29, 2018, from <http://sibilisresearch.com/data/cape-ratios-by-sector/>
- 37) Stock Charts. (2017, November 13). Average True Range. Retrieved April 7, 2018, from http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:average_true_range_atr
- 38) Stock Charts. (2017, December 20). Keltner Channels. Retrieved April 8, 2018, from http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:keltner_channels
- 39) Stone, C. (2017, February 22). Sector rotation: Knowing the essentials. Retrieved December 15, 2017, from <https://www.investopedia.com/articles/trading/05/020305.asp>
- 40) Wilkins, G. (2016, October 17). 5 Basic Financial Ratios And What They Reveal. Retrieved February 23, 2018, from <https://www.investopedia.com/financial-edge/0910/6-basic-financial-ratios-and-what-they-tell-you.aspx>
- 41) Ingraham, C. (2017, December 18). Analysis | For roughly half of Americans, the stock market's record highs don't help at all. Retrieved from https://www.washingtonpost.com/news/wonk/wp/2017/12/18/for-roughly-half-of-americans-the-stock-markets-record-highs-dont-help-at-all/?noredirect=on&utm_term=.f22490547572

Appendix:

	Top Length	Left Strength	Right Strength	Bottom Length	Left Strength	Right Strength
ABBV	4	6	3	5	2	3
CMG	7	2	3	6	5	2
CSCO	7	6	3	7	6	2
DECK	6	6	4	7	2	3
DIS	4	2	3	7	4	3
HAS	7	3	6	7	2	3
NAV	6	6	2	6	2	3
PCAR	5	6	2	5	3	4

Parameter Values for M-Top Strategy

M-Top Optimizer Code:

Inputs:

Fast_Length (5),
length_1 (5),
left_strength_1 (4),
right_strength_1 (4),
length_2 (5),
left_strength_2 (4),
right_strength_2 (4),

Slow_Length (15);

Variables:

High_point (0),
Low_point (0),
Local_Max (0) ,
Local_Min (0) ,
Local_Top_Bar (0),

```

Local_Bottom_Bar (0),
Top_Hit (False) ,
Bottom_Hit (False) ,
Top_Hit_2 (False) ,
open_trades (False),
timer (0),
stop_check (0),
Stop_loss_value (0),
Profit_target_value (0),
OHPivotPrice (0),
OLPivotPrice (0),
OHPivotBar (0),
Difference_TB (0),
OLPivotBar (0);

```

```

High_point = pivot(High, length_1, left_strength_1, right_strength_1, 1, 1, OHPivotPrice, OHPivotBar);
Low_point = pivot(Low, length_2, left_strength_2, right_strength_2, 1, -1, OLPivotPrice, OLPivotBar);

```

```

{If high_point = 1 then
Begin
Sell Short 100 Shares Next Bar at market ;
open_trades = true;
end;}

```

```

If High_point = 1 and Top_Hit = False then
Begin
Local_Top_Bar = OHPivotPrice;
Top_Hit = true;
timer = OHPivotBar;
End;

```

```

If Top_Hit = True and Low_point = 1 then
Begin
Local_Bottom_Bar = OLPivotPrice;
Bottom_Hit = True;
Difference_TB = Local_Top_Bar - Local_Bottom_Bar;
End;

```

```

If Top_Hit = True and Bottom_Hit = True and High_point = 1 and absvalue((OHPivotPrice-
Local_Top_Bar)/ Local_Top_Bar) * 100 < .20 then
Begin
Top_Hit_2 = True;
end;

```

If Top_Hit = True and Bottom_Hit = True and High_point = 1 and absvalue((OHPivotPrice-Local_Top_Bar)/ Local_Top_Bar) * 100 > .20 then

```
Begin
Local_Top_Bar = OHPivotPrice;
Top_Hit = true;
timer = OHPivotBar;
Bottom_Hit = False;
Top_Hit_2 = False;
End;
```

If Top_Hit = True and Bottom_Hit = True and Top_Hit_2 = True and close crosses below Local_Bottom_Bar and open_trades = False and ((Local_Top_Bar - Local_Bottom_Bar)/Local_Bottom_Bar)*100 > .25 then

```
Begin
Sell Short 100 Shares Next Bar at market ;
Stop_loss_value = Local_Bottom_Bar;
Profit_target_value = (Difference_TB * 100);
open_trades = True;
End;
Setstoploss(Stop_loss_value);
Setprofittarget(Profit_target_value);
```

If Top_Hit = True and Bottom_Hit = True and Top_Hit_2 = True and close crosses below Local_Bottom_Bar and open_trades = False and ((Local_Top_Bar - Local_Bottom_Bar)/Local_Bottom_Bar)*100 < .25 then

```
Begin
Top_Hit = False;
timer = 0;
Bottom_Hit = False;
Top_Hit_2 = False;
open_trades = False;
End;
```

If timer > 20 and open_trades = True then

```
Begin
Buy to cover 100 shares this bar on close;
Top_Hit = False;
timer = 0;
Bottom_Hit = False;
Top_Hit_2 = False;
open_trades = False;
End;
```

If timer > 20 then

Begin

 Top_Hit = False;

 timer = 0;

 Bottom_Hit = False;

 Top_Hit_2 = False;

End;

if close crosses above Stop_loss_value then

Begin

stop_check = stop_check + 1;

end;

If close < Stop_loss_value then

Begin

stop_check = 0;

End;

If stop_check > 1 then

Begin

 Buy to cover 100 shares this bar on close;

 Top_Hit = False;

 timer = 0;

 stop_check = 0;

 Bottom_Hit = False;

 Top_Hit_2 = False;

 open_trades = False;

end;

If open_trades = true then

Begin

timer = timer + 1;

end;