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Risks and Rewards of Trading Futures

By:

Alexander Arnal and Ethan Patrick

Approved By:

Professor Dimitrios Koutmos and Professor Maxim Bichuch

Abstract

New advancements in technology have opened the door for unique ways to manage ones money. This project ultimately tests the functionality of trading futures contracts using an automatic trading strategy. The specific products traded were crude oil, S&P 500, and 10-year T-notes. The project then tested the effectiveness of these using risk measures and compared it to the standard holding of the S&P 500.

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1. Introduction

In today's world of investing, there are many roads that one can take to find financial success. With the progression of technology and internet speeds, a new world has been opened to the common investor with having the ability to trade right from their home. Not only can things like stocks be traded, but also Forex, futures, and options. This gives a trader a huge array of instruments to make money. The goal of this paper is to specifically examine the practicality and risks of trading futures contracts. The idea is to show that, even when trading a risky asset class, proper entry and exit of the market can significantly reduce risk. In order to compare futures trading with a baseline, the paper uses the S&P 500 index. The project went about doing this by developing the trading strategies in May, and then letting them run through the summer so a legitimate amount of data can be tested.

The majority of this project was completed using the online broker called TradeStation. This broker offers a wide array of tools that lets users create, develop, and test automatic trading systems. An automatic system refers to a series of code that creates buy and sell signals as well as entry and exit rules. In order to have enough raw and consistent data to test our hypothesis, the project needed to be auto traded.

Using TradeStation, our project focusing on creating strategies for three specific futures contracts; the S&P 500, crude oil, and 10-year Treasury notes. The S&P 500 is a collection of the biggest cap companies in the stock market and is often referred to as the benchmark for stocks. Crude oil was chosen due to its deep impact on economics throughout the world. Finally 10-year T-notes were chosen due to their correlation with interest rates and negative correlation with stocks.

2. Methodology

This project implemented three different phases in order to test the efficiency of trading futures. They were as follows:

1) Discovery and Creation: This phase primarily dealt with the research and creation of the trading strategies. This concerned the theories behind the strategies as well as coming up with comparison methods to other trading styles that will be used in the data analysis part. Once this was complete, the theories were turned into EZLanguage, the proprietary code used on TradeStation.

2) Data Collection: Once the trading systems were created and optimized, they were "walked through" in real time over the spring and summer to test their effectiveness. Each trade that was taken was recorded, along with the profit and loss for each and the reason the trade exited.

3) Data Analysis: After the "walk through" of the systems, performance summaries for the trading period were generated. These reports included multiple risk measures and performance standards popular to the industry as well as comprehensive profit-loss reports. From there, risk measures decided upon in the first phase were calculated with the data generated. Once completed, the project gave a good idea of how well each strategy would fair versus just holding the S&P ETF. This allowed multiple conclusions to be drawn as well as several lessons learned.

3. Background

3.1 Futures Contracts

In this project, the main trading instrument were futures contracts. A futures contract is defined as a, "contractual agreement, to buy or sell a particular commodity or financial instrument at a predetermined price in the future."(2) Futures are considered a risky way to bet on future prices of all sort of products ranging from corn to live cattle to the fear level known as the VIX index. The key behind futures is the margin it takes to place the trade. In many derivative products, the buyer or seller only has to put a portion of money down of what the contract is actually worth. This allows for a more competitive market for prices which allows consumers of these products to potentially get a much better price. The downside or the other side to this are the people not looking to ever cash in on these contracts and actually get delivery on the product. These are traders that are primarily looking for a way to make big gains with limited money invested. That is exactly where the risk comes into play. This project takes on this role of a speculator of futures prices.

To understand the margin requirement, take the example of a crude oil contract. Theoretically say the initial margin is $5000 to open either a buy or sell contract. The contract specifications are for 1000 barrels of oil at the end of the month when it expires. Say the price of oil is $100 a barrel. This means that the specific contract is for $100,000 worth of Crude oil. This results in only having to put down $5000 to get gains or losses on $100,000. To understand the profits of any contract, you would find out the smallest movement in the price or the tick value. Take the example of crude oil again. The smallest movement that is measured and traded in this product is $0.01. Since the contract is buying 1000 barrels, this equates to a $10 movement per contract per tick. For example, if someone has 1 contract that they bought at $100.00 and then sold it at $100.10, which would be a movement of $0.10 or 10 ticks which equates to $100 in profit. This leads for extreme leverage on a little bit of money which has its respected pros and cons.

The margin size of the contract takes into account the typical size of the daily change in futures price, and the volatility. Having a higher volatility will lead to an increase in the required margin size. The final piece of futures pricing is the associated fees and commissions for each trade. One fee is for the futures exchange while the other is for the broker. These can be assumed to be about the base tick value per contract. So to buy and sell oil, it might take $20 in fees. The main point of trading futures is to take advantage of low initial cost, which allows for significantly higher profits over other asset classes. This project aims to test the effectiveness and risk of trading futures. The specific products that were chosen to test this were ones with particularly high volume. Since there is no way to know exactly if the order would fill, since we are using a simulation, the best outcome was to use something with very high volume. The products crude oil, S&P 500, and 10 Year T-notes all met this criteria. Each one of them average over 100k contracts a day so trading 1 or even 10 would most likely have now problem executing at that price.
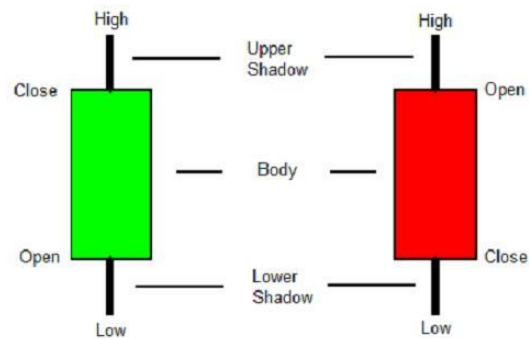
3.2 Bar Charts

Figure 1: Open, High, Low, Close Candlesticks

These bars are known as candlesticks in the world of trading. They originated from Japan and were brought into western popularity by Steve Nison. (5) These bars are a very compact method of presenting data in a visual manner. Open, high, low, and close of the price in a period of time are contained within each candle. The body represents the open and close of the price on a given time frame. For example given a fifteen minute period of time, if the price moved up, the bottom of the body would represent the price at the start of the fifteen minute window. The top of the body would then be the price at the end of the fifteen minutes. The upper and lower wicks are show the high and low, respectively, during the whole time period. When the price has a net movement up the body is generally colored green by default and red if the price moves down. Also when the price moves down in a given time the open is at the top of the body and the close is at the bottom. When candlesticks are aligned side by side they form a candlestick chart which represents price movements over time; four fifteen minute candles would show the price movement over an hour.

3.3 Moving Averages

Of the three trading strategies employed, there was a common theme integrated into all of them. The common ground is the idea of a moving average. The definition of a moving average, "is a mathematical result that is calculated by averaging a number of past data points."(10) The data points in this case are the closing prices at any given timeframe. This means that if one were viewing a bar chart on a 15 minute time frame, then each data point would be the closing price every 15 minutes. The length of a moving average simply refers to the number of data points its averaging. For example, a 15 minute bar chart that has a moving average of 10 applied to it will take the last 10 closing prices and plots the average value. When the next 15 minutes happens, the moving average would add that data point in and get rid of the oldest one, thus moving the price.

What's important to traders is that "moving averages follow the trend while smoothing the price movement". (8) The reason they follow the trend is that they are a reflection of the price. For trading purposes, there are a number of ways to compute moving averages, but for this project, it focused on two main ones; the simple moving average (MA) and the exponential moving average (EMA). "A simple moving average is formed by computing the average price of a security over a specific number of

periods."(9) This is the equivalent of what was described in the example above. "In the exponential moving average equation the most recent market action is assigned greater importance as the average is calculated. The oldest pricing data in the exponential moving average is however never removed."(11) Due to this calculation the exponential average can be seen as a closer follower of price and trend than the simple moving average.

Since our project relied heavily on this concept of moving averages, it's important to understand the trading strategy behind it, not just what it looks like. The whole point of smoothing trading data is that one can identify the trend better. On a smaller timeframe chart the price could be very up and down and no clear trend may be viewable to the trader. If they were to apply a moving average with a length of 10, the trend might be viewable at that level. The point of using these moving averages is like using a microscope to zoom in and out using different lengths until something is viewable in terms of trend. The main reason behind wanting to capture trend is that it allows one to know the direction of the price. This of course depends entirely on what time frame they are viewing. For example a moving average that shows an uptrend on a 5 minute chart might not be applicable to a daily chart or vice versa.

The simplest form of a trading strategy involving moving averages is known as a crossover system. This strategy employs two moving averages, one being 'fast', and one being 'slow'. The fast moving average simply implies it has a shorter length than the slow one. This allows for a short term trend and a long term trend be captured at the same time. As far as trade signals go, there is a "buy signal when the shorter (faster) moving average advances above the longer (slower) moving average. A sell signal would be given when the shorter moving average crosses below the longer moving average."(2) When discussing a crossover strategy the notation can simplified to (short MA length, long MA length).

This strategy is very simple, but that is one of the best parts about it. Most traders who use technical analysis use moving averages just to see the trends a little bit better and not get caught up in messy data. This strategy is easy to understand how it works, but the key for the project was understanding why it did. In the end, there are two factors that add backing to the results.

The first assumption that this project makes about why moving averages work is because if they didn't, there would be no trend in the data being viewed. If there is no trend to capture, a trading system will be extremely hard to employ. Moving averages are first and foremost a way to view trends. Most of the common pitfalls with this is that traders use too large of a timeframe mixed with too large of a length of the moving average. This leads to an extreme lag on trade signals. The reason for this is that the MA is an average of the most recent prices so when the price moves it is averaged and so it will not perfectly follow the price. The longer the period the less the newest price move will affect the average and the more the MA will lag behind the price. Picture someone using a 1 hour chart with a (10, 20) EMA crossover system versus the same setup on a daily chart. The trade signals will clearly be different, but the hourly no doubt creates faster signals based of its timeframe. This leads to different trades and missed trades. The key we found was that using a smaller timeframe with relatively small lengths for both fast and long led cleaner, more

tradable trends. Below is a comparison of the ES hourly chart with two different moving average crossover pairs. From left to right they are, (10, 20) and (30, 80).
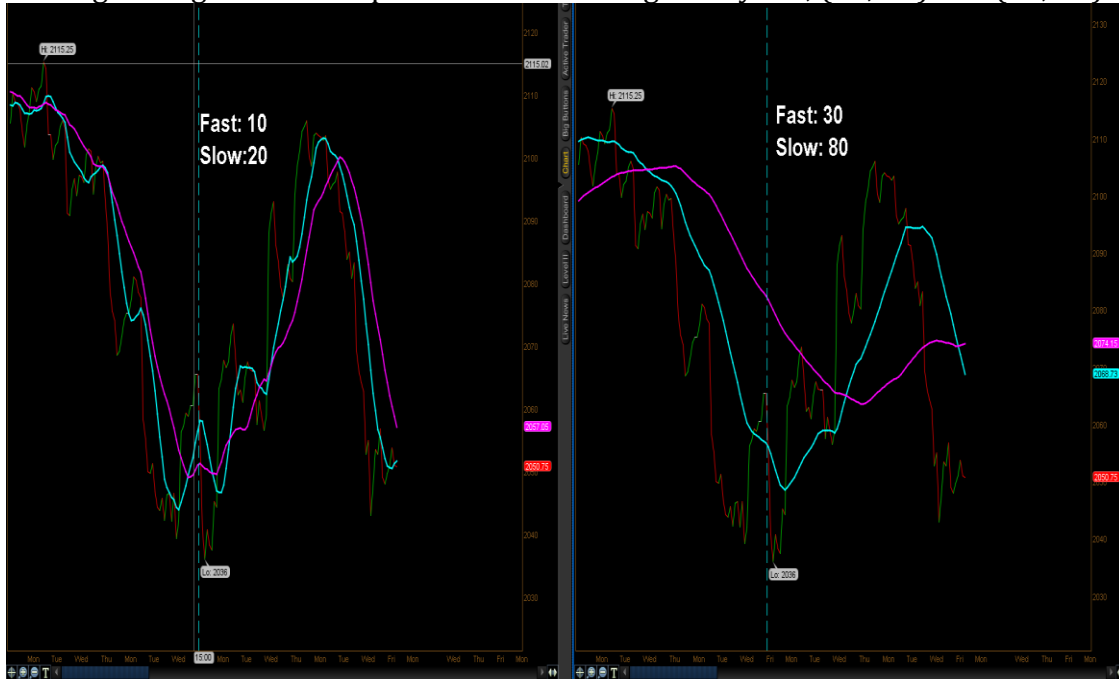

Figure 2: Moving Average example

This picture should really portray the mechanics behind moving averages. First off, the graph on the left is using much shorter moving averages than the one on the right. A simple way to see this is to just check the smoothness of the line. The graph on the left is much choppier with the MAs but that's intuitive because it is grabbing less data to average out. Visually those are the main differences, but the real thing that matters is the trade signals. The chart on the right exemplifies the downside of using unsmoothed data which leads to a system killer in the form of tons of trades. Since the project primarily uses crossovers as signals, there would be many reverse orders going in with lengths this choppy because there will be more crossovers and hence more entry and exit signals. With commissions and the loss of the trade, it really starts to add up. On the opposite side of things, there is the graph on the right which only crosses over and under 1 time each. This is extreme side of smoothing data which creates very clear signals. However, clean signals mean nothing when they are so lagged. They create buy orders when the price is usually topping out and sell orders when a rally is imminent. The real use of this is just for the visual aid, not for creating trade signals.

With that, one could infer that there is a unique combination of short and fast lengths that could be very profitable. That is exactly what one of the systems uses. The back testing ran millions of combinations to find the best possible one and that is what was implemented in the strategy.

3.4 TradeStation

In order understand how this project functioned, one must understand the brokerage TradeStation. A lot of the firms specialize only in creating a manual trading

environment. What this means is that these other brokers have platforms which are really just a trading shell where one would view charts, place orders etc. These platforms are meant for manual entry of trades and are not conducive to testing or creating strategies. Many traders have access to charts to view their products. However, it's very hard to get exact numbers on how a strategy would work by just eyeballing it.

Take the example of a trader who is using Ameritrade brokerage firm on ThinkorSwim their current platform. Pretend the trader has a strategy that they use to make some money. The strategy could be something simple like when the 10 day moving average of the closing price of the S&P crosses the 20 day moving average, the trader would enter a buy order. This leads to a couple of implications. It's very hard for the trader to manually place his entry at the right time every time. Also it's hard to find out if this is the best set of moving average lengths that lead to the highest profit. This can be done by guess and check, but it's doubtful to find the perfect combination. This is where TradeStation sets itself apart from other trading platforms. It specializes in creating an environment in which the trader can turn their strategy into their unique code. This is extremely valuable because it allows for the strategy to be seen visually on the charts with the buy and sell orders. Not only can one program their trading strategy, the brokerage will actually trade it live. This means that that same trader using Ameritrade can turn his strategy that might have had many errors and took many hours at the computer of waiting and watching, into essentially a program.

Perhaps the best part of this program creation on TradeStation is their immensely deep optimization options for a programed strategy. In that same example of the trader using the moving averages, they could now optimize those lengths. Optimization allows the user to test every possibility of an input over a set range. This means that the trader could optimize the shorter length to be anywhere from 1-10 and the longer one to be anywhere from 20-50. This would run the strategy and find out every trade it took and record the data. Then it compares it to all the other possibilities and outputs the best one based off of profit. This allows for a robotic trading system that is optimized sometimes for millions of combinations. This is a great tool for a trader who wants to test a strategy they have in their mind and get actual raw data. All of the systems created for this project were optimized over the last 5 years meaning the most profitable output in that time period was found. In order to test if this data worked well it was 'walked through' this summer which essentially means to test live. All of the results were very similar to their back testing results on the walkthrough which add credibility to the data generated from this simulation. This project really couldn't have been done without this broker as it allowed us to test something that is new and quite different from the normal investment ideas.

3.5 Risk Measures

When assessing a portfolio or a just a single strategy it becomes important to develop metrics with which to compare performance. The end profit may not reveal the whole story and while large returns are attractive they are oftentimes accompanied by inordinate risk. In the long term a risky strategy can leave a firm bankrupt. Therefore it becomes important to define risk and develop measures that can be used to quantify the risk of a strategy.

3.5.1 Coherent Risk Measures

A coherent risk measure satisfies four principles, translation invariance, subadditivity, positive homogeneity, and Monotonicity. (3) In order to define these four properties for a portfolio we must first define a function of risk measure, ρ, and a domain G, which the values of the portfolio exist in.

Translational Invariance (3)

$For\ all\ X \in G\ and\ all\ real\ numbers\ \alpha, we\ have\ \rho(X + \alpha \cdot r) = \rho(X) - \alpha$

So for the purpose of risk measures if $\alpha \cdot r$ is a portfolio or asset with guaranteed return α then combining X with $\alpha \cdot r$ would result in a combined risk of $\rho(X) - \alpha$. Therefore if $\alpha = \rho(X), \rho(X + \alpha \cdot r) = 0$.

Subadditivity (3)

$For\ all\ X_1, X_2 \in G, \rho(X_1 + X_2) \leq \rho(X_1) + \rho(X_2)$

If we were to combine two portfolios X_1, X_2 then the combined risk is bounded above by the individual risk of each portfolio. If this property is not met then it is beneficial to avoid diversification and simply split up individual assets.

Positive Homogeneity (3)

$For\ all\ \lambda \geq 0\ and\ all\ X \in G, \rho(\lambda X) = \lambda \rho(X)$

This means that an increase, or decrease in a portfolio by some ratio λ, should increase, or decrease risk by λ. This

Monotonicity (3)

$For\ all\ X, Y \in G\ with\ X \leq Y, we\ have\ \rho(X) \leq \rho(X)$

If a portfolio X is more favorable than Y, then the risk should be less.

This definition is needed to see why some risk measures may be deficient and require modifications. Also the definition of coherent risk measure is important in relation to traditional portfolio theory, which promotes diversification to minimize risk. (1)

3.5.2 Mean and Standard deviation

Prior to discussion or calculations it is reasonable to first lay down the framework for what will be necessary recurring values in both risk measures. The first is the mean, generally represented as μ in statistics, which is a very straightforward calculation. Given a list of n numerical values the mean is calculated using the following equation:

$$\mu = \frac{1}{n}\sum_{i=1}^{n} x_i$$

The second value to be calculated is the standard deviation, which will be written as s. Given a list of n values and a mean, μ the standard deviation is calculated as follows:

$$s = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \mu)^2}$$

3.5.3 Value at Risk: VaR

VaR is possibly the most well-known measure of risk as well as one of the simplest to calculate. VaR is defined given a confidence level $\alpha \in (0,1)$. The VaR at this confidence level is the smallest value l such that the probability of any loss, $L \geq l = (1 - \alpha)$. The formulaic definition is as follows:

$$VaR_\alpha(L) = \inf\{l \in \mathbb{R}: P(L > l) \leq 1 - \alpha\}$$

Using historical data

Step one – Order trades by net profit

Step two – Choose a percentile

Step three – The trade at this percentile is the VaR. If there 100 trades and the percentile is 90 then the VaR is the 10th worst trade.

VaR takes a percentile and produces the maximum loss given this confidence level. When calculating VaR for a portfolio or strategy it is likely to expect losses will be constrained by the VaR. For example consider the following list of trades.

Table 1: Trade List example 1

Trade #	Loss
95	100
96	100
97	110
98	120
99	125
100	130

The 95th percentile VaR would be 100 in this example. The interpretation of this is that 95% of the time losses should be less than or equal to 100. The VaR is a solid, simple, representation of risk than can be quickly calculated and used for comparisons.

Model approach

Instead of using a procedural approach to assess the VaR it is sometimes necessary to use predictive methods. By applying a statistical model such as normal, lognormal, or even exponential, it is possible to calculate VaR for much higher confidence levels even when using a smaller amount of raw data. It would not make sense to calculate the 99th percentile based on historical data only including 100 trading days, the VaR would be the worst trade that happened to occur during that period.

In order to use a normal distribution to predict VaR, the first step is to calculate the mean and standard deviation. These values can then be plugged into the probability density function, pdf, of a normal distribution:

$$f(x) = \frac{1}{s\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2s^2}}$$

In order to calculate the VaR using this equation first set a percentile: standard ones being 90th, 95th, and 99th. The problem is not as simple as setting the pdf equal to a percentile, instead the integral must be taken to get the cumulative density function. So the equation that needs to be solved to calculate the 90th percentile would be:

$$.90 = \frac{1}{s\sqrt{2\pi}} \int_{-\infty}^{x} e^{-\frac{(x-\mu)^2}{2s^2}}$$

To make solving this equation simple, the normal distribution can be converted to a standard normal distribution, a normal distribution with mean, 0 and standard deviation, 1. Suppose X is some normal distribution with mean μ and standard deviation *s*. Then X can be converted to standard normal with the following equation.

$$standard\ normal, Z = \frac{X - \mu}{s} \sim N(0,1)$$

The reason for doing this is that percentile values for standard normal have already been calculated and so a "Z table", a table containing values for the standard normal distribution, can be referenced. So then to compute the VaR only the following equation needs to be solved:

$$VaR = \mu + Zs$$

To get Z it is only necessary to view the chart, pick the percentile closest to the desired percentile from the interior of the Z table and record the corresponding Z value. The values of Z for the three percentiles most useful for calculating VaR are as follows:

Table 2: Common Percentile Z values of a Standard Normal

Percentile	Z
90th	1.282
95th	1.645
99th	3.236

Subadditivity of VaR

While VaR provides a simple means of judging the risk of a portfolio it is not without fault. We provided a definition of a coherent risk measure above and unfortunately VaR violates this definition; in particular VaR is not subadditive. Therefore VaR is not necessarily reduced through diversification. In practice it is rare for VaR to violate the property but it is possible. (4)

Example: *Suppose two dice are thrown five times to obtain the following results (4)*

	Dice 1	Dice 2	Dice 1 + Dice 2
Throw 1	2	4	6
Throw 2	3	1	4
Throw 3	4	5	9
Throw 4	5	6	11
Throw 5	6	6	12

The VaR at probability 1/3 are:

	Dice 1	Dice 2	Sum	Dice 1 + Dice 2
VaR	-3	-4	-7	-6

Table 3: Example of VaR's violation of subadditivity

$$So\ VaR(Dice\ 1) + VaR(Dice\ 2) = -7 < -6 = VaR(Dice\ 1 + Dice\ 2)$$

3.5.5 Conditional Value at Risk: CVaR

CVaR builds on VaR and attempts to enhance the accuracy by solving the issue of subadditivity that VaR faces. To calculate the CVaR for a given percentile, average the VaR for all percentiles greater than or equal to the given one. Given a percentile $\alpha \in [0,1]$ the mathematical definition of CVaR is:

$$CVaR_\alpha(X) = \frac{1}{\alpha} \int_0^\alpha VaR_\gamma(X)d\gamma$$

So to calculate the CVaR take the integral of the VaR over all percentiles past the desired percentile. This is then divided by the percentile.

Using historical data

Step one – Order trades by net profit

Step two – Choose a percentile, 5% is a common choice

Step three – Take the lowest 5% trades by net profit. If there are 100 trades take the 5 lowest.

Step four – The CVaR is the average of these lowest trades.

CVaR has some major advantages to VaR. One is that it is sensitive to extreme values due to the process of averaging. VaR simply takes the loss at a certain threshold, say the 95th percentile, CVaR instead takes the average of the losses beyond that point. For example examine these two circumstances:

Table 4: Example Trade List 2

Trade #	Loss
95	100
96	100
97	110
98	120
99	125
100	130

Table 5: Example Trade List 3

Trade #	Loss
95	100
96	100
97	200
98	300
99	400
100	500

Imagine there are set of one hundred trades these being the final six. Therefore to calculate the 95th percentile VaR for the set of trades on the left merely take the five worst loss which is 100 in this case. The CVaR for this same set of trades would be the average of those five worst trades which is 117. In this case the CVaR and the VaR equate to a similar value. Now take a look at the example on the right. Once again the 95th percentile VaR is 100. This time however the losses past this threshold are much more extreme. The CVaR, which is the average of these extreme losses, is 300. All of a sudden the CVaR paints a very different picture than the VaR. The VaR says that there with 95% confidence that losses will not exceed 100. The

downside is that it mentions nothing of those 5% cases in which it does and that's where CVaR steps in.

Though CVaR solves the violation of subadditivity that VaR has under certain conditions, VaR is generally preferred in banking. CVaR is theoretically superior, but in practical situations VaR has several advantages. It requires smaller sets of data, it is easy to back test, and it is easier to calculate. (4)

3.6 Other Useful Measures

Besides traditional risk measures which produce the dollar value necessary to protect one's self from loss, there are some other measures which can be used to compare portfolios.

3.6.1 Sharpe Ratio

The Sharpe ratio is a ratio of risk adjusted returns per unit of volatility. To calculate the Sharpe ratio, a risk free rate of return is subtracted from the daily return, or any whatever desired time horizon. This value is divided by the standard deviation of the risk adjusted returns.

$$\frac{Daily\ Return - Risk\ free\ rate\ of\ return}{Standard\ Deviation\ of\ Risk\ adjusted\ returns}$$

Since there is no such thing as a truly risk free rate of return, T-notes are typically used as the benchmark. For this project the 3-month T-note return rate was selected, which had a daily return of $0.33. The larger the Sharpe ratio the better since this means the returns largely outweigh the volatility that the portfolio is exposed to. (13) The Sharpe ratio does not have units and therefore has little meaning by itself. Instead it used to compare different portfolios or see the effect of adding an asset to a portfolio.

3.6.2 Sortino Ratio

The Sortino ratio builds upon the Sharpe ratio by separating good volatility, that which produces profit, from harmful volatility, large losses.

$$\frac{Daily\ Return - Risk\ free\ rate\ of\ return}{Downside\ Risk}$$

$$Downside\ Risk = \sqrt{\frac{1}{n}\sum(daily\ return - Risk\ free\ rate\ of\ return) * f(n)}$$

f(n)=0 if daily return-Risk free return ≥ 0
f(n)=1 if daily return-Risk free return < 0

The Sortino ratio is calculated by subtracting the risk free return from the average daily returns. This value is then divided by downside risk, the formula for calculating this is located above. By doing this the formula produces a ratio between returns in excess of the risk free return and the standard deviation of losses. In this case losses are considered to be anything below the risk free return. Therefore the larger the Sortino ratio the lower the likelihood of incurring large losses.

4. Individual Strategies

Product Traded: Crude Oil Futures
Strategy Employed: Moving Average Crossover
Ticker: CL
Contract Length: 1 Month
Chart Type and Timeframe: candlestick/1hour
Tick Size: .01
Tick Value: $10
Margin (*subject to change): $5340

Summary of Strategy:

As mentioned before the crude oil system used a moving average crossover system on an hourly chart. The strategy traded 5 days a week, 23 hours a day. The main reason behind using a moving average system was that moving averages are best utilized on something that follows a trend. That is exactly what oil is known to do as its one of the most cyclical products out there. It is a unique blend of supply and demand, politics and speculators that create this price movement. Although oil may be subject to dramatic spikes or crashes based off of news, it usually continues that trend for some time after. This allows trend following systems to do well. Like all strategies created, the inputs of length and price were optimized using TradeStations back testing., This allowed for the best possible 'guess' for these systems to be profitable.

The unique aspect of this strategy came in the form of the scaling in code. Scaling in is the practice of adding to a position as it makes money. This differs from buying all contracts at once with equal stops and profit targets. The theory behind this is that one only takes on more risk when they are up x amount of dollars. This theory in combination of a trend following system was incredible. It allowed the strategy to essentially "ride" the trend to its stopping or reversal point as opposed having a set profit target.

Product Traded: S&P 500 Futures
Strategy Employed: Pivot Point Price Crossover
Ticker: ES
Contract Length: 3 Months
Chart Type and Timeframe: candlestick/1hour
Tick Size: .25
Tick Value: $12.5
Margin (*subject to change): $5060
Summary of Strategy:

This particular strategy used the idea of moving averages also to create it trade signals. The biggest difference was how the 'moving average' was computed. Instead of just using closing price for each data point, there was blend computed called a pivot. A pivot point is a technical resource used by intraday traders mainly, and acts as the decision point for the day whether the product moves below or above it. The exact formula for the pivot point is $\frac{(highByPeriod + lowByPeriod + 2 * openByPeriod)}{4}$. This is

typically used with a period of a day, however this strategy was optimized to be run on the hourly chart using a slightly less timeframe. Instead of having two of these pivot points and creating a crossover system, the current close price was used in place. The theory behind this was that the pivot point is already so lagged that creating a 'fast' length would not give fast enough trade signals. Once again all inputs such as profit and stop loss were optimized using TradeStations back testing.

Product Traded: 10 Year T-note futures
Strategy Employed: Slope
Ticker: ZN
Contract Length: 3 Months
Chart Type and Timeframe: candlestick/1hour
Tick Size: '005 Basis Points
Tick Value: $15.63
Margin (*subject to change): $1485
Summary of Strategy:

The final strategy involved trading 10 year T-note futures using slope. This system is by far the most simple as it goes long when the slope crosses above 0, and shorts when it goes under. It used an hour time frame for this system in order to avoid too many unnecessary crossovers, which would kill the profits. The system had stop losses and profit targets built in with every trade and multiple exit conditions that were once again optimized on using back testing.

Futures are seen as an asset type that carries a large amount of risk. The goal of this project is to determine whether it is possible to develop a set of strategies that would trade futures while incurring minimum risk. The first step in achieving this goal was creating a set of rules to trade by.

A major theme in the strategy development was that the longer a trade is open the more exposed it is to risk. If a contract was locked in for a month then it is possible for the price to crash during this month and there is no choice but to wait it out and hope for the price to return. Instead the more efficient approach would be to close the trade, lock in profits, and reopen it at a later time. Therefore the idea behind the strategies developed for the project was to take advantage of the fact that futures allows 24/7 trading: because of this it is possible to enter and exit the market at the most optimal times and avoid large losses.

5. Results of Systems

5.1 Performance Reports

For each of the three systems, a performance summary was created to help view the results on a multi-faceted level. The performance reports were automatically generated by TradeStation and as such the start and end date for each strategy may differ. The overall period in which this data was recorded was from January 1st, 2014, to August 12th, 2014. The performance reports included in the appendix are edited versions of the performance reports TradeStation produces. The included edited reports are what we deemed as important and were what we paid attention to when developing our strategies.

5.1.1 Useful Values from Performance Reports

This data was not used for comparison and as such some of the data sets vary in length. Instead the values were used to further develop and perfect each strategy. There are five major values from the reports that we paid attention to the most.

Net profit during the trading period

This is the total profit from the start of the year, to the selected end date. This is important because the trading strategy would be pointless if it does not generate an acceptable profit.

Profit factor

Profit factor is the ratio of net gross over net loss. Therefore the larger this value the better the strategy. For our strategy development the goal was a profit factor of at least 1.5, preferable 2. This is important because if the profit factor is close to 1 then it would mean the strategy is not very robust and just one more loss may make the strategy a net loss. If the profit factor is below 1 then the strategy loses money.

Monthly Returns

Instead of just looking at the total returns it is a good idea to look at a monthly breakdown of profits. A good exercise when checking the validity of a strategy is to exclude the most profitable trade/day/month etc., and see if it is still profitable. By doing this it rules out the possibility that all the profits were made in one go instead of a consistent series of gains.

Percent profitable

Percent profitable is simply the percentage of trades which made money. The important part is that it is not necessary for this to be over 50%. Instead trend following strategies have large winning trades since they follow a trend. Therefore a net profit can be had even with a profitability of 25%.

Maximum Drawdown

Maximum drawdown is the most money the strategy lost from a peak profit until reaching the next peak profit. This is the number that we paid attention to the

most. The reason is that if the maximum drawdown is too large then the strategy can lose too much before becoming profitable and need to be stopped. The goal was to keep the maximum drawdown below 10%, but less is always better.

5.1.2 Crude oil Summary
Net profit during the trading period
The net profit for the Crude oil strategy was \$14,810.00 from January 1st to August 12th. This a gain of 14.81% on the original \$100,000 account. These profits were acquired trading a single contract of Crude oil which requires a minimum account of roughly \$5000. This value is the margin required for a Crude oil futures contract and is subject to change depending on brokers and volatility.

Profit factor
The overall profit factor was 2.03. This is an excellent profit factor since it means the strategy is quite robust. Even with commissions and occasional slippage it would be expected to return a profit.

Monthly Returns
This strategy only traded over a total of seven months, of which six were profitable. The only month which did not have a net profit lost \$1200.00. In this case the most profitable month was July which made \$6,730.00. Even if this month is excluded the strategy had a net profit of \$8080.00.

Percent profitable
The percent of profitable trades was only 23.81%. Out of the 42 trades that the strategy took only 10 were winners. This may seem like an extremely poor performance but this is a trend following system and therefore only makes a profit if the asset is trending. When the asset moves sideways the strategy incurs numerous small losses as the strategy takes a false signal for a trend. This can easily be seen when looking at the average profit of the 10 winning trades which was \$2,572.00. Compare this to the average of \$-450.31 for losing trades.

Maximum Drawdown
The maximum drawdown occurred on July 2nd, and was \$5370.00. This is 5.37% of the original account. This is far below the goal of 10.00% and is just over one third of the total profit of the strategy. Therefore this is a perfectly acceptable maximum drawdown.

5.1.3 S&P 500 Summary
Net profit during the trading period
The net profit during the trading period totaled to \$12,763.50 or 12.76% on the original account of \$100,000. The strategy that was implemented on the S&P 500 and only traded a maximum of one contract at any given time.

Profit factor

The profit factor for the strategy was 1.27, i.e. for every $1.00 lost $1.27 dollars were earned. While all the numbers have been adjusted for commissions this profit factor can be considered rather low. This measure would suggest somewhat poor performance despite the overall earnings of 12.76%. A further breakdown shows that the profit factor for long trades was 1.54 versus the 1.08 of the short trades. Essentially this value would recommend avoiding shorts as they offer barely more than break even.

Monthly Returns

During the recorded eight months three reported a loss and the remaining five months were profitable. All three of the months which saw negative returns were less than 1% of the original $100,000, whereas four out of the five profitable months were greater than 1%. February was the most profitable month with a net profit of $5501.00. If this month is removed than the total gains are still $7262.00.

Percent profitable

The total number of trades was 319, of which 41.07% were profitable: 131 winning trades and 188 losing trades. More specifically 44.87% of all long trades were profitable while only 37.42% of all short trades made money. This follows from the fact that short trades accounted for very little of the overall profit.

Maximum Drawdown

Maximum drawdown is the largest amount of losses sustained at one time. It does not have to be a single large loss, it can be the accumulation of a series of losses before a winning trade. The S&P 500 strategy had a maximum drawdown of $3,376.50. This only accounts for 3.38% of the total $100,000 account and it is the largest loss incurred at one time. This drawdown is quite low in comparison to the total profit of the strategy.

5.1.4 10 year T-note Summary
Net profit during the trading period

The year to date net profit of the 10 year Treasury note was $3632.88 or 3.63% of the original $100,000 account. Same as the S&P 500 strategy this one traded only a single contract during the trading period.

Profit factor

The profit factor mirrors the previous results of long versus short. For longs, the profit factor was 1.65 which means that for every dollar invested into a long the expected return would be $1.65. Contrast this with shorts which results in a profit factor of .91, which means there is an expected loss of nine cents on each dollar invested. The combined profit factor comes out to be 1.19. This is very far from being ideal as it is very close to one. This would suggest that the strategy is not very elastic and if conditions were to become even slightly unfavorable the strategy could begin to lose money.

Monthly Returns

The trading period includes eight months. Of these eight months six were profitable, however four out of these six saw returns less than 1%. In fact a majority of the total profit earned during the trading period was made in the first month of January. Once this month is removed the strategy becomes more or less breakeven. This is problematic and suggests that the strategy may not be robust since it relies on somewhat of an outlier month.

Percent profitable

There were a total of 264 trades performed throughout the test. Of these there were only 97 profitable trades and 167 losing trades; that is the overall percent of profitable trades was only 36.7%. The specific profitability of long versus short trades was already discussed and the outcome was that longs were favored.

Maximum Drawdown

The maximum drawdown experienced by this strategy occurred on 5/29 totaling $3279.25. At first this seems quite acceptable, a maximum drawdown of 3.28% on an account of $100,000; but it is worth noting that this is 99.45% of the net profit. This means that at one point the total losses accrued in a row equaled the net profit during the trading period. This is far from ideal since that further suggests over a longer trading period this strategy may not be profitable.

5.2 Calculated Risk Measures
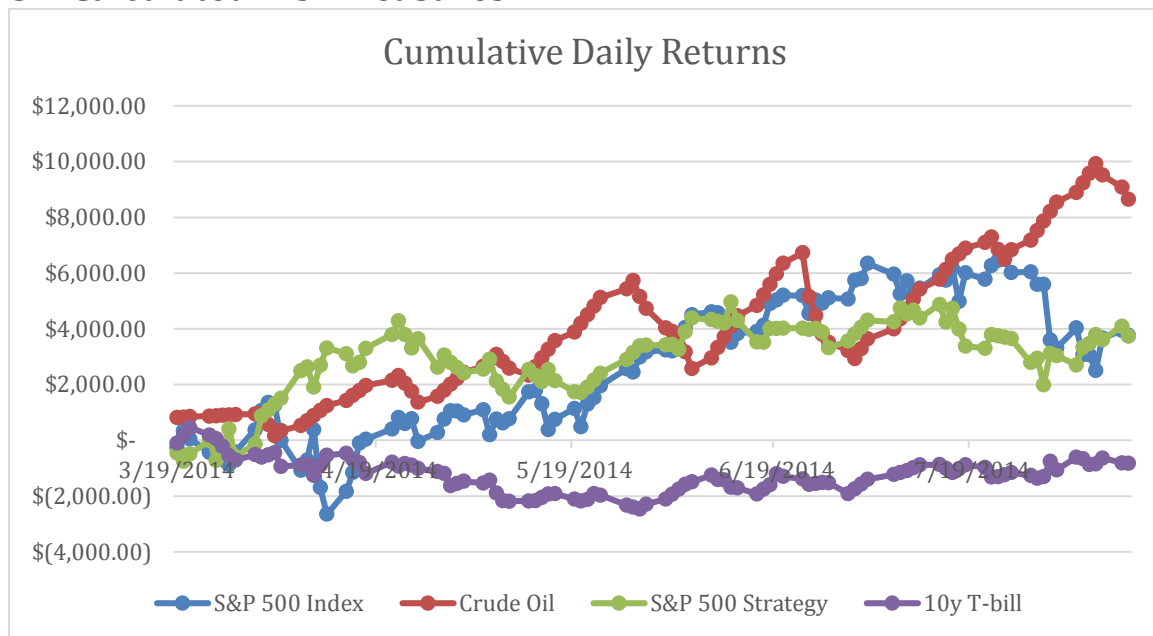
Figure 3: Cumulative Daily Returns

This is a chart of the cumulative daily returns of the four assets used in this project, S&P 500 index buy and hold (blue), the Crude oil strategy (red), the S&P 500 strategy (green), and the 10 year T-note strategy (purple). The chart tracks how much profit the strategy made throughout the 102 day trading period. The Crude oil strategy performed the best, profit wise, while the S&P 500 index and strategy ended with nearly identical returns. The 10 year T-note strategy struggled and by the end had negative returns.

In order to be able to compare the risk measures, VaR and CVaR, as well as the other measures, Sharpe and Sortino ratios, all four data sets were taken over the same range of dates. The start date was March 19th, 2014, and the end date was August 12th, 2014. This is five months of data, which comes out to be 102 total trading days. All returns were converted to daily returns since the number of trades each strategy took varied. The risk measures were then calculated with a time horizon of one day.

5.2.1 S&P 500 Index

Risk measures per contract			Return Rate per contract
VaR = 90th Percentile			3.78%
$ 809.64			
CVaR = Avg of all trades past 90th percentile			
$ 1,216.25			
VaR using Normal Distribution			
Mean			
$ 37.04			
Standard Deviation			
$ 601.83			
Percentile	**VaR**		
90th	$ 808.58		
95th	$ 1,027.05		
99th	$ 1,984.55		
Sharpe Ratio			
0.06			
Sortino Ratio			
0.09			

Table 6: S&P 500 Index Returns, VaR, CVaR, Sortino Ratio

This is the 90th percentile VaR and CVaR for the S&P 500 Index given an account size of $100,000 over the period from March 19th, 2014 until August 12th, 2014. The VaR and CVaR are based on daily returns during this time period. This includes 102 trading days which is near the limit of a single contract duration for crude oil futures. The 90th, 95th, and 99th percentile VaR of the S&P 500 index buy and hold are all included as well. A normal distribution of returns, given a standard deviation of $601.14 and mean of $39.54 predicts a 90th percentile VaR of $808.58. The actual recorded 90th percentile VaR using historical methods was $809.64. Due to the two value varying only slightly, a normal distribution is at least useful for larger percentiles. In addition, the Sortino and Sharpe ratios are included given a daily risk free rate of return of .00033%.

5.2.2 Crude Oil Strategy

Risk measures per contract			Return Rate per contract
VaR = 90th Percentile			8.65%
$ 435.00			
CVaR = Avg of all trades past 90th percentile			
$ 670.00			
VaR using Normal Distribution			
Mean			
$ 84.80			
Standard Deviation			
$ 356.48			
Percentile	**VaR**		
90th	$ 541.81		
95th	$ 671.21		
99th	$ 1,238.36		
Sharpe Ratio			
0.24			
Sortino Ratio			
0.36			

Table 7: Crude Oil Strategy Returns, VaR, CVaR, Sortino Ratio

This is the 90th percentile VaR and CVaR for the crude oil strategy given an account size of $100,000 over the period from March 19th, 2014 until August 12th, 2014. The 90th, 95th, and 99th percentile VaR of the Crude Oil strategy are all included as well. A normal distribution of returns, given a standard deviation of $356.48 and mean of $84.80 predicts a 90th percentile VaR of $541.81. The actual recorded 90th percentile VaR using historical methods was $435.00. The predicted VaR is 24.55% larger than the historical VaR. This would suggest the returns of this specific strategy do not fit a normal distribution very well.

5.2.3 S&P 500 Strategy

Risk measures per contract			Return Rate per contract
VaR = 90th Percentile			3.74%
$ 671.00			
CVaR = Avg of all trades past 90th percentile			
$ 821.35			
VaR using Normal Distribution			
Mean			
$ 36.68			
Standard Deviation			
$ 464.42			
Percentile	**VaR**		
90th	$ 632.07		
95th	$ 800.65		
99th	$ 1,539.55		
Sharpe Ratio			
0.08			
Sortino Ratio			
0.14			

Table 8: S&P 500 Strategy Returns, VaR, CVaR, Returns

This is the result of the strategy which was coded to run on the S&P 500 futures contract. These numbers were calculated using data from March 19th, 2014 until August 20th. The 90th percentile VaR and CVaR were calculated using historical methods. The 90th, 95th, and 99th percentile VaR of the S&P 500 strategy are all included as well. A normal distribution of returns, given a standard deviation of $464.42 and mean of $36.68 predicts a 90th percentile VaR of $632.07. The actual recorded 90th percentile VaR using historical methods was $671.00. These values only vary by 5.80% and so the normal distribution gives a reasonable estimate.

5.2.4 10 year T-note Strategy

Risk measures per contract		Return Rate per contract
VaR = 90th Percentile		-0.816%
$ 302.25		
CVaR = Avg of all trades past 90th percentile		
$ 390.30		
VaR using Normal Distribution		
Mean		
$ (8.00)		
Standard Deviation		
$ 204.67		
Percentile	**VaR**	
90th	$ 254.39	
95th	$ 328.68	
99th	$ 654.31	
Sharpe Ratio		
0.04		
Sortino Ratio		
0.07		

Table 9: 10y T-note Strategy Returns, VaR, CVaR, Returns

These are the results of risk measure calculations on the strategy used on 10 year T-note contracts. Immediately it is worth pointing out that this is the one strategy out of the three that were coded that resulted in losses during the trading period. The 90th, 95th, and 99th percentile VaR of the Crude Oil strategy are all included as well. A normal distribution of returns, given a standard deviation of $204.67 and mean of $-8.00 predicts a 90th percentile VaR of $254.39. The actual recorded 90th percentile VaR using historical methods was $302.25. The predicted VaR is 15.84% less than the one acquired using historical methods. While this is not a large of variance as the Crude Oil strategy it still raises some concern of the ability of a normal distribution to represent returns.
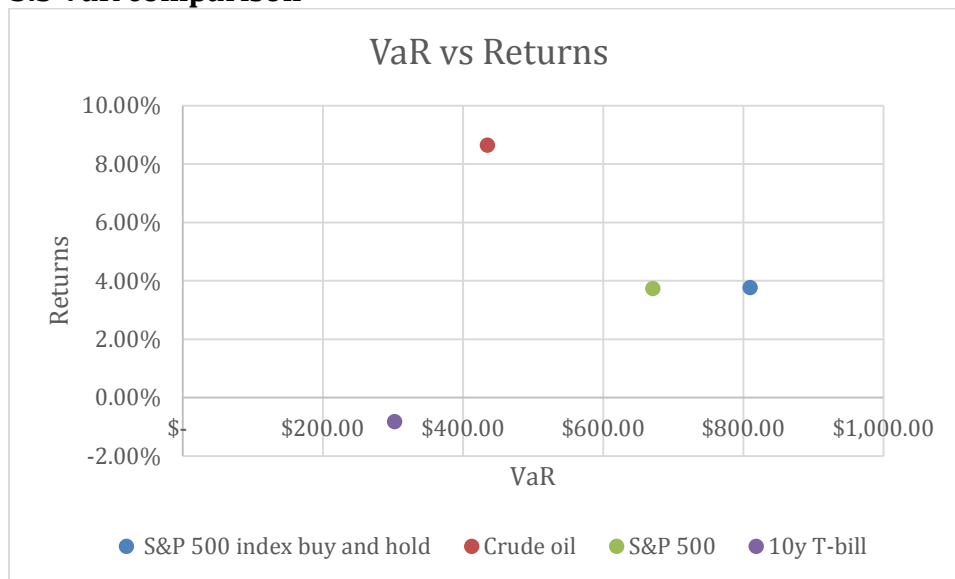
5.3 VaR comparison

Figure 4: VaR vs. Returns

This chart plots the returns on the Y-axis and the VaR on the X-axis. Points further to the left have a lower VaR and higher points have larger returns. The VaR used is the one calculated using historical methods.

In order of VaR the strategies are as follows; 10 year T-note-$302.25, Crude Oil-$435.00, S&P 500-$671.00, and S&P 500 index-$809.64. Therefore of all four strategies buy and hold of the S&P 500 index was the riskiest according to VaR. One reason this occurred was that there was an extremely strong bull market during the summer of 2014. As such the S&P 500 index constantly broke record highs. This also means there was a large amount of volatility during this period and so a buy and hold strategy would take large losses during this fast climb. This can be seen by directly comparing the S&P 500 index buy and hold to the S&P 500 strategy which actively tries to avoid large losses. Their respective returns were 3.78% and 3.74%. The returns are nearly identical with the strategy seeing only slightly lower returns. This is occurs because the strategy is made to avoid large losses and in doing so it misses some profitable trades. The main difference is that the S&P 500 strategy had a VaR of only $671.00 while the buy and hold had a VaR of $809.64. In this case implementing a strategy to manage trades resulted in a reduction of VaR by 17.12% while maintaining nearly identical returns during the 102 day trading period. The reason for this is that the strategy uses a stop loss to close positions and avoid large losses. For the strategy the largest daily loss was $1024.00 while the largest loss for the buy and hold was $2088.47.

The Crude Oil strategy one ups the S&P 500 strategy by simultaneously producing a lower VaR, $435.00 and a higher profit, 8.65%. This result is due, in part, to the strong trends that Crude Oil experienced during the 102 day trading period. This caused the strategy to remain in trades for longer periods of time and caused a very large profit. For this same reason the VaR is very low. Losses only occur when the strategy gives a false signal and enters the market expecting a trend when in fact there are none. Regardless, the strategy had 46.27% less risk than the S&P 500 buy

and hold according to the VaR. In addition it had 128.84% more profit. Even if the risk wasn't significantly reduced the Crude Oil strategy significantly outperformed the buy and hold despite the S&P 500 having such a strong bull market in the summer of 2014.

The 10 year T-note strategy had the lowest returns of any of the strategies and even worse it posted negative results. The return during the trading period was -0.82%. This occurred due to the low volatility of T-notes. All three strategies we developed were trend following and the 10 year T-note trended very little during the trading period. Since the returns and as a consequence, losses, were so small this strategy also had the least risk, with a VaR of only $302.24. This result is the only one of the three which may contradict our original idea. While it may have produced reduced risk, this is a worthless result if it does not at least go even with a buy and hold strategy.

Overall the VaR paints a picture of the possibility that risk can be properly managed regardless of asset class. All three strategies resulted in a VaR less than that of buying and holding the S&P 500. At the very least this is evidence that proper management of entries and exits can reduce exposure to extreme losses and can protect against harmful volatility.

All these results and conclusions are further confirmed by the calculations of VaR using a normal distribution. For 90th, 95th, and 99th percentiles the order of VaR do not change. The VaR increases with each increase of percentiles as is expected, in order to increase the confidence that all losses will be less than a certain value, this upper bound must be increased. Furthermore since the distribution of all four strategies was chosen to be normal, the factor by which the VaR increases for each percentile is roughly the same for all four strategies. All in all the model approach to calculating VaR is useful for prediction but produces results that do not differ from the historical approach.
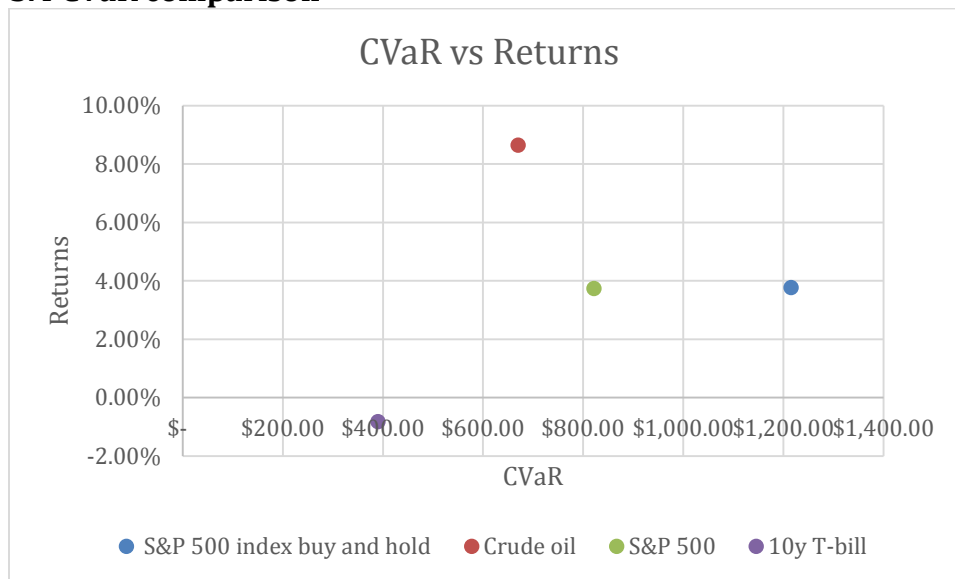
5.4 CVaR comparison

CVaR vs Returns

Figure 5: CVaR vs. Returns

Calculating the CVaR results in similar conclusions as those for the VaR. After averaging the ten lowest trades the order of risk is still as before, 10 year T-note, Crude Oil, S&P 500, then S&P 500 buy and hold. So for buy and hold S&P 500 the CVaR is $1216.25. The Crude Oil strategy's CVaR is $670.00. The S&P 500 strategy has a CVaR of $821.35, and the 10 year T-note strategy is $390.30. While the order may have remained unchanged, some of the Conditional Values at Risk are closer than the VaR. Specifically the Crude Oil and S&P 500 strategy. The VaR of S&P 500 was 54.25% more than the Crude Oil strategy, but the CVaR is only 22.59% more than the Crude Oil strategy. This is because the largest single loss of Crude Oil is $1570.00 while the largest loss for S&P 500 was only $1024.00. Therefore the most extreme loss was significantly more for Crude Oil which increased the average of the ten largest losses much more than the S&P 500.

All these returns and risk measures were calculated based upon a $100,000 dollar account. Therefore the 90th percentile CVaR of all three of our strategies were under 1.00% of the total account. Specifically the Crude Oil CVaR was 0.67% while the returns on this account were 8.65%. Compare this to the buy and hold strategy of the S&P 500 which had a CVaR of 1.22% and had a return of 3.78%. Therefore the risk versus reward of the two methods are strongly in favor of Crude Oil.

So these results bring up more evidence for our main point, which is that properly developing a method for entering and exiting the market can significantly reduce risk despite the considered riskiness of the asset. Furthermore because of the greater influence of online brokers the market is more accessible and therefore quicker than ever to execute orders. Specifically automatic trading can make it easy to develop and execute a strategy.
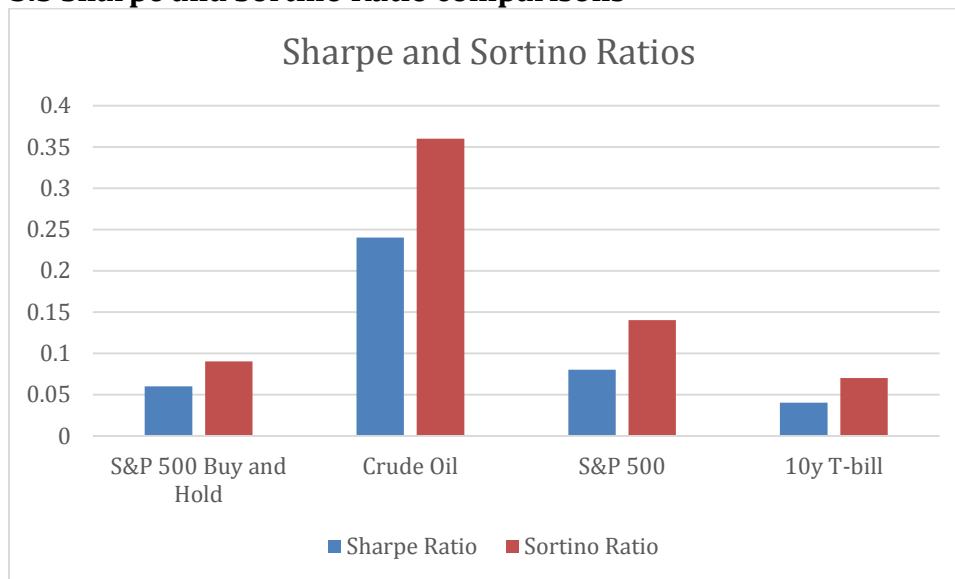
5.5 Sharpe and Sortino Ratio comparisons

Figure 6: Sharpe and Sortino Ratios

For both the Sharpe and Sortino ratios, the larger it is the better. First off the order of Sharpe ratios is Crude oil strategy, S&P 500 strategy, S&P 500 buy and hold, and lastly 10 year T-note strategy. Their respective values are 0.24, 0.08, 0.06, and 0.04. The Sortino ratios are in the same order and their values are, 0.36, 0.14, 0.09, and 0.07. The values of the Sortino ratio are higher because the formula excludes profitable risk adjusted returns in its volatility calculation. So the downside risk is smaller the standard deviation of all risk adjusted returns. The Crude oil strategy has the largest ratio and therefore by both of these measures is a better strategy than the other three methods. The reason that the Sharpe ratio of the Crude Oil strategy is so much larger, three times that of the second highest, is that the average daily return is higher than the other three. Not only is the average the highest, but the standard deviation of daily returns is the second lowest, $356.48, the lowest being 10 year T-notes at $204.67. Thusly the Crude Oil strategy has the largest Sharpe and Sortino ratios.

This result, combined with the results of the VaR and CVaR, strongly suggest that the Crude Oil strategy is the preferred of the four. While it doesn't have the lowest VaR or CVaR it is the lowest of the three that were profitable. Since it has the highest Sharpe ratio, by a wide margin, it also has the best returns per unit of volatility, or risk. Lastly the Crude Oil was the most profitable.

The Sharpe and Sortino ratios also confirms the slight edge that the S&P 500 strategy has over the S&P 500 buy and hold. The returns of both are extremely close therefore both have similar averages, $36.35 and $36.71, respectively. The reason that the Sharpe ratio ends being larger is that the volatility of the returns is significantly less. So the risk adjusted returns per unit of volatility, combined with a significantly lower VaR and CVaR means that the S&P 500 strategy is superior to buying and holding S&P 500.

Lastly, the 10 year T-note strategy has the lowest of both ratios. Since both ratios are risk adjusted returns per unit of volatility it is not a surprising result. The

10 year T-note strategy had the lowest return in absolute value, and was in fact negative. Therefore even though the strategy had the lowest standard deviation, it still has the lowest Sharpe and Sortino ratio.

6. Concluding Remarks

6.1 Conclusion

Overall at the end of this project we came to several conclusions based off the data we had analyzed. The first and foremost is that these strategies resulted in less risk than strictly buying and holding the S&P. This was a significant finding because futures contracts are thought to be one of the riskiest instruments while the S&P serves as a consistent benchmark. This was added on due to the fact that this summer was one of the longest and strongest bull markets in the last 5 years. However, despite the three strategies being less risky than the buy and hold S&P not all of them were more profitable.

The crude oil strategy outperformed all the others in regards to profit and risk. This was primarily due to oil trending very hard during the months of testing. Since it was a trend following system it logically did better than normal. The S&P strategy was less risky but ended up being marginally less profitable. In all that strategy only effectively decreased the risk while racking up commissions and futures fees .The 10-year T-note ended up being the least risky of the four, but actually didn't end up turning a profit. We hypothesize that this was due to two factors. The first being that we didn't pick a large enough time frame to effectively capture the trend. The second is that this instrument did not move much or trend really in any strong direction during this period. This would clearly lead to a lack of profits which is exactly what ended up happening.

All in all this project acted as a proof of concept on a small scale for a number of things. It specifically addressed how well risk can be managed using automatic trading and the effectiveness of futures contracts as a trading instrument. The second is that one can have more profit and less risk when using a properly developed system. Lastly not all future products are particularity good for active trading. There is definitely a case when simply buying and holding the S&P ETF is a better play than going through all this work. However, this project really is just meant to test the waters on a new and fast growing way to trade.

7. Works Cited

1. Andreev, Andriy, Antti Kanto, and Pekka Malo. "On Closed-Form Calculation of CVaR." (n.d.): n. pag. Web. 19 Apr. 2015.
2. "Arthur Hill On Moving Average Crossovers." [ChartSchool]. N.p., n.d. Web. 16 Apr. 2015.
3. Artzner, Philippe, Freddy Delbaen, Jean-Marc Eber, and David Heath. "Coherent Measures of Risk." Mathematical Finance 9.3 (1999): 203-28. Web.
4. Danielsson, Jon, and Bjorn N. Jorgensen. Subadditivity Re-Examined: The Case for Value-at-Risk. N.p., Oct. 2005. Web. 19 Apr. 2015.
5. "Candlestick Chart." Wikipedia. Wikimedia Foundation, n.d. Web. 20 Apr. 2015.
6. "Coherent Risk Measure." Wikipedia. Wikimedia Foundation, 21 July 2014. Web. 03 Apr. 2015.
7. "Futures Contract Definition | Investopedia." Investopedia. N.p., 23 Nov. 2003. Web. 08 Apr. 2015.
8. "Kitco News." Kitco News. N.p., n.d. Web. 16 Apr. 2015.
9. "Moving Averages - Simple and Exponential." [ChartSchool]. N.p., n.d. Web. 16 Apr. 2015.
10. "Moving Averages: What Are They? | Investopedia." Investopedia. N.p., 20 Aug. 2006. Web. 16 Apr. 2015.
11. "Thinkorswim by TD AmeritradeLearning Center." Learning Center. N.p., n.d. Web. 16 Apr. 2015.
12. "Understanding The Sharpe Ratio." Investopedia. N.p., 07 Jan. 2007. Web. 20 Apr. 2015.

8. Appendix
Crude Oil Performance Report

Annual Returns				
Period	Net Profit	% Gain	Profit Factor	# Trades
1/1/2014	$14,810.00	14.81%	2.03	43
Monthly Returns				
Period	Net Profit	% Gain	Profit Factor	# Trades
8/1/2014	$1,830.00	1.62%	2.05	7
7/1/2014	$6,730.00	6.33%	5.61	7
6/1/2014	($1,200.00)	-1.12%	0.78	13
5/1/2014	$1,380.00	1.30%	1.66	9
4/1/2014	$920.00	0.87%	1.28	6
3/1/2014	$650.00	0.62%	1.35	5
2/1/2014	$4,500.00	4.50%	6.17	2
Individual Trades				
	All Trades	Winners	Losers	
Total Number of Trades	42	10	32	
Percent Profitable	23.81%	28.57%	19.05%	
Winning Trades	10	6	4	
Losing Trades	32	15	17	
Avg. Trade Net Profit	$269.29	$2,572.00	($450.31)	
1 Std. Deviation of Avg. Trade	$1,541.49	$1,671.89	$293.54	
Avg. Trade + 1 Std. Deviation	$1,810.77	$4,243.89	($156.77)	
Avg. Trade - 1 Std. Deviation	($1,272.20)	$900.11	($743.85)	
Drawdown				
Max. Drawdown (Intra-day Peak to Valley)	Max. Drawdown (Trade Close to Trade Close)			
Value	($5,370.00)			
Date	7/2/2014 12:00			

S&P 500 Performance Report

Annual Returns				
Period	Net Profit	% Gain	Profit Factor	# Trades
1/1/2014	$12,763.50	12.76%	1.28	320
Monthly Returns				
Period	Net Profit	% Gain	Profit Factor	# Trades
8/1/2014	$3,803.50	3.49%	1.7	38
7/1/2014	($286.00)	-0.26%	0.96	49
6/1/2014	($176.00)	-0.16%	0.96	44
5/1/2014	$550.50	0.51%	1.09	42
4/1/2014	$2,815.00	2.65%	1.35	56
3/1/2014	($715.50)	-0.67%	0.92	55
2/1/2014	$5,501.00	5.43%	2.34	33
1/1/2014	$1,271.00	1.27%	1.7	10
Individual Trades				
	All Trades	Winners	Losers	
Total Number of Trades	319	131	188	
Percent Profitable	41.07%	44.87%	37.42%	
Winning Trades	131	70	61	
Losing Trades	188	86	102	
Avg. Trade Net Profit	$38.77	$441.38	($241.77)	
1 Std. Deviation of Avg. Trade	$367.67	$166.67	$133.74	
Avg. Trade + 1 Std. Deviation	$406.43	$608.04	($108.04)	
Avg. Trade - 1 Std. Deviation	($328.90)	$274.71	($375.51)	
Drawdown				
Max. Drawdown (Intra-day Peak to Valley)	Max. Drawdown (Trade Close to Trade Close)			
Value	($3,376.50)			
Date	5/20/2014 11:00			

10 year T-note Performance Report

Annual Returns				
Period	Net Profit	% Gain	Profit Factor	# Trades
1/1/2014	$3,632.88	3.63%	1.21	265
Monthly Returns				
Period	Net Profit	% Gain	Profit Factor	# Trades
8/1/2014	$399.38	0.39%	1.27	31
7/1/2014	$1,185.50	1.16%	1.71	37
6/1/2014	$305.63	0.30%	1.15	31
5/1/2014	($809.13)	-0.79%	0.71	34
4/1/2014	($877.00)	-0.85%	0.74	37
3/1/2014	$216.25	0.21%	1.07	46
2/1/2014	$557.75	0.54%	1.34	24
1/1/2014	$2,654.50	2.65%	2.72	32
Individual Trades				
	All Trades	Winners	Losers	
Total Number of Trades	264	97	167	
Percent Profitable	36.74%	38.64%	34.85%	
Winning Trades	97	51	46	
Losing Trades	167	81	86	
Avg. Trade Net Profit	$12.35	$211.27	($103.18)	
1 Std. Deviation of Avg. Trade	$226.62	$250.69	$92.07	
Avg. Trade + 1 Std. Deviation	$238.98	$461.95	($11.11)	
Avg. Trade - 1 Std. Deviation	($214.27)	($39.42)	($195.25)	
Drawdown				
Max. Drawdown (Intra-day Peak to Valley)	Max. Drawdown (Trade Close to Trade Close)			
Value	($3,708.13)			
Date	5/29/2014 15:00			