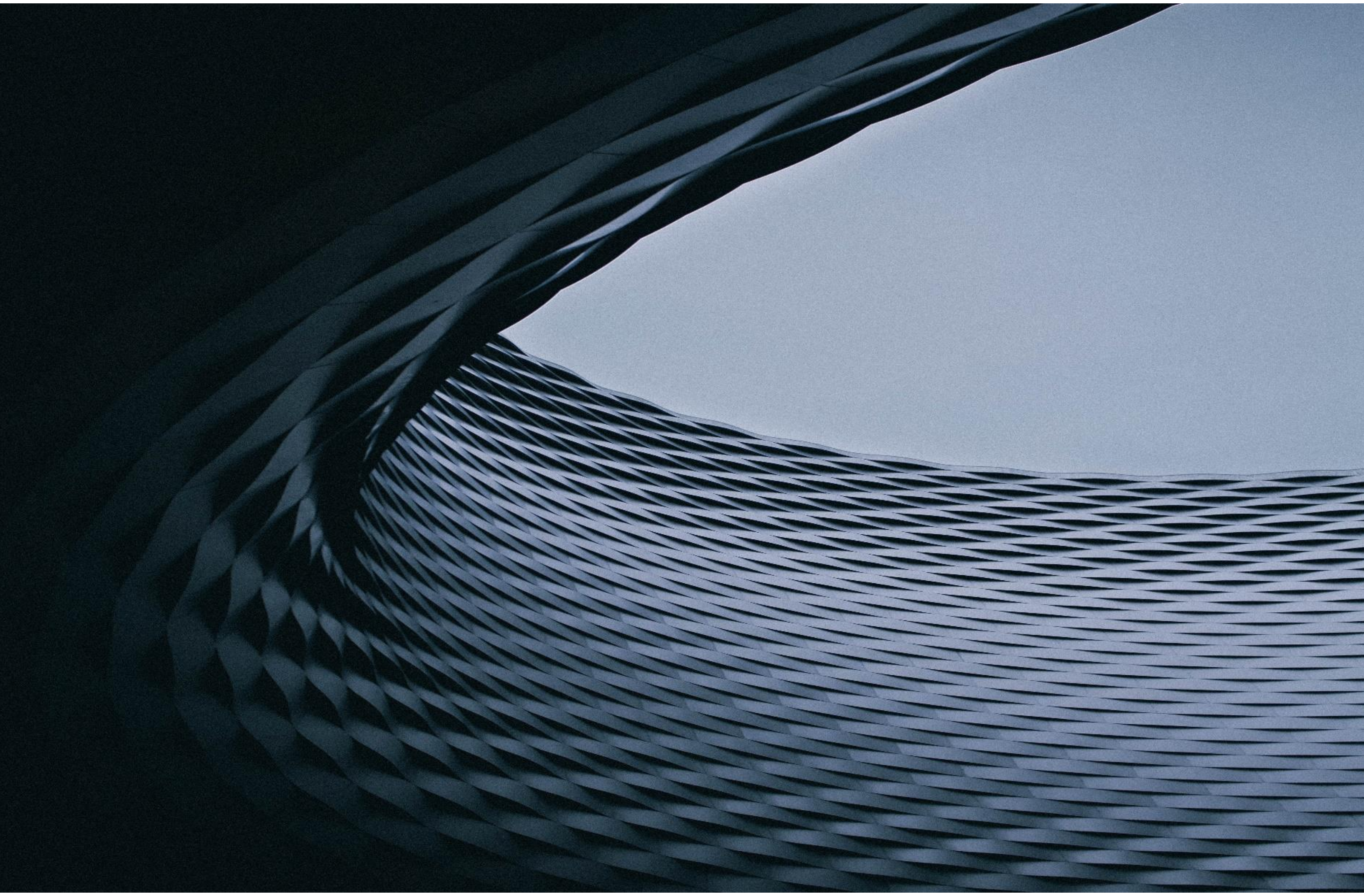

Using Volatility to Add Alpha and Control Portfolio Risk

John Rothe, CMT

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Volatility is a well-known and widely-studied aspect of financial markets, and has been the focus of numerous academic and industry research efforts over the years.

It is widely recognized that volatility can have a significant impact on investment portfolios, and as such, controlling risk has become a key priority for many investors.

One approach to managing portfolio risk is to use volatility as a tool to control the exposure of a portfolio to risk. This paper aims to explore the use of volatility as a risk management tool and alpha generator, with a focus on the practical application of this approach in the management of investment portfolios.

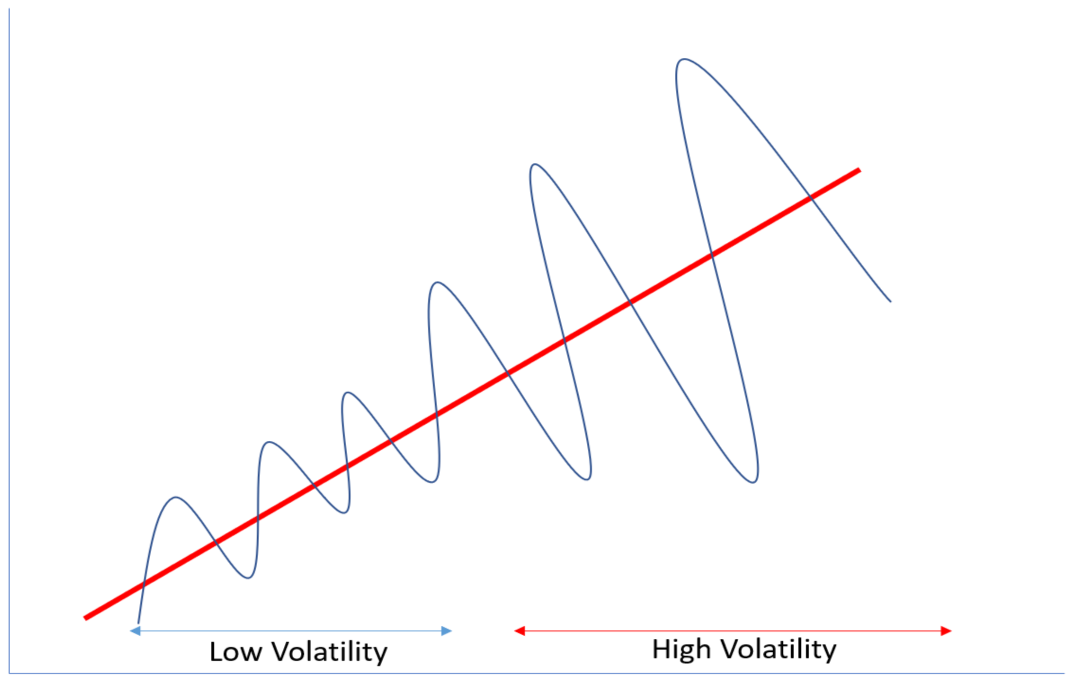
The paper will begin by reviewing the concept of volatility and its impact on financial markets, before examining the various methods that are used to measure volatility.

It will then move on to discuss the use of volatility-based risk management strategies, including the use of volatility-based stop loss orders and the impact of these strategies on portfolio risk and return.

The paper will conclude by summarizing the key findings and offering insights into the use of volatility as a risk management tool and alpha generator.

Impact on Financial Markets and Investors

Volatility refers to the fluctuation of asset prices in financial markets, and it is a key factor that affects both the risk and return of investments. The impact of volatility in financial markets can be both positive and negative, depending on the market conditions and the investment strategies employed by investors.



On one hand, high volatility can create investment opportunities, as it creates price inefficiencies and enables investors to buy low and sell high.

On the other hand, high volatility can also increase the risk of investment losses, as it makes it difficult for investors to predict the future direction of prices and can lead to sharp price movements in either direction.

Volatility can also impact the performance of investment portfolios. For example, a highly volatile portfolio is likely to experience larger losses during market downturns, compared to a less volatile portfolio. Comparatively, a highly volatile portfolio may also provide higher returns during market upturns, compared to a less volatile portfolio.

Standard Volatility Measurements

For investors, volatility in the stock market often refers to the fluctuations or ups and downs in the prices of stocks and other securities over time and can be measured using a variety of statistical measures, such as the standard deviation of returns or the average true range of price movements.

There are several popular ways to measure volatility, including:

1. **Standard deviation of returns:** A statistical measure of the dispersion of returns around the mean. It measures the average deviation of returns from the mean, giving an idea of how much the returns vary from the average.
2. **Average True Range (ATR):** This is a technical indicator that measures the average range of price movements for a given security over a specified period of time. It takes into account both price gaps and large price movements, providing a more comprehensive measure of volatility.
3. **Implied Volatility:** A measure of expected volatility calculated from option prices. It provides a forward-looking estimate of volatility based on the price of options and is often used to gauge market sentiment.
4. **VIX Index:** Also known as the "fear index," the VIX Index is a measure of expected volatility in the stock market based on options prices. It is calculated by the Chicago Board Options Exchange (CBOE) and is widely used as a gauge of investor sentiment and market uncertainty.

For this paper, we will be measuring volatility by using Average True Range (ATR) calculations.

The Impact of Volatility on Trends

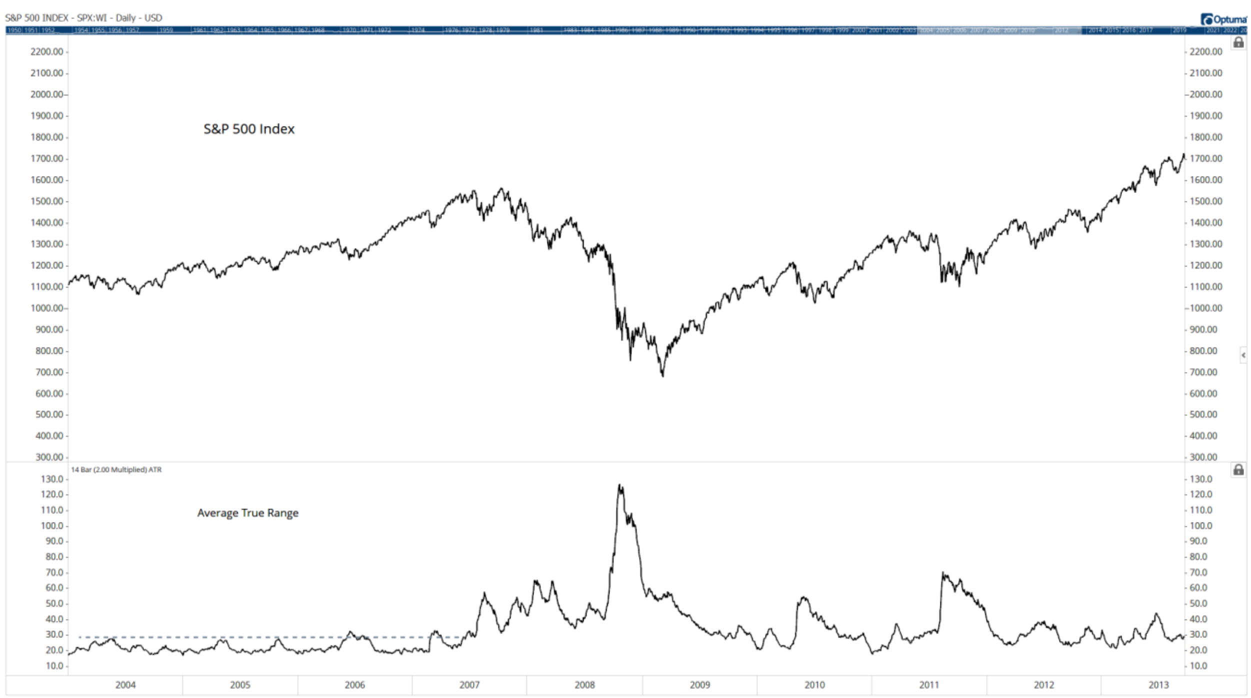
Volatility is a widely-used measure of risk in financial markets, and it reflects the degree of fluctuation in the prices of assets, such as stocks or bonds. It is often used to gauge the level of uncertainty in the market, and as such, can provide valuable insights into the direction of the market and the likelihood of future price movements. In this context, volatility can be used to indicate a change in trend in the stock market.

One of the key reasons why volatility can indicate a change in trend is because it reflects the observed level of risk in the market. In general, high volatility levels are associated with higher levels of risk, while low volatility levels are associated with lower levels of risk.

When the level of volatility in the market increases, it often signals a change in investor sentiment and a shift in the underlying market dynamics. This change in sentiment can result in a shift in market direction, with prices moving higher or lower, depending on the prevailing market conditions.

There is a strong empirical evidence that supports the view that volatility can indicate a change in trend in the stock market. For example, a study by Baker and Haugen (2010) found that periods of high volatility are often followed by significant changes in market direction.

Similarly, a study by Ang and Chen (2002) found that high volatility levels are associated with greater market instability and greater likelihood of a market reversal.



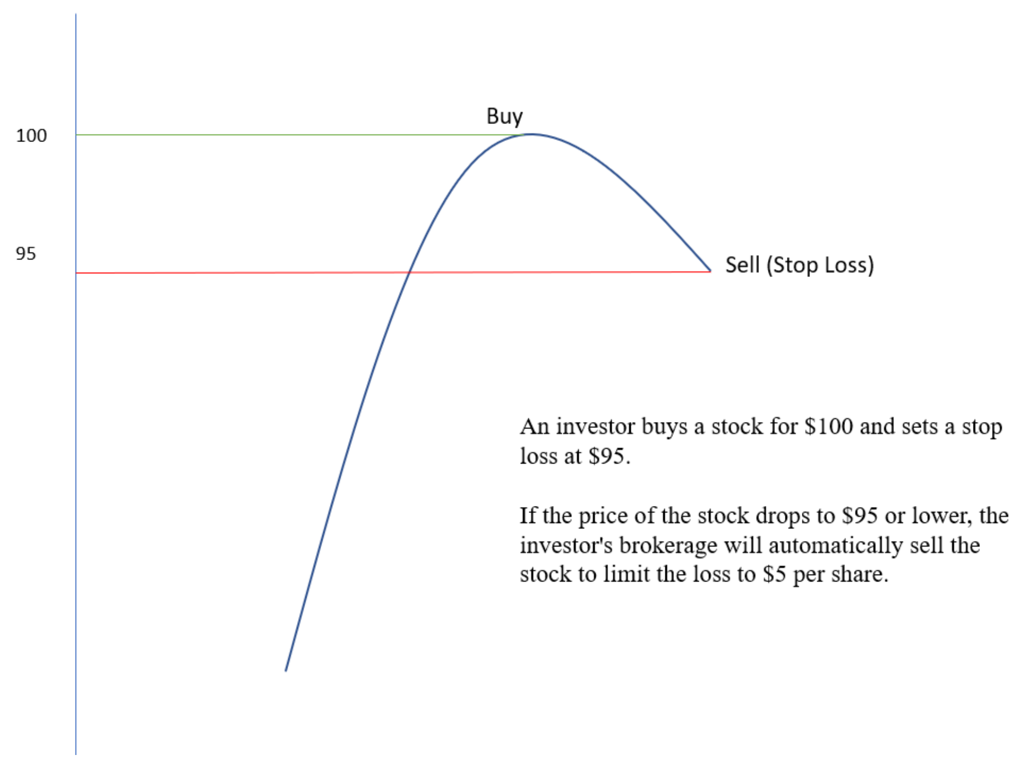
The rise in volatility and the change of trend in the S&P 500 index during the 2008-2009 market decline.

Studying trends in volatility can also provide valuable information about the underlying market conditions. For example, rising high volatility levels can indicate that the market is experiencing increased uncertainty or investor risk aversion, which can be a result of a variety of factors, such as economic data releases, political events, or changes in monetary policy. In contrast, low volatility levels can indicate that the market is relatively calm and stable, and that investors are confident about the future direction of prices.

Using Stop-Losses to Control Risk

A stop loss is a risk management strategy used by investors to limit potential losses on a trade or investment. It involves setting a predetermined price at which an investor will sell a stock or other security in order to minimize losses if the price moves in an unfavorable direction.

For example, if an investor buys a stock for $100 and sets a stop loss at $95, then if the price of the stock drops to $95 or lower, the investor's brokerage will automatically sell the stock to limit the loss to $5 per share. This type of order is sometimes called a "stop loss order" or a "stop order."



Stop loss orders can be used to manage risk in a variety of investments, including stocks, bonds, exchange-traded funds (ETFs), and other securities. They can be especially useful for short-term traders who are looking to quickly exit a trade if the price moves against them.

Average True Range

The Average True Range (ATR) is a technical indicator that measures the average range of price movements for a given security over a specified period of time.

Developed by J. Welles Wilder Jr., the ATR is used to help traders identify market volatility and to set stop loss orders that are based on market conditions rather than a fixed price level.

The ATR is calculated by first determining the true range of a security, which is defined as the greatest of the following three values:

1. The current high minus the current low
2. The absolute value of the current high minus the previous close
3. The absolute value of the current low minus the previous close

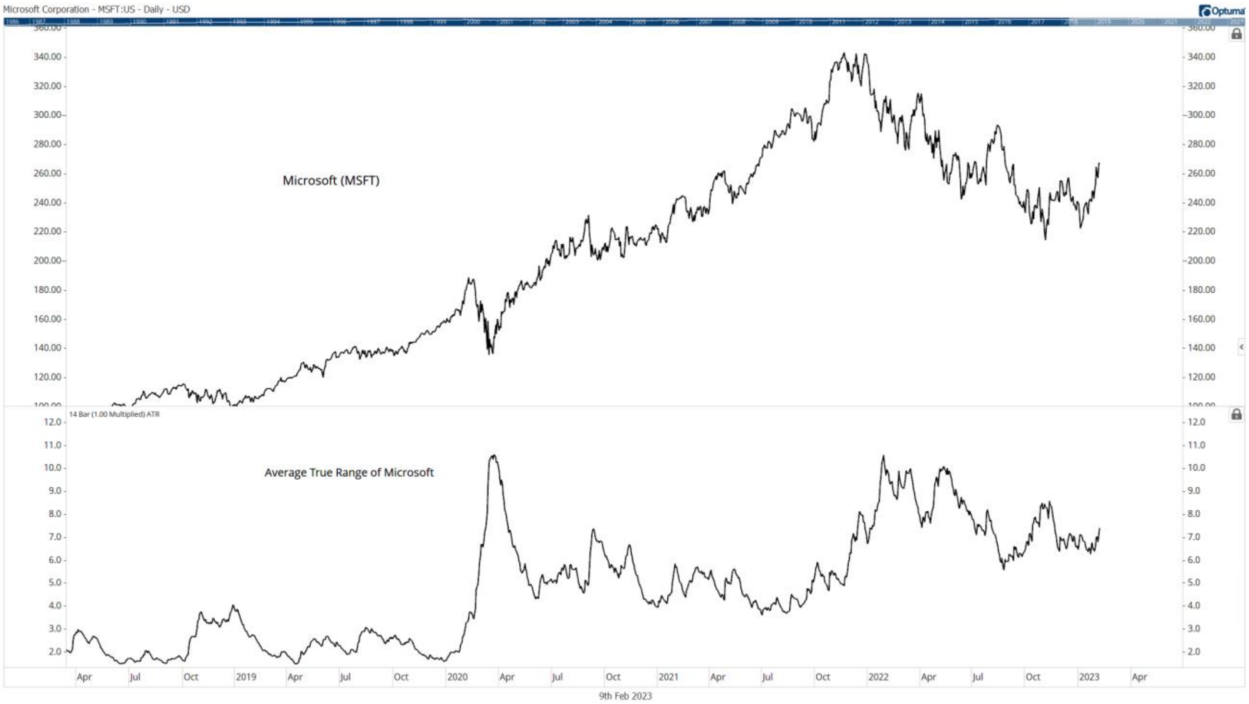
The true range is then calculated over a specified number of periods, typically 14, and the result is the ATR. The ATR is expressed as a single value and is typically plotted as a line on a price chart.

$$\left(\frac{1}{n}\right)\sum_{i}^{n} \mathrm{TR}_i$$

where: TR*i*=Particular true range, such as first day's TR,

then second, then third

n=Number of periods



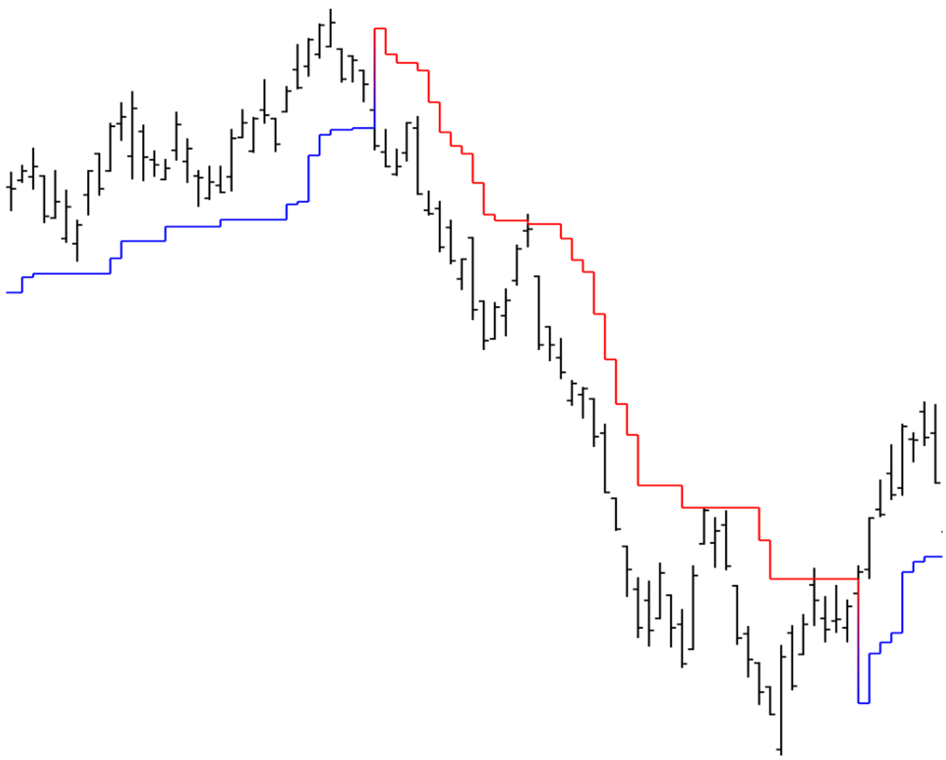
Microsoft (top) and its Average True Range (bottom).

Traders use the ATR to help identify market volatility and to adjust their risk management strategy accordingly. For example, in a volatile market, a trader might set a stop loss order using a multiple of the ATR, with a higher multiple used in a more volatile market and a lower multiple used in a less volatile market.

Wilder Volatility Stop Loss

The Wilder Volatility Stop Loss is a technical indicator that is used by traders to help manage risk. The indicator was developed by J. Welles Wilder Jr. and is based on the concept of the Average True Range (ATR), which measures the average range of price movements for a given security over a specified period of time.

The Wilder Volatility Stop Loss is used by traders to set stop loss orders that are based on market volatility rather than a fixed price level. To calculate the Wilder Volatility Stop Loss, a trader first determines the ATR for a security over a specified period of time, typically 14 periods. The Wilder Volatility Stop Loss is then calculated by multiplying the ATR by a factor that is chosen by the trader, typically between 1 and 4.



Wilder Volatility Stop Loss Example (Source OPTUMA)

The Wilder Volatility Stop Loss has several advantages over traditional stop loss orders, which are set at a specific price level.

In a volatile market, a fixed stop loss order may be triggered by price fluctuations that are not representative of a change in trend. By adjusting the stop loss order based on market volatility, the Wilder Volatility Stop Loss helps to reduce the risk of false signals and to better manage risk in the market.

In addition to managing risk, the Wilder Volatility Stop Loss can also be used to help identify entry and exit points in the market. For example, if a trader sees a security making a strong move in a particular direction, they might enter a long position and set a Wilder Volatility Stop Loss to lock in profits or to limit their risk if the trend reverses.

Using Volatility as a Trading Signal (System Testing and Results)

Time Frame

To test the validity of a volatility-based trading system, numerous backtests where run over a ten-year time frame.

2000-2010 was chosen as the test time period as the US stock market faced a bull market in equities, 2 bear markets, and a period of both rate tightening and loosening by the FOMC.

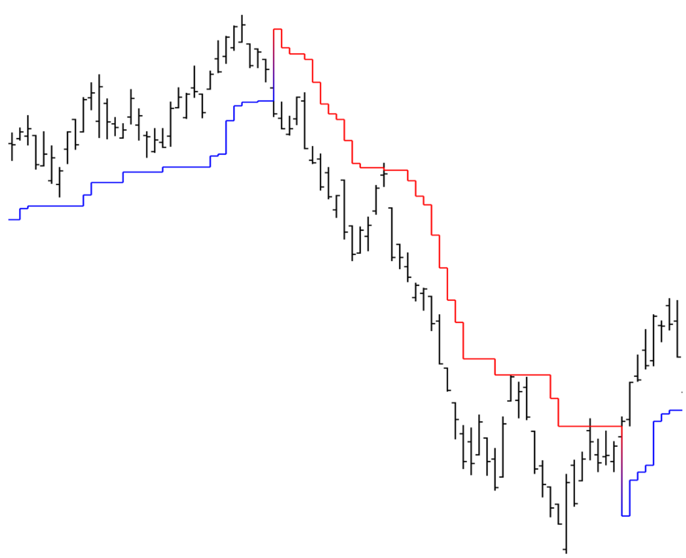
During this time frame the S&P 500 index declined 49% from 2000 to 2002, followed by a 101% increase over the next five years, and finally a 57% decline from 2007 to 2009.

The decade 2000 to 2009 was termed a "lost decade" as the S&P 500 index lost approximately 1% per year in annual total return over the decade.

Testing Metrics

The goal of the test was to see if using a volatility-based stop, using Wilder's method (WVS) could provide alpha to a portfolio.

Since WVS can be used as a stop loss for both long and short trades, an entry signal can be generated where a stop loss for a short trade may occur.



Instead of using it as a stop loss for a short position, a break above the red line is used as an entry signal

The primary testing metric used was the Sortino ratio. The Sortino ratio is commonly used in finance to evaluate the performance of portfolios and mutual funds, especially for those targeting a specific minimum acceptable return.

It is similar to the Sharpe ratio, which is another commonly used risk-adjusted performance measure. However, the Sortino ratio takes into account only the downside risk, or the deviation of returns below a specified target return, while the Sharpe ratio considers total risk.

In other words, it measures the return of a portfolio relative to its downside risk. A high Sortino ratio indicates that a portfolio has generated high returns while incurring low downside risk, making it an attractive option for risk-averse investors.

On the other hand, a low Sortino ratio suggests that the portfolio has underperformed compared to its minimum acceptable return, despite incurring a higher level of downside risk.

The Sortino ratio is calculated as the excess return of a portfolio over a specified minimum acceptable return divided by the downside deviation of the portfolio returns:

Sortino Ratio = (Portfolio Return - Minimum Acceptable Return) / Downside Deviation

Where:

- Portfolio Return is the average return of the portfolio over a specified period of time.
- Minimum Acceptable Return is the benchmark or minimum acceptable return that an investor has set for their portfolio.
- Downside Deviation is the standard deviation of the negative returns of the portfolio, calculated only for those returns that are below the minimum acceptable return.

Backtest Criteria

The backtest criteria on the following pages used the following:

- daily data (end of day prices)
- executing trades at signal
- using the 1/1/2000-12/31/2009 period
- no use of margin
- assumed no trading cost
- assumed no slippage
- analyzing price only data

The results are compared to a buy and hold strategy using the SPDR ETF “SPY” as a proxy for the S&P 500 Index.

All testing was done using OPTUMA software (https://www.optuma.com).

Buy Criteria: Close() > WVS(ATR 5 bars, Factor=2.50)

Sell Criteria: Close() < WVS(ATR 5 bars, Factor =2.50)

Blended Results (1/1/2000 – 12/31/2009)

Risk vs Reward: SPY Buy and Hold vs SPY, QQQ, IWM using WVS

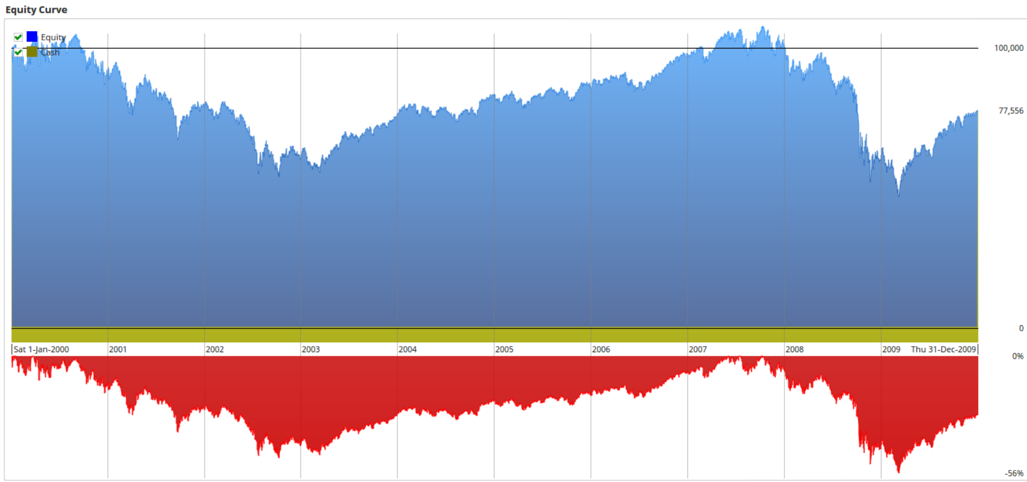
Sortino Ratio: SPY Buy and Hold vs SPY, QQQ, IWM using WVS

Data Source: OPTUMA

Individual Test Results (1/1/2000-12/31/2009):

Buy and Hold Results “SPY”:

Test Results	
Start Date	1/1/2000
End Date	12/31/2009
Starting Balance	$100,000.00
Ending Balance	$77,555.71
$ loss	($22,444.29)
% loss	-22.4%
Number of trades	2
System Performance	
Annualized Returns	-1.3%
Annualized Volatility	16.6%
Beta	0.00
CAGR	-2.5%
Sharpe Ratio	-0.23
Maximum drawdown %	56.4%
Longest recovery time	7 years 2 months
Trading Expectancy	($22,444.29)
Index Results	
Index Returns	0.0%
Index Volatility	0.0%
Index CAGR	NAN%
Index Sharpe	0.00

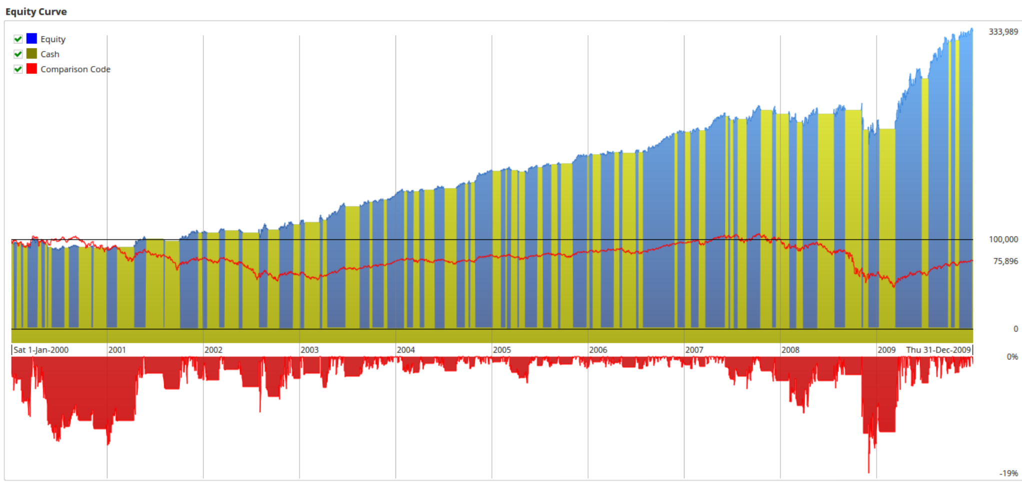


Buy and Hold Results	
Annualied Return	-1.30%
Annualized Volatility	16.60%
Profit Factor	0.00
CAGR	-2.50%
Sortino Ratio	-0.29
Maximum Drawdown	56.40%
Longest Recovery Time	7 years, 2 Months

Chart and Data Source: OPTUMA

SPDR ETF “SPY” vs S&P 500 Index using system test criteria:

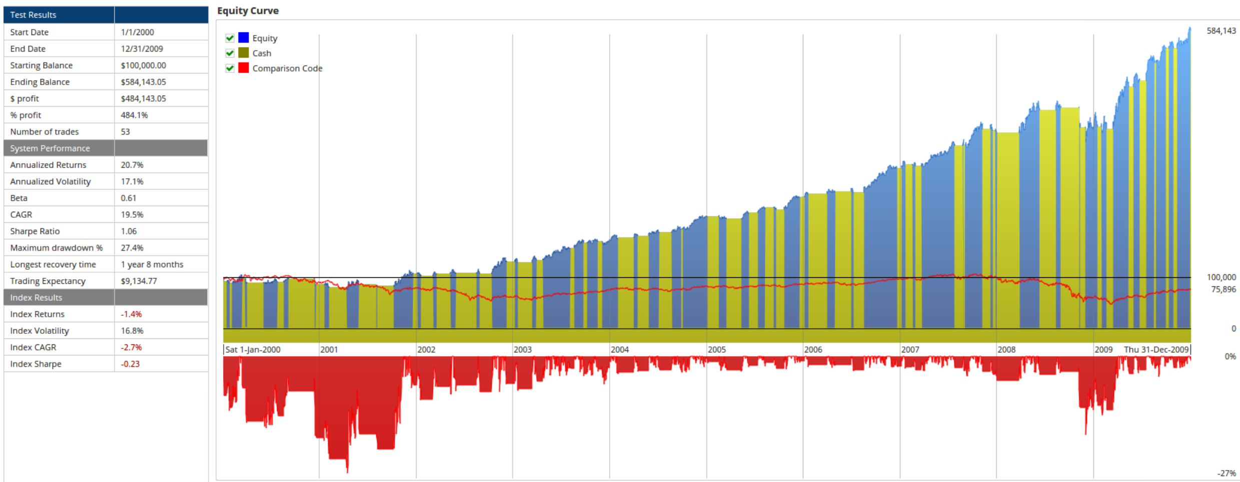
Test Results	
Start Date	1/1/2000
End Date	12/31/2009
Starting Balance	$100,000.00
Ending Balance	$333,989.15
$ profit	$233,989.15
% profit	234.0%
Number of trades	58
System Performance	
Annualized Returns	13.7%
Annualized Volatility	11.7%
Beta	0.52
CAGR	12.9%
Sharpe Ratio	0.96
Maximum drawdown %	18.6%
Longest recovery time	1 year 1 month
Trading Expectancy	$4,034.30
Index Results	
Index Returns	-1.4%
Index Volatility	16.8%
Index CAGR	-2.7%
Index Sharpe	-0.23



SPDR ETF "SPY"	
Annualied Return	13.70%
Annualized Volatility	11.70%
Profit Factor	2.08
CAGR	12.90%
Sortino Ratio	1.12
Maximum Drawdown	18.60%
Longest Recovery Time	1 year, 1 month

Chart and Data Source: OPTUMA

Invesco QQQ ETF vs S&P 500:



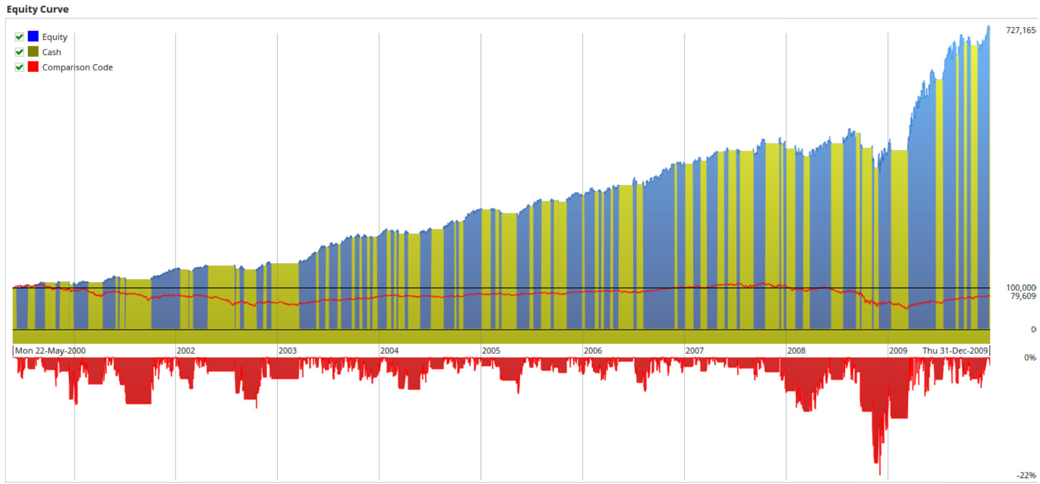
QQQ ETF	
Annualied Return	20.70%
Annualized Volatility	17.10%
Profit Factor	2.56
CAGR	19.50%
Sortino Ratio	1.38
Maximum Drawdown	27.40%
Longest Recovery Time	1 year 8 months

Chart and Data Source: OPTUMA

Russell 2000 ETF “IWM” vs S&P 500:

Start date 5/22/2000 – first day IWM was available to trade.

Test Results	
Start Date	5/22/2000
End Date	12/31/2009
Starting Balance	$100,000.00
Ending Balance	$727,164.88
$ profit	$627,164.88
% profit	627.2%
Number of trades	62
System Performance	
Annualized Returns	23.7%
Annualized Volatility	15.4%
Beta	0.66
CAGR	23.0%
Sharpe Ratio	1.37
Maximum drawdown %	22.4%
Longest recovery time	7 months 2 weeks 6 da
Trading Expectancy	$10,115.56
Index Results	
Index Returns	-1.0%
Index Volatility	16.9%
Index CAGR	-2.4%
Index Sharpe	-0.21



Russell 2000 "IWM"	
Annualied Return	23.70%
Annualized Volatility	15.40%
Profit Factor	2.57
CAGR	23.00%
Sortino Ratio	2.38
Maximum Drawdown	22.40%
Longest Recovery Time	7 months 2 weeks

Chart and Data Source: OPTUMA

Backtest Limitations and Further Signal Testing

One of the limitations of backtesting is the assumption that there are no false signals (only correct signals are shown) and that an investor will match the signal price 100% of the time.

In order to overcome some of these limitations and to further analyze a trading system based on volatility signals, a signal only test was performed using the individual members of the S&P 500 index.

The objective of this test is to see if using WVS as a buy signal provides alpha vs the S&P 500 index -- and for how long by analyzing the 120 days post signal.

In addition, this test can help test the validity of the WVS signal while removing some of the limitations of the backtest (such as the necessity to trade on the exact signal).

For the signal test, the same time frame and buy criteria are used, as well as historical index data to avoid survivorship bias.

Buys occurred when an individual stock closes above its respective Wilder volatility stop (WVS) using an ATR multiplier of 2.5 with a 5-day period.

The resulting data confirms that the addition of a volatility-based signal to a trading strategy has merit not only for mitigating risk, but as a trading signal, and can provide alpha over a buy and hold strategy.

922,389 signals were generated between 1/1/2000 and 12/31/2009 with a 120 day mean return of 6.07% vs -.03% for the S&P 500 index.

The probability of gain improved over the index slightly (59.15% vs 56.17%) and the probability of loss was reduced (40.85% vs 43.83%).

Statistics	Abs Signal	Index
Probability of Gain	59.15%	56.17%
Probability of Loss	40.85%	43.83%
Mean Return	6.07%	-0.03%
Median Return	4.48%	1.65%
80th Percentile	22.62%	8.60%
20th Percentile	-13.00%	-8.78%
Skewness	3.92	-0.67
Kurtosis	76.63	4.37
Standard Deviation	32.00%	12.49%

Absolute Profit Analysis

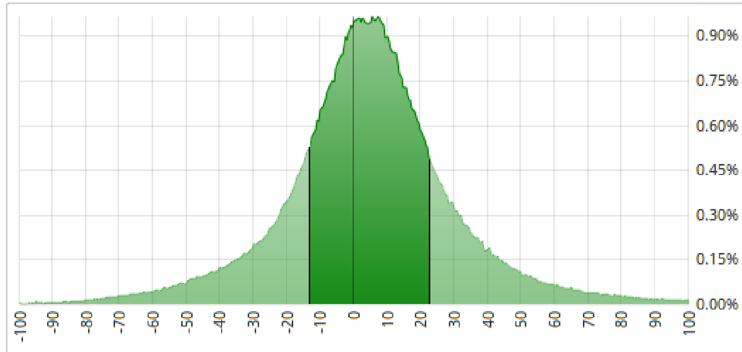
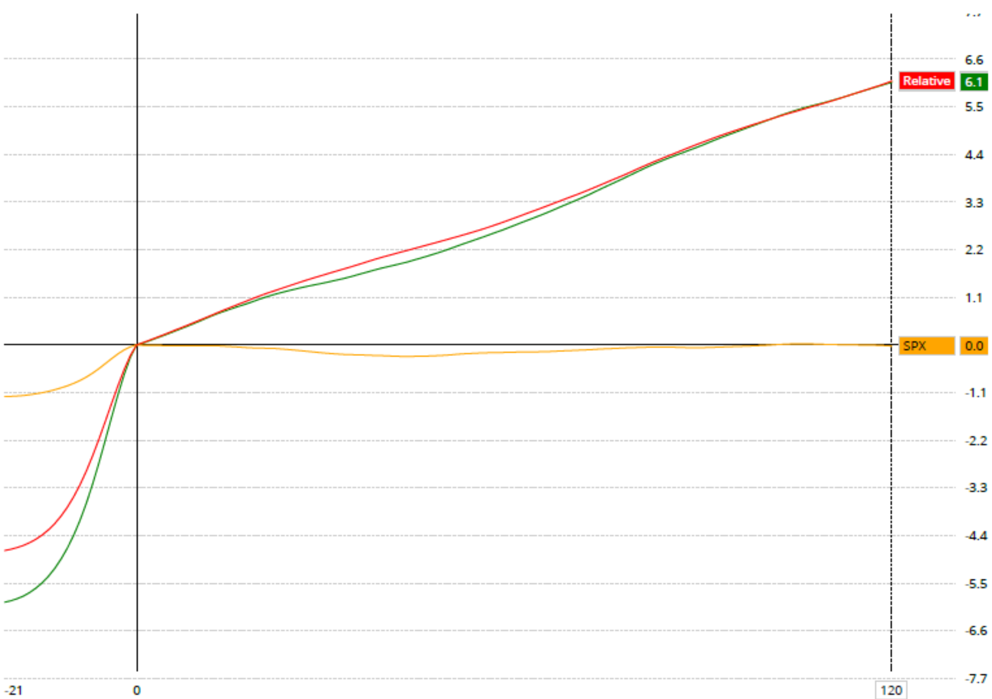


Chart and Data Source: OPTUMA

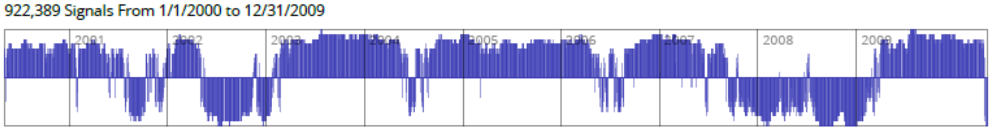
Probability of Gain	59.15%
Mean Return (120 Days)	6.07%
Annualized Return	13.17%

Mean Returns



Signal Distribution

922,389 Signals From 1/1/2000 to 12/31/2009



Conclusion

The previous test show that volatility-based trading systems can provide multiple benefits to a portfolio including:

1. Generate additional alpha by highlighting the start of a rising trend.
2. Mitigate downside risk by limiting losses in trend-based strategies.
3. Reduce a portfolio’s recovery time after large market declines.

In conclusion, volatility is a critical factor to consider when managing portfolio risk. By utilizing tools such as Average True Range (ATR) and Wilder's volatility stop (WVS), investors can gain a better understanding of market conditions and make more informed investment decisions.

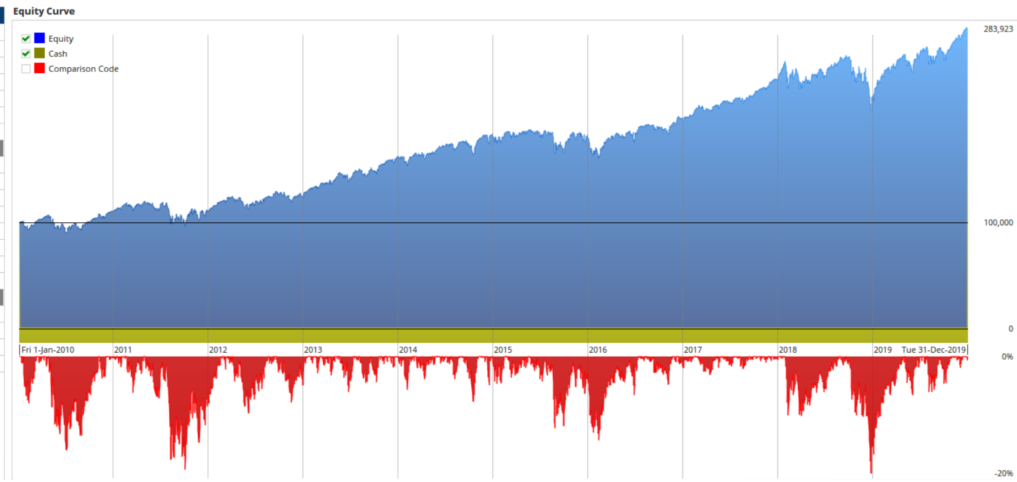
By taking a proactive approach to managing risk, investors can increase the likelihood of achieving their long-term financial goals while minimizing the impact of market volatility.

Appendix

Results 2010-2020

SPY Buy and Hold

Test Results	
Start Date	1/1/2010
End Date	12/31/2019
Starting Balance	$100,000.00
Ending Balance	$283,923.46
$ profit	$183,923.46
% profit	183.9%
Number of trades	1
System Performance	
Annualized Returns	11.7%
Annualized Volatility	12.7%
Beta	0.99
CAGR	11.1%
Sharpe Ratio	0.72
Maximum drawdown %	20.2%
Longest recovery time	1 year 1 month
Trading Expectancy	$183,923.46
Index Results (SPX:WI)	
Index Returns	11.9%
Index Volatility	12.7%
Index CAGR	11.3%
Index Sharpe	0.74

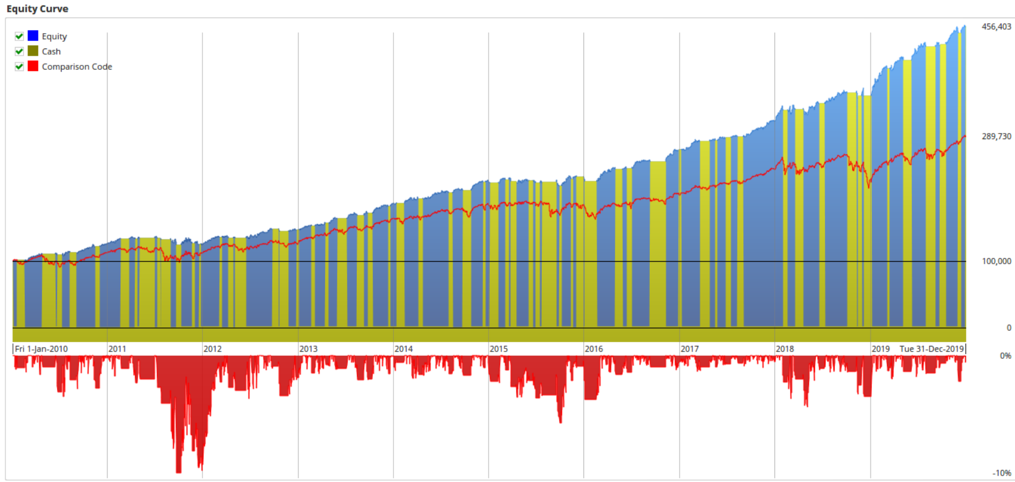


SPY Buy and Hold (2010-2020)	
Annualied Return	11.70%
Annualized Volatility	12.70%
Profit Factor	0.00
CAGR	11.10%
Sortino Ratio	0.96
Maximum Drawdown	20.20%
Longest Recovery Time	1 year 1 month

Chart and Data Source: OPTUMA

SPY using WVS

Test Results	
Start Date	1/1/2010
End Date	12/31/2019
Starting Balance	$100,000.00
Ending Balance	$456,403.00
$ profit	$356,403.00
% profit	356.4%
Number of trades	60
System Performance	
Annualized Returns	16.8%
Annualized Volatility	8.0%
Beta	0.49
CAGR	16.5%
Sharpe Ratio	1.80
Maximum drawdown %	10.1%
Longest recovery time	8 months 1 week 4 days
Trading Expectancy	$5,940.05
Index Results (SPX:WI)	
Index Returns	11.9%
Index Volatility	12.7%
Index CAGR	11.3%
Index Sharpe	0.74

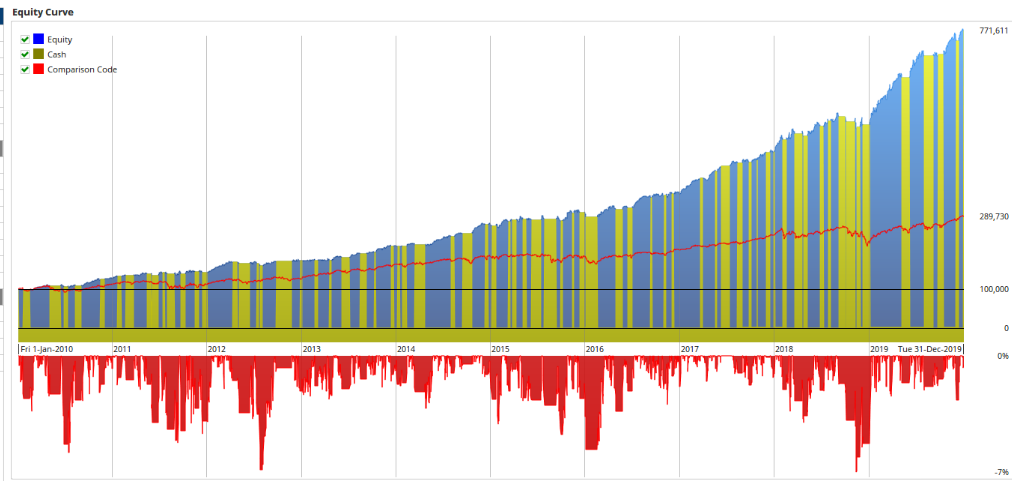


SPY w/WVS (2010-2020)	
Annualied Return	16.80%
Annualized Volatility	8.00%
Profit Factor	2.95
CAGR	16.50%
Sortino Ratio	3.29
Maximum Drawdown	10.10%
Longest Recovery Time	8 months 1 week

Chart and Data Source: OPTUMA

QQQ using WVS

Test Results	
Start Date	1/1/2010
End Date	12/31/2019
Starting Balance	$100,000.00
Ending Balance	$771,610.63
$ profit	$671,610.63
% profit	671.6%
Number of trades	69
System Performance	
Annualized Returns	23.3%
Annualized Volatility	10.1%
Beta	0.55
CAGR	22.9%
Sharpe Ratio	2.06
Maximum drawdown %	7.3%
Longest recovery time	4 months 1 day
Trading Expectancy	$9,733.49
Index Results (SPX:WI)	
Index Returns	11.9%
Index Volatility	12.7%
Index CAGR	11.3%
Index Sharpe	0.74

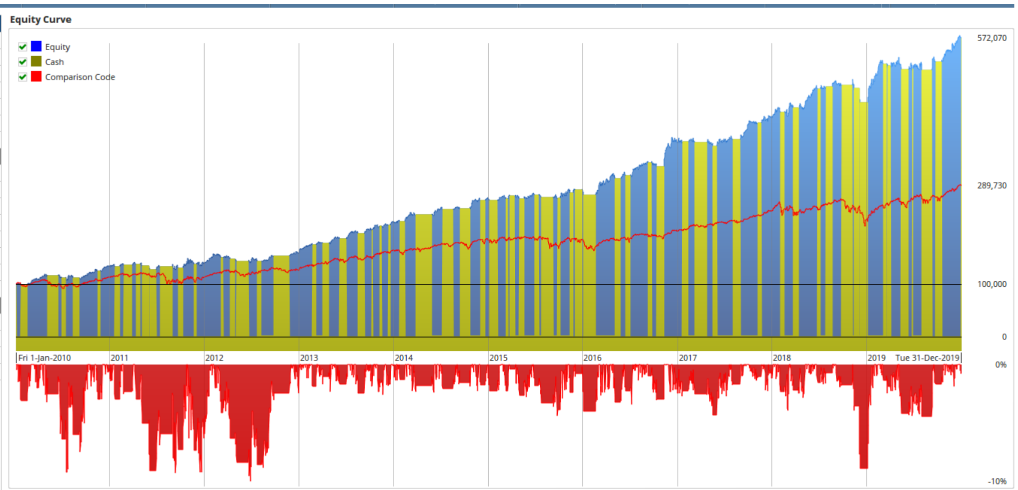


QQQ w/WVS (2010-2020)	
Annualied Return	23.30%
Annualized Volatility	10.10%
Profit Factor	2.76
CAGR	22.90%
Sortino Ratio	5.08
Maximum Drawdown	7.30%
Longest Recovery Time	4 months 1 day

Chart and Data Source: OPTUMA

IWM using WVS

Test Results	
Start Date	1/1/2010
End Date	12/31/2019
Starting Balance	$100,000.00
Ending Balance	$572,069.94
$ profit	$472,069.94
% profit	472.1%
Number of trades	63
System Performance	
Annualized Returns	19.6%
Annualized Volatility	11.1%
Beta	0.54
CAGR	19.2%
Sharpe Ratio	1.55
Maximum drawdown %	10.4%
Longest recovery time	9 months 2 weeks 6 days
Trading Expectancy	$7,493.17
Index Results (SPX:WI)	
Index Returns	11.9%
Index Volatility	12.7%
Index CAGR	11.3%
Index Sharpe	0.74



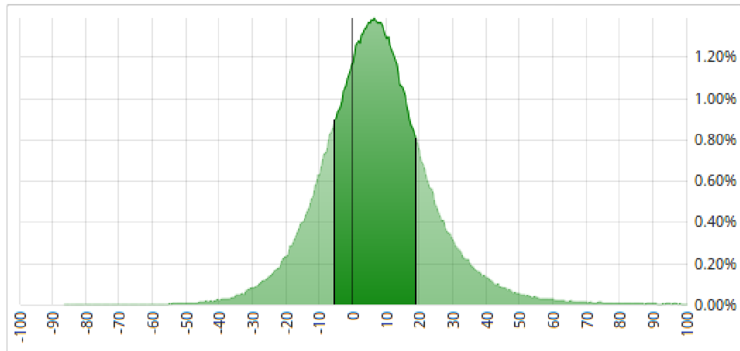
IWM w/WVS (2010-2020)	
Annualied Return	19.60%
Annualized Volatility	11.10%
Profit Factor	2.71
CAGR	19.20%
Sortino Ratio	3.3
Maximum Drawdown	10.40%
Longest Recovery Time	9 months 2 weeks

Chart and Data Source: OPTUMA

Signal test using historical S&P 500 index members (2010-2020)

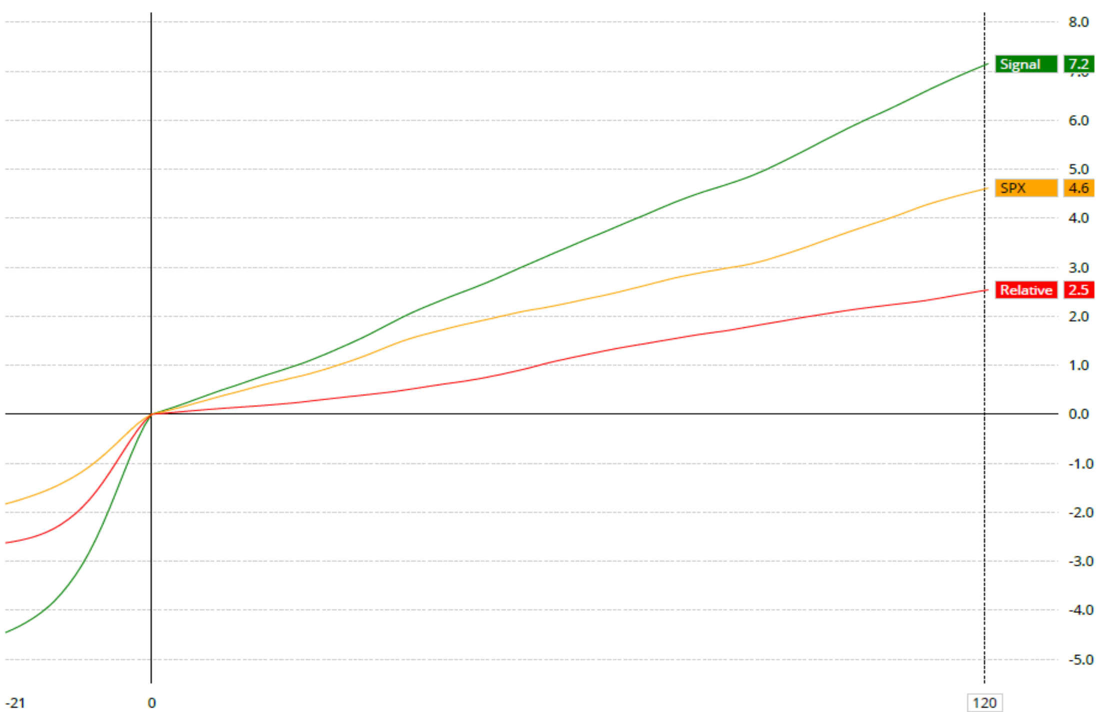
Statistics	Abs Signal	Index
Probability of Gain	67.64%	78.49%
Probability of Loss	32.36%	21.51%
Mean Return	7.16%	4.62%
Median Return	6.39%	5.37%
80th Percentile	18.84%	9.74%
20th Percentile	-5.75%	-0.64%
Skewness	1.55	-0.50
Kurtosis	18.31	3.55
Standard Deviation	17.81%	6.73%

Absolute Profit Analysis



Probability of Gain	67.64%
Mean Return (120 Days)	7.16%
Annualized Return	15.62%

Mean Returns



Signal Distribution

697,070 Signals From 1/1/2010 to 12/31/2019

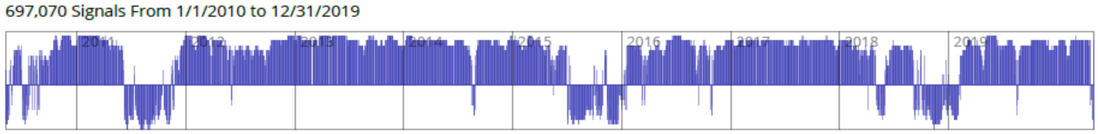


Chart and Data Source: OPTUMA

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