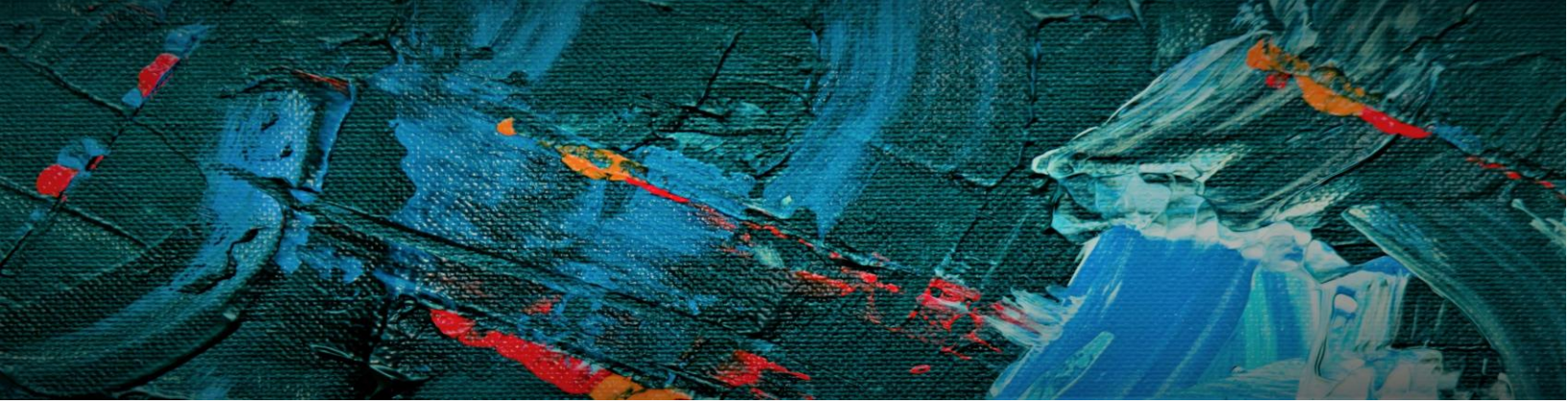
AdaptAsset

Financial Solutions Realized

Automatic Investment Management

A Modern Perspective



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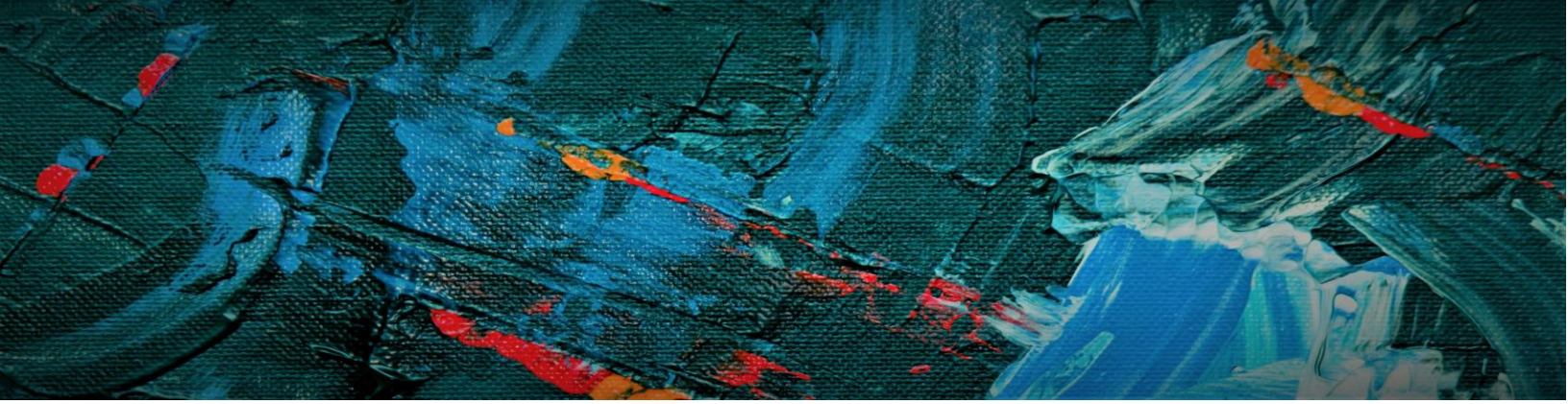

Who We Are

AdaptAsset is a quantitative, systematic investment firm focused on enhancing proven strategies and methods. Backed by a wealth of history and data, our approach is to provide innovative strategies that can excel in a variety of environments.

The Team

Through a broad diversity of experience and knowledge, the AdaptAsset teams brings rigor and creativity to pioneer its solutions. With expertise from research to software engineering and risk assurance, AdaptAsset aims to harness the unique strengths of its team members to provide an unparalleled experience for its clients.

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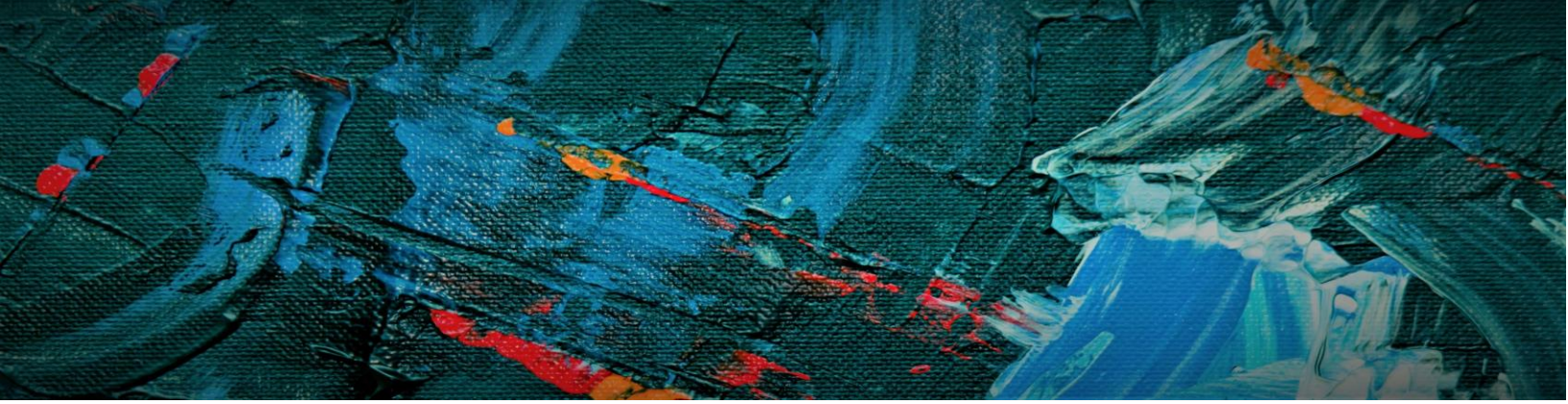
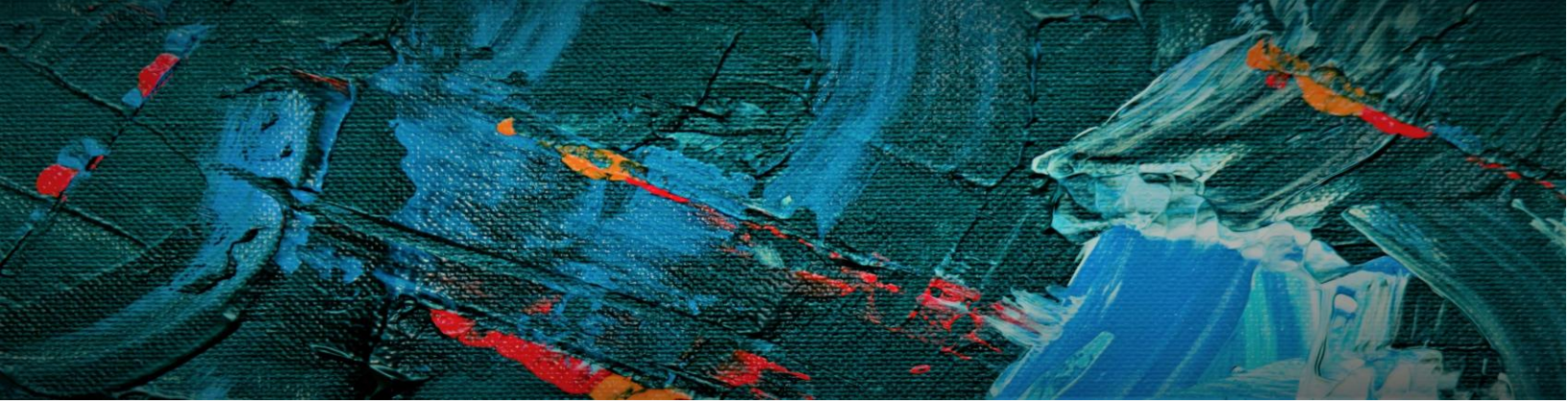


Objective

We aim to take a closer look at Automatic Investment Management (AIM), an investing method pioneered in the 1980's. While it proved versatile for its time, advances today have led our testing and analysis to be much more rigorous and allow for significant improvements to be made over the core AIM framework.

By adapting and modifying the core AIM framework through several different economic cycles and volatility levels, we can create an investment system that contains many of the same elements that made AIM so popular many years ago, while being much more agile and responsive.



Background

Automatic Investment Management, or AIM for short, was an investment strategy pioneered by Robert Lichello in 1977. It attempted to create a more disciplined and advantageous system than traditional buy-and-hold that was in nature long-term thinking but could also react to volatile events by mathematically deciding when to purchase and sell securities.

AIM attempted to answer four main investment questions:

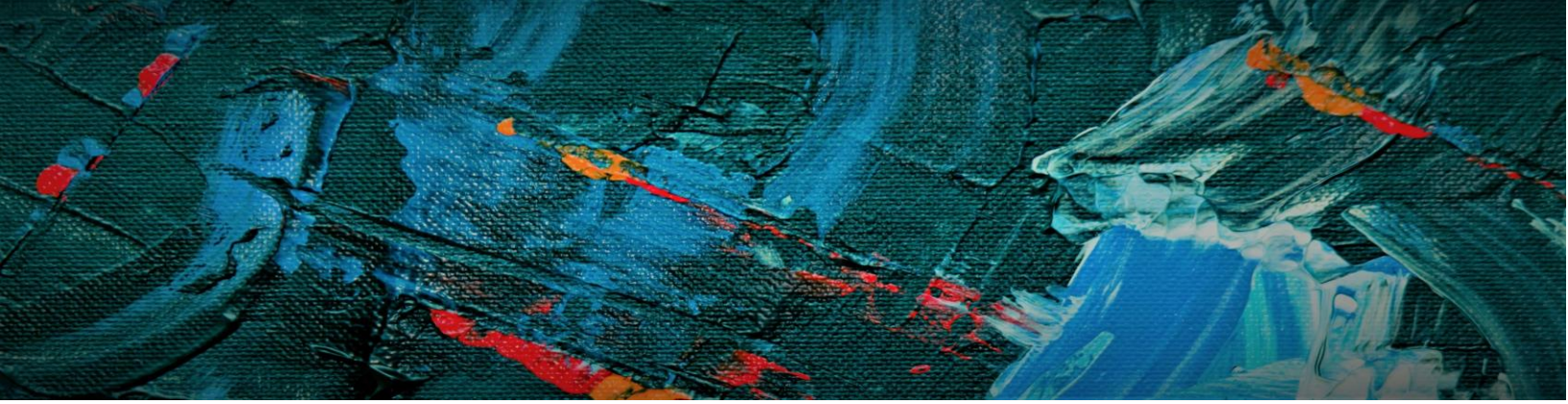
i. When starting a new investment strategy, what is the proper starting amount?

ii. How much should initially be kept in a cash reserve?

iii. When, and how much profit should be taken?

iv. When, and how much reinvestment should be implemented?

At its core, AIM was a method to increase one's investment in a position, without needing to put in additional follow-on capital. This can be similarly thought of as "trading around a core position". AIM attempts to buy low and sell high, all the while steadily reinvesting those profits to increase the position's size, without the need of additional outside capital.



Automatic Investment Management

The first test of any new investment strategy should be to understand its goals, and upon achieving that, figure out how to accomplish those goals. When examining Automatic Investment Management, we must look at it as a replacement to the traditional investing method of buy and hold.

Trading around a core position as well as other variations are merely modifications upon this base concept. AIM attempts to solve both functions, however, in order to establish a starting point, we must try to analyze it purely from a buy and hold perspective. To achieve this, we will try to isolate purely any alpha generated by the investment conditions beyond buy and hold.

The starting parameters will ideally be as close as possible, as well as testing over several time periods to try and eliminate any rogue effects. Recall that one of AIM's primary functions is to solve how much an investment should start with. To test its similarity to buy and hold, we will start with the same conditions as buy and hold, 100% initial investment. Our goal is to see if AIM is given the same starting parameters, whether it can generate any outperformance, or will any potential outperformance come largely from the starting conditions and not AIM itself [Exhibit 1]. Note that all risk statistics assume end-of-month values.

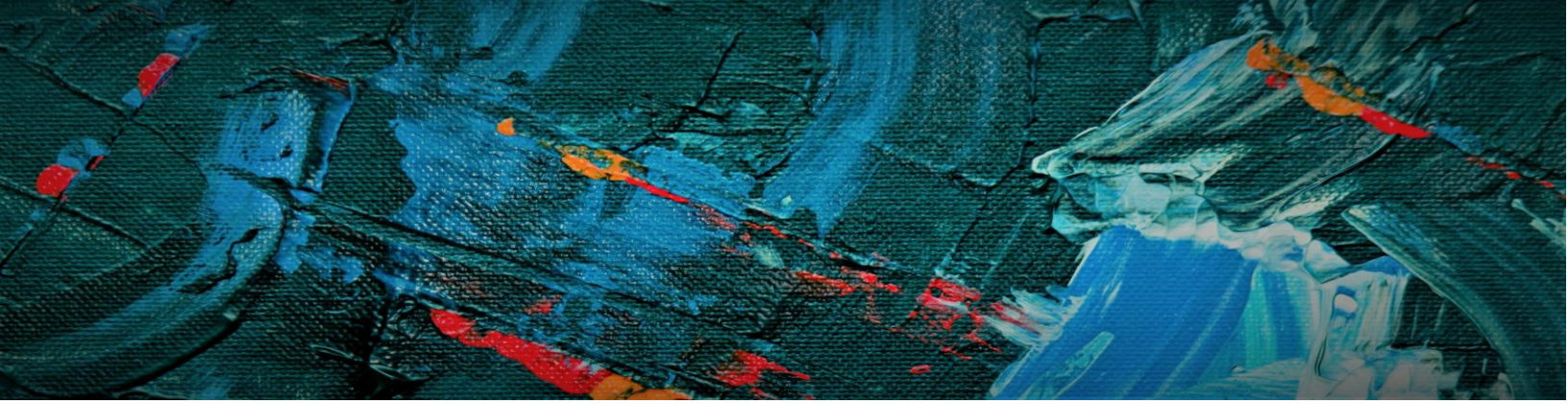
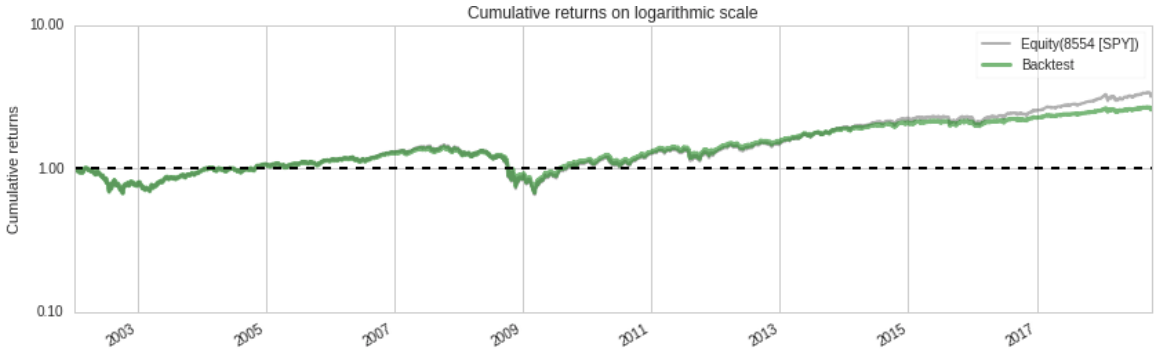


Exhibit 1: 100% Initial Investment with 10% Buy/Sell Parameters (2002-2018)



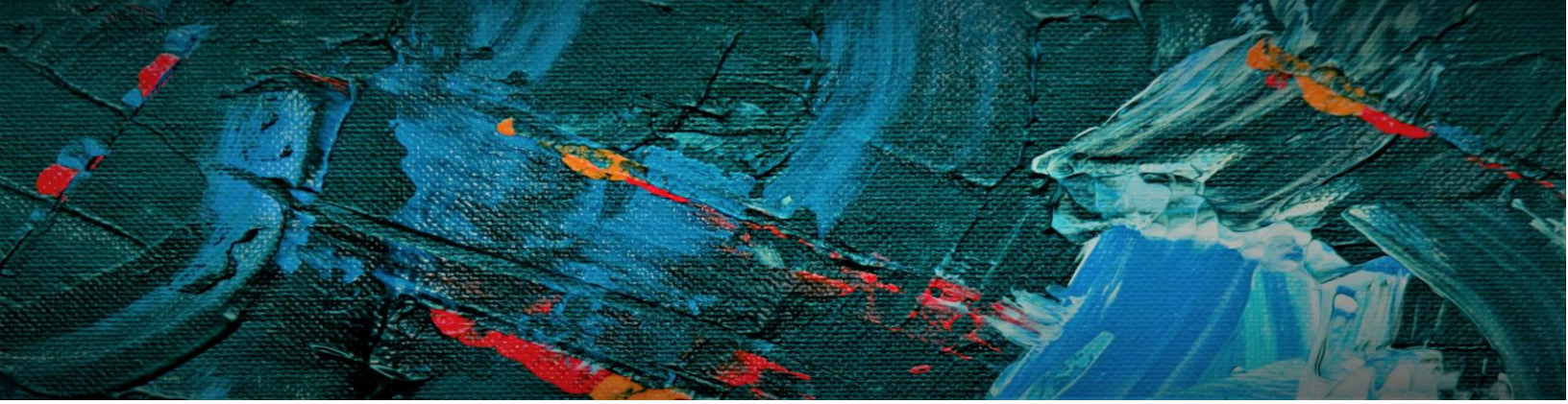
Source: Quantopian, AdaptAsset. Simulated Performance

100% Invested at Inception	
Compound Return	5.9%
Volatility	17.0%
Sharpe Ratio	0.42
Maximum Drawdown	-51.3%
Alpha	0.57
Growth of $1	$2.61

Before we begin to modify the underlying Automatic Investment Management framework, it's important to understand the chart and data table. The chart shows the growth of $1 invested from January 2002 through October 2018, where it has grown to $2.61. This equates to an annualized compounded growth of 5.9%.

The chart helps to visualize the path undertaken by the portfolio, which includes the approximate 50% drawdown during 2008. This is confirmed by glancing at the max drawdown of 51.3% from peak to trough.

The portfolio volatility of 17.0% led to a Sharpe ratio of 0.42. While the Sharpe ratio indicates that the portfolio's return was greater than the risk-free rate, the return must be compared to the underlying benchmark, the S&P-500. When compared to the benchmark, the Alpha value of -0.03 indicates that the Portfolio performed



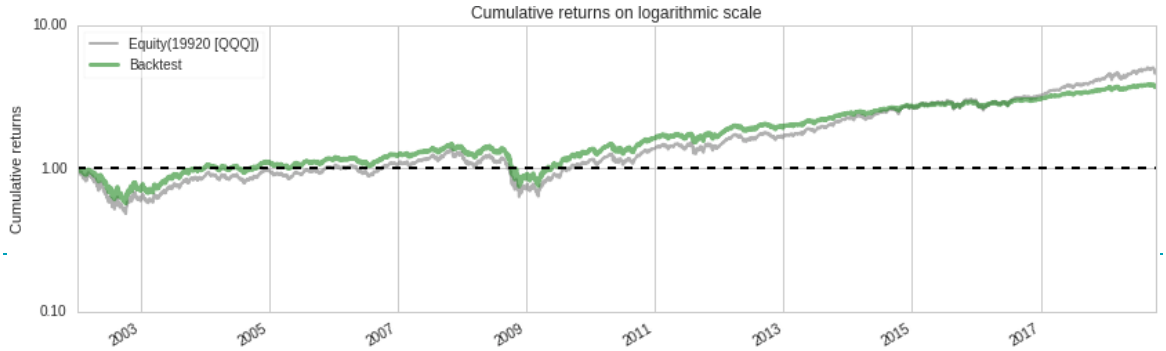
worse than the Benchmark. In other words, a potential investor would have been better off buy buying and holding the S&P-500 than following the investment strategy.

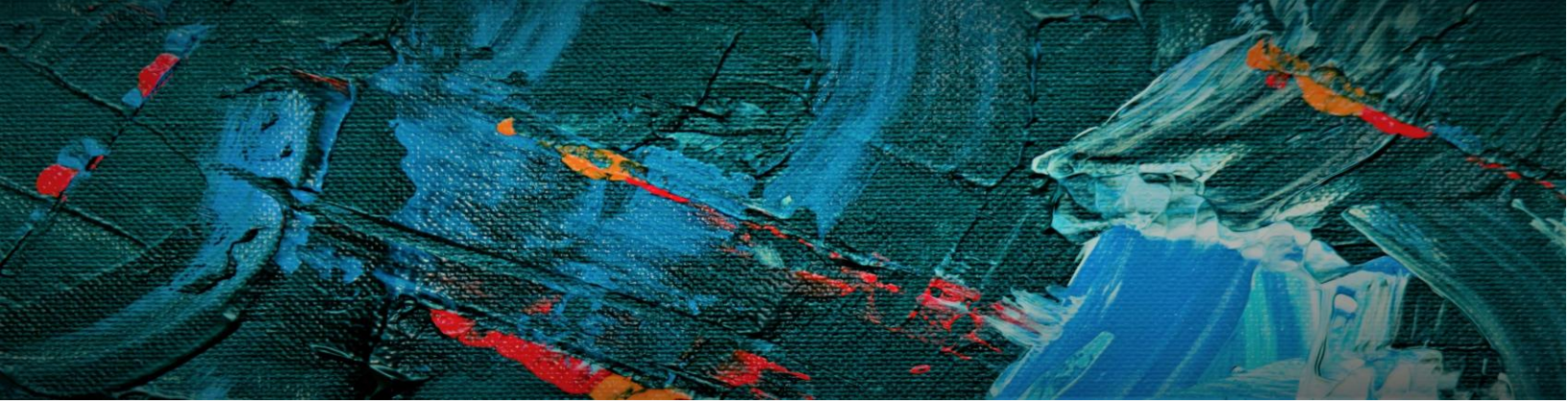
While disappointing, there are a few possible explanations for the low Alpha value. The portfolio was fully invested from the inception date. AIM relies on having available cash to average down, allowing the strategy to then begin to perform as intended. This led to the strategy only being able to raise cash from 2014 on, well past the point when having spare cash available would have been useful to help returns. In addition, raising cash as the market increased, while taking profits off the table, dragged returns as the equity component of the strategy began to shrink.

Another possible condition could have risen from the fixed Buy and Sell parameter. Having fixed Buy and Sell parameters reduces the strategy's effectiveness to adapt to different market environments, an effect that will be examined in a later strategy. In addition, the magnitude of the Buy and Sell percentages are important. If the system is not able to generate significant differences in market value from the underlying Portfolio Control, then the strategy will not execute an order to buy or sell. Using a diversified instrument, such as the S&P 500, may not have the volatility level to satisfy the Buy and Sell Parameters on a regular basis.

Our goal is to exhibit scenarios under which Automatic Investment Management can outperform its underlying benchmark by creating conditions that are more suitable for a trading environment compared to buy and hold. We express this logic in Exhibit 2, where we will lower the initial investment amount, lower the Buy and Sell parameters, and increase the volatility of the instrument.

Exhibit 2: 50% Initial Investment, 5% Buy/Sell Parameters, Volatility (2002-2018)



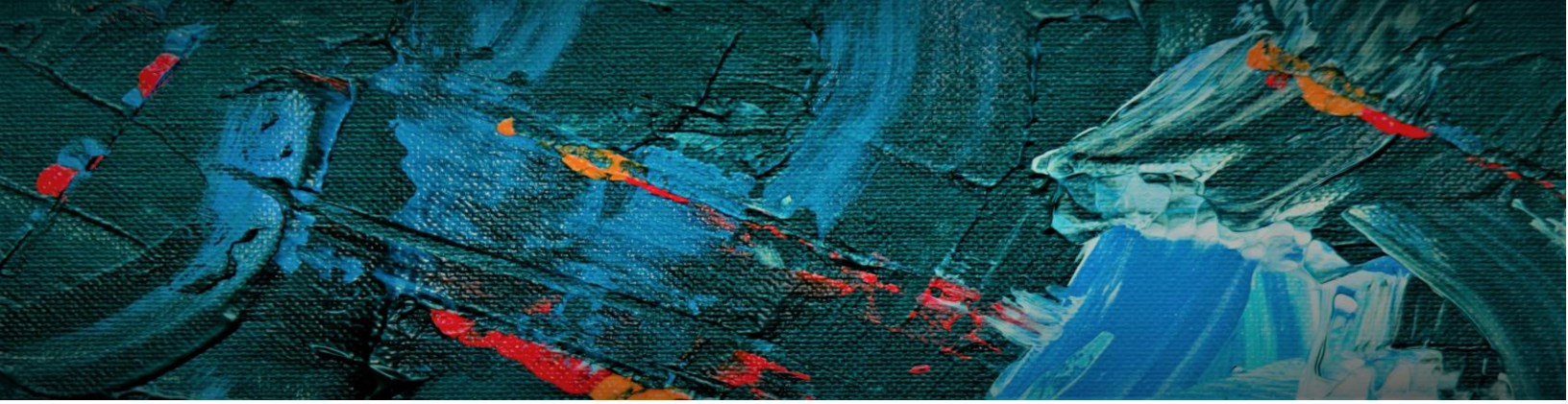


Source: Quantopian, AdaptAsset. Simulated Performance

50% Initial Investment	
Compound Return	8.2%
Volatility	19.1%
Sharpe Ratio	0.51
Maximum Drawdown	-49.4%
Sortino Ratio	0.74
Growth of $1	$3.76

In Exhibit 2, the underlying benchmark was changed from the S&P-500 to the Nasdaq 100. This increased the volatility of the portfolio from 17.0% to 19.1%, but also led to an increase in CAGR to 8.2%. Ultimately, this resulted in an increase in the Sharpe Ratio from 0.42 to 0.51.

For the first half of the simulation, the AIM strategy outperformed the benchmark. However, this was likely due to the initial starting allocation of 50%. This allowed AIM to average in at lower prices and be able to benefit from an increase in returns over the following years. As the strategy moved to post-2008, performance of the strategy relative to the benchmark declined, ultimately leading to the strategy underperforming from 2016 on. This was likely due to the accumulation of cash in the strategy as it waited for an opportunity to repurchase at a lower price.



A Modern Perspective

There are several parameters that can be introduced to Automatic Investment Management to improve performance. These improvements will center around creating a more dynamic buy and sell order flow, allowing the strategy to use leverage, as well as including broad market trading restrictions. The goal of these improvements is to reduce the total drawdown, increase the flexibility of the strategy to adapt to different volatility environments, as well as being able to maximize the return during periods when the strategy is heavily allocated.

In Exhibit 3, the underlying benchmark was changed to 2x leveraged S&P-500. This change increased the volatility of the strategy, allowing for a greater period to exhibit excess returns, while preserving a long period of time to backtest the strategy across different volatility environments.

In addition, a portfolio rebalance was added to the investment strategy that will reinvest extra cash above a certain threshold at the beginning of each year. This prevents the strategy from accumulating an excess amount of cash during long periods of strong performance in the underlying security, while still preserving free capital to take advantage of any drawdowns that could occur.

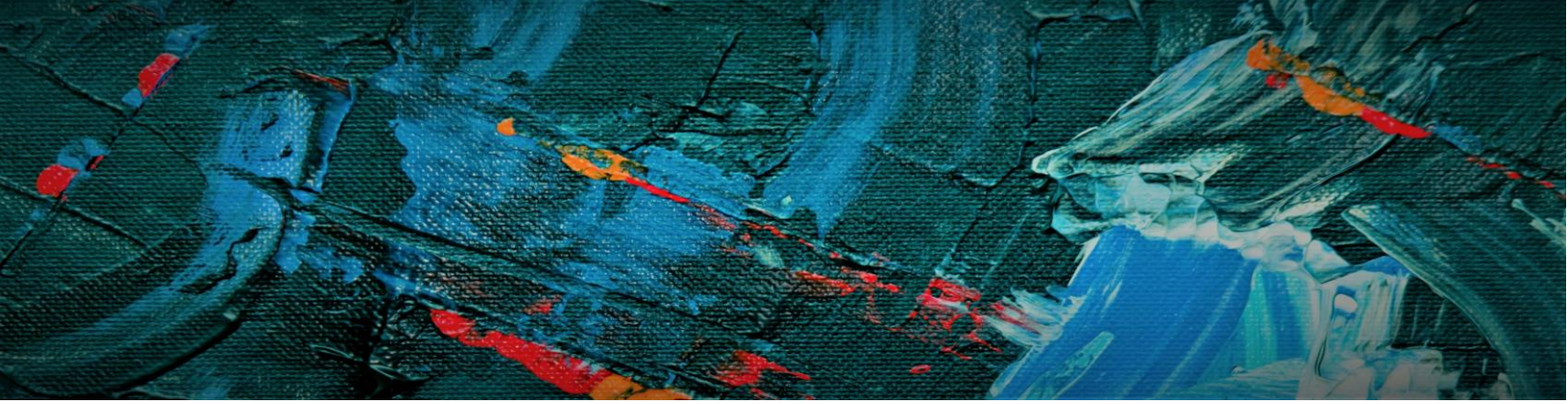
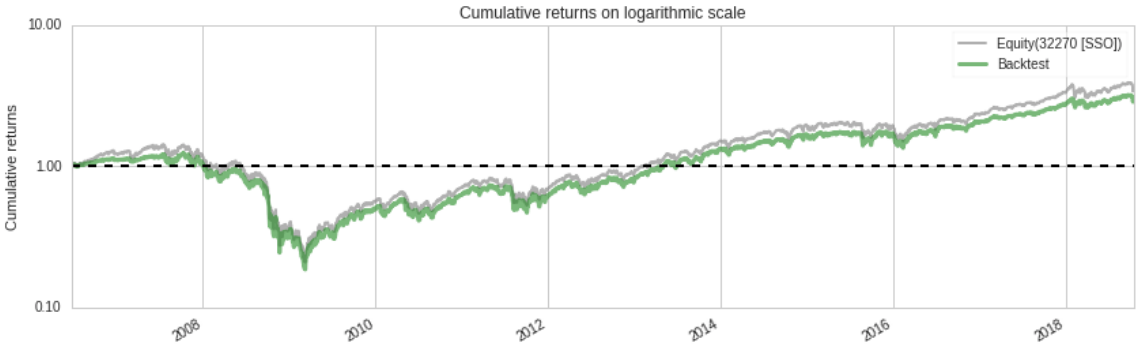


Exhibit 3: 5% Buy/Sell Parameters, Rebalance, 2X Index (2006-2018)

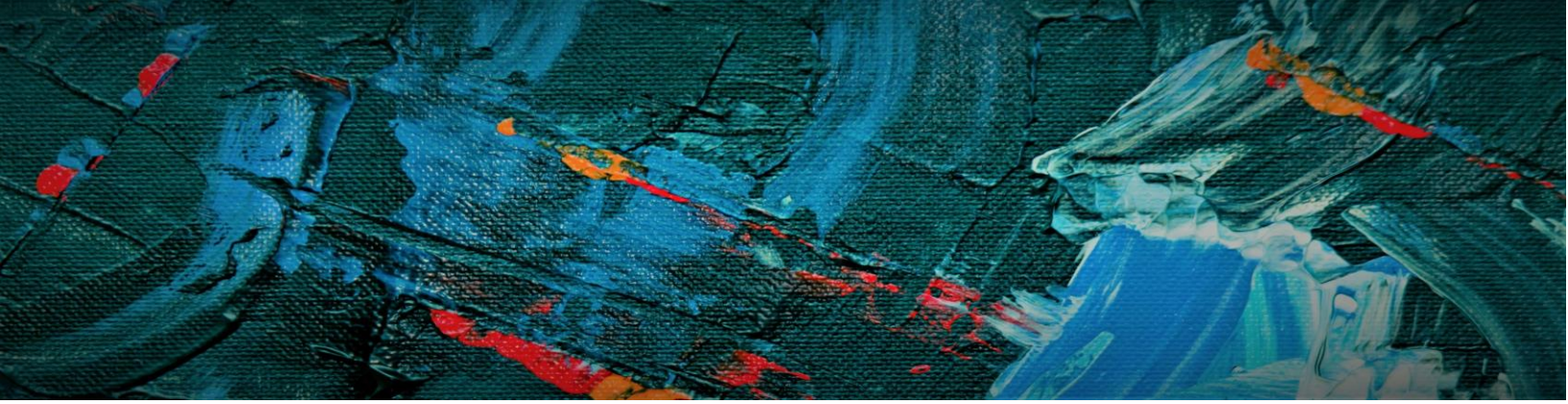


Source: Quantopian, AdaptAsset. Simulated Performance

Rebalance	
Compound Return	9.0%
Volatility	36.2%
Sharpe Ratio	0.42
Maximum Drawdown	-85.0%
Sortino Ratio	0.59
Growth of $1	$2.89

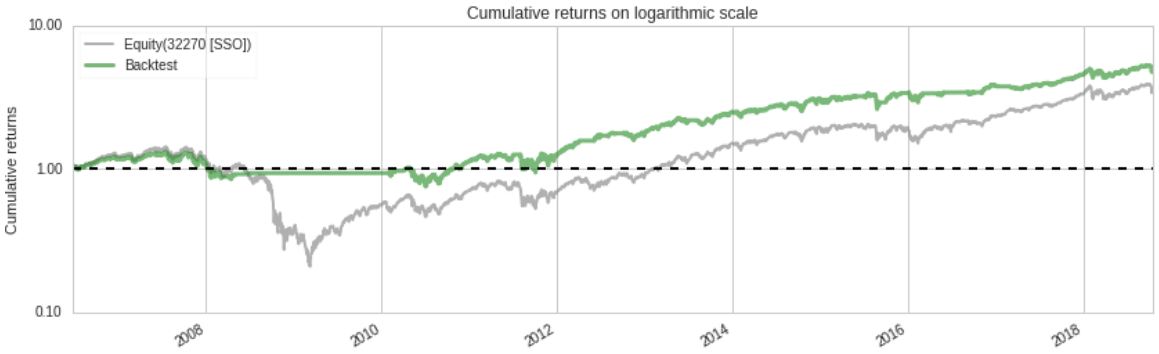
Compared to Exhibit 2, the compound return in Exhibit 3 was increased from 8.2% to 9.0%, a significant improvement. However, the higher leverage led to a higher level of volatility of 36.2%, as well as a higher drawdown of 85%. These impacted the risk-adjusted returns of the strategy by lowering the Sharpe Ratio to 0.42 and the Sortino Ratio from 0.74 to 0.59.

The impact from rebalancing was likely minimal as the only time that the rebalance would have taken effect was during the final years of the backtest. Given that most of the volatility occurred in the first half of the simulation, the backtest likely had little effect on the strategy's overall performance.



In Exhibit 4, we will continue to run the strategy based on the 2X leveraged S&P-500 and focus on controlling the excess risk. To accomplish this, the strategy will use a set of underlying moving averages to dictate when the strategy can and cannot trade. The goal of the moving average implementation is to prevent the strategy from being active during large downtrends in the market. This will hurt the strategy's ability to buy low during drawdowns in the underlying security but will be made up for by lower overall losses, thereby reducing the strategy's overall risk parameters. The moving average parameter will function such that when the average is declining, the strategy will hold only cash, and when the average inflects and begins to rise, the strategy will reinvest most of the portfolio.

Exhibit 4: 5% Buy/Sell Parameter, Rebalance, Moving Average (2006-2018)



Source: Quantopian, AdaptAsset. Simulated Performance

Moving Average	
Compound Return	13.6%
Volatility	22.7%
Sharpe Ratio	0.68
Maximum Drawdown	-42.7%
Sortino Ratio	0.95
Growth of $1	$4.79

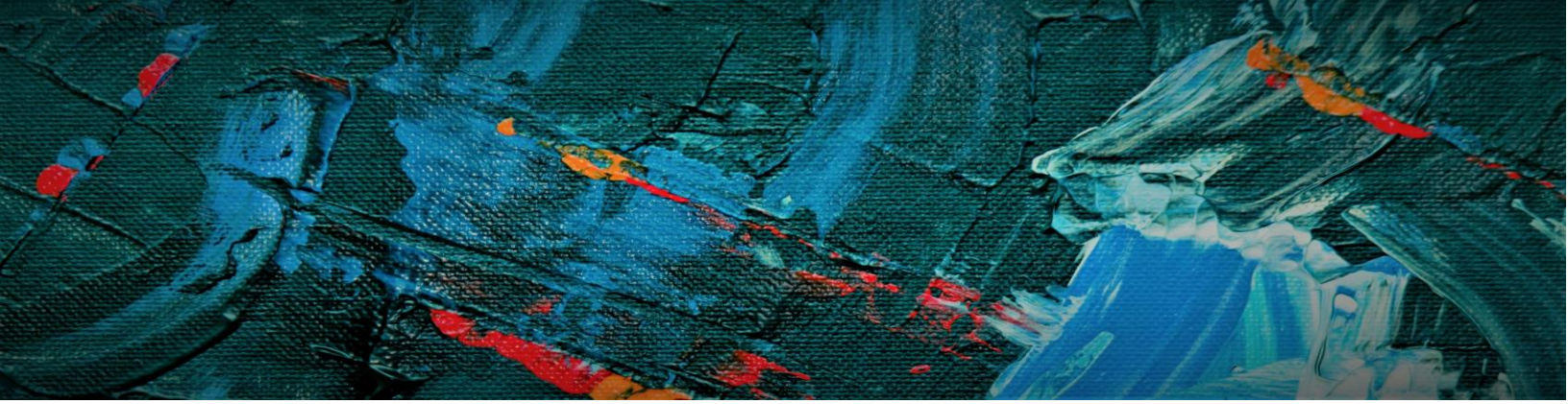


Exhibit 4 shows a substantial improvement in performance over Exhibit 3. The compound return has increased from 9.0% to 13.6% alongside a reduction in volatility from 36.2% to 22.7%. This led to a large increase in risk-adjusted return as the Sharpe Ratio increased to 0.68 and the Sortino Ratio increased to 0.95.

This large improvement in performance was likely due to the conditional periods that the Moving Average parameter allowed the strategy to trade. Looking at the performance graph, we can see that the Moving Average parameter allowed the system to avoid most of the drawdown during the 2008 Recession. This helped to reduce the drawdown to 42.7% from 85.0% previously. In addition, the added parameter had a limited effect on capping upside return as there were few periods where the strategy held cash for extended periods of time outside of the recession.

In Exhibit 5, we will attempt to improve the strategy's responsiveness by adjusting the buy and sell parameters. Currently, the strategy uses a fixed percentage system which triggers an order any time that the difference between the current value and the portfolio control exceeds the buy/sell threshold. While this allows for a simpler calculation, it forces the strategy to be less responsive in the face of different volatility environments. By shifting the buy/sell parameter towards one based on the current volatility level, this will allow the strategy to become more responsive to the local volatility environment. During high volatility events, such as a significant drawdown, having an adaptable buy/sell system will respond better than a fixed strategy by having orders placed at wider scales rather than at fixed intervals. Conversely, during lower volatility periods, an adaptive volatility measurement will allow the strategy to trade at smaller intervals compared to the fixed strategy. Exhibit 5 will utilize the same parameters as Exhibit 4 except for a changed buy/sell parameter.

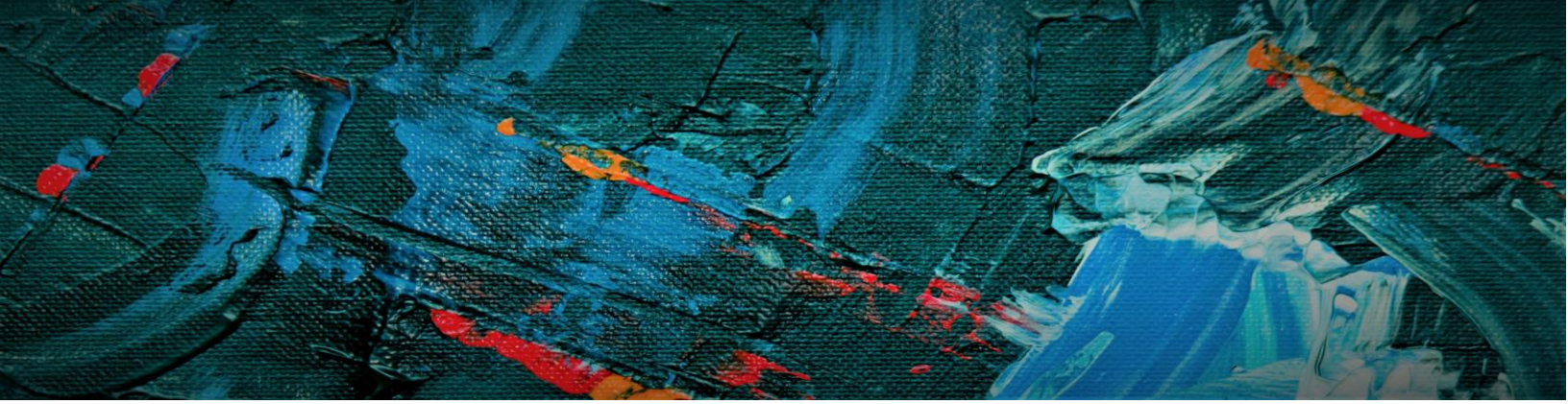
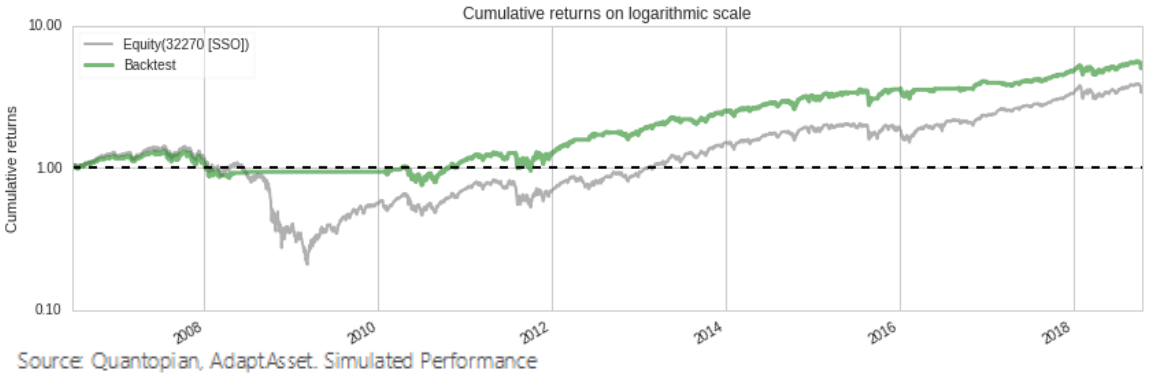


Exhibit 5: Adaptive Buy/Sell, Rebalance, Moving Average (2006-2018)



Source: Quantopian, AdaptAsset. Simulated Performance

Adaptive Buy/Sell	
Compound Return	14.1%
Volatility	23.0%
Sharpe Ratio	0.69
Maximum Drawdown	-42.8%
Sortino Ratio	0.97
Growth of $1	$5.06

Exhibit 5 showed an increase in compound return from 13.6% to 14.1%. This was achieved with almost the same volatility profile, which helped to increase the Sharpe Ratio and Sortino Ratio to 0.69 and 0.97, respectively. While the adaptive buy/sell proved beneficial, the effect was muted as there were several periods where the strategy exhausted its cash reserve, hampering the flexibility of the adaptive order parameter.

In Exhibit 6, we will attempt to improve performance by allowing the strategy to borrow additional assets and exceed a 1.0 leverage ratio. The goal will be to provide additional returns during periods when the strategy is performing well, and to rely on the moving average parameter to avoid excess losses during drawdowns. In addition, allowing borrowing will prevent periods when the strategy cannot perform optimally due to insignificant cash holdings.

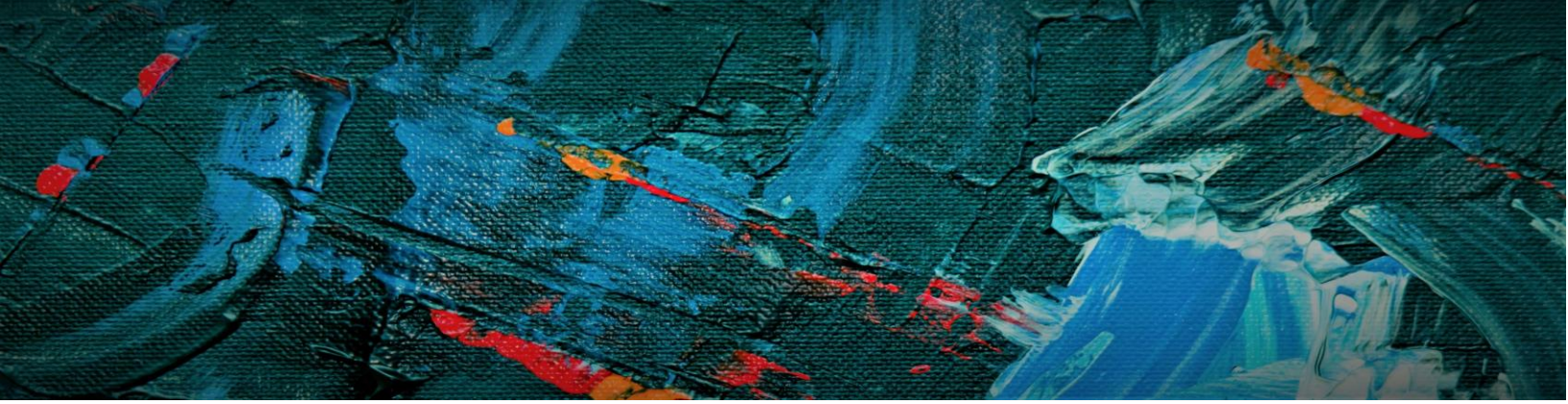
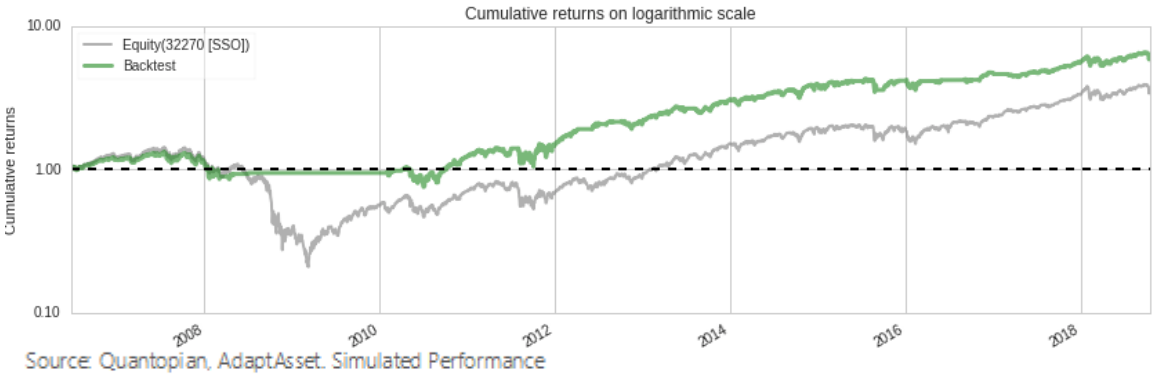


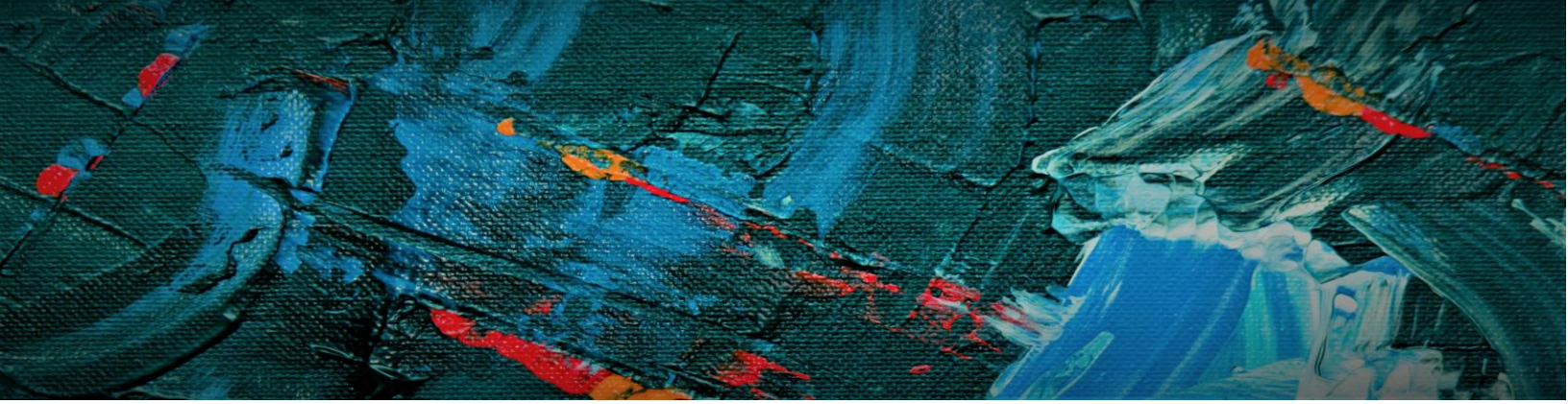
Exhibit 6: Adaptive Buy/Sell, Moving Average, Leverage



Leverage	
Compound Return	15.5%
Volatility	24.3%
Sharpe Ratio	0.72
Maximum Drawdown	-42.9%
Sortino Ratio	1.02
Growth of $1	$5.91

Exhibit 6 shows a significant improvement in compound return from 14.1% to 15.5%, along with a modest increase in volatility from 23.0% to 24.3%. The improved performance helped to increase the risk-adjusted metrics of Sharpe and Sortino Ratios to 0.72 and 1.02 respectively.

The increase in available leverage allowed the strategy to take advantage of higher volatility events where previously Automatic Investment Management would have exhausted its cash reserve before completing all its purchase orders. The Moving Average parameter continued to provide downside protection, allowing the leverage to boost returns to the upside without significantly increasing the risk profile.



Results & Analysis

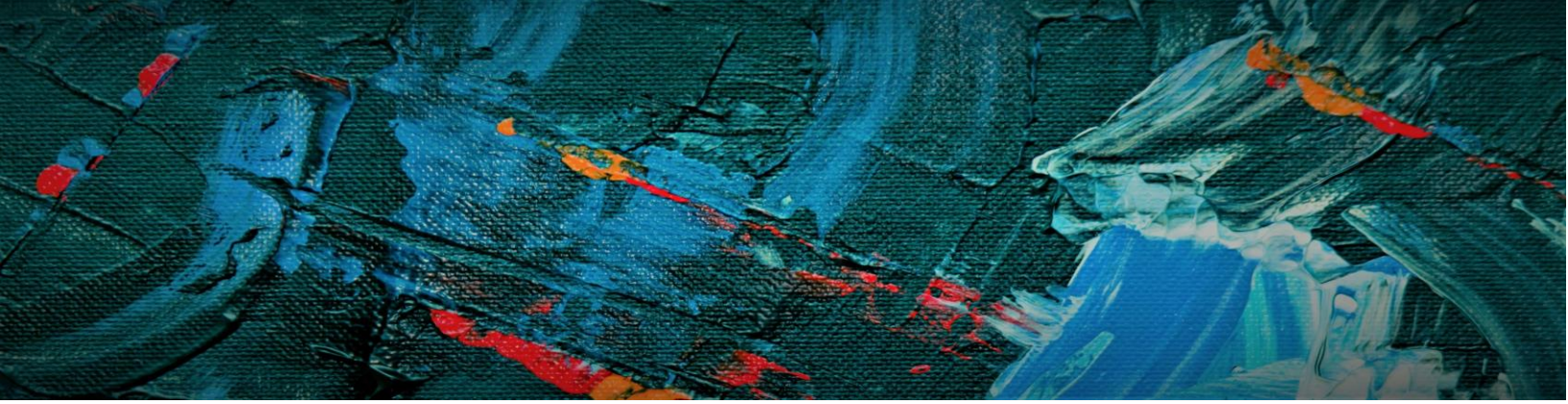
Automatic Investment Management is a strategy centered around building a long-term position without the need for additional capital. The strategy focuses on growing portfolio control, a metric that measures the amount of total capital invested into a position. The strategy uses buy and sell parameters to trade around the core position by buying low and selling high to steadily grow the amount of invested capital in a position.

While promising in concept, the strategy has a hard time outperforming its underlying benchmark. As seen in Exhibit 1, the strategy suffers from a lack of available capital to use during drawdowns, as well as tending to sell excess amounts during periods of positive returns. This culminates in the strategy selling too early, and not having enough free capital to take advantage of potential drawdowns.

Increasing the underlying volatility helps the strategy to perform better as a higher volatility level presents more opportunities for the strategy to boost returns by trading around the core position. However, as seen in Exhibit 2, while this is beneficial, the strategy is much more influenced by the starting allocation, an arbitrary variable that masks the ability of the underlying strategy to perform.

We examined several different methods to increase returns of the strategy while still preserving its core framework. In Exhibit 3, the underlying benchmark was increased to a leveraged fund to increase the volatility to help the strategy perform better, as well as introducing an annual rebalance to ensure that the strategy does not accumulate too much excess cash for extended periods of time.

Increasing the volatility of the underlying benchmark led to a higher volatility exhibited by the strategy, resulting in the next variation, implementation of a moving average parameter, that attempted to signal periods of time when the

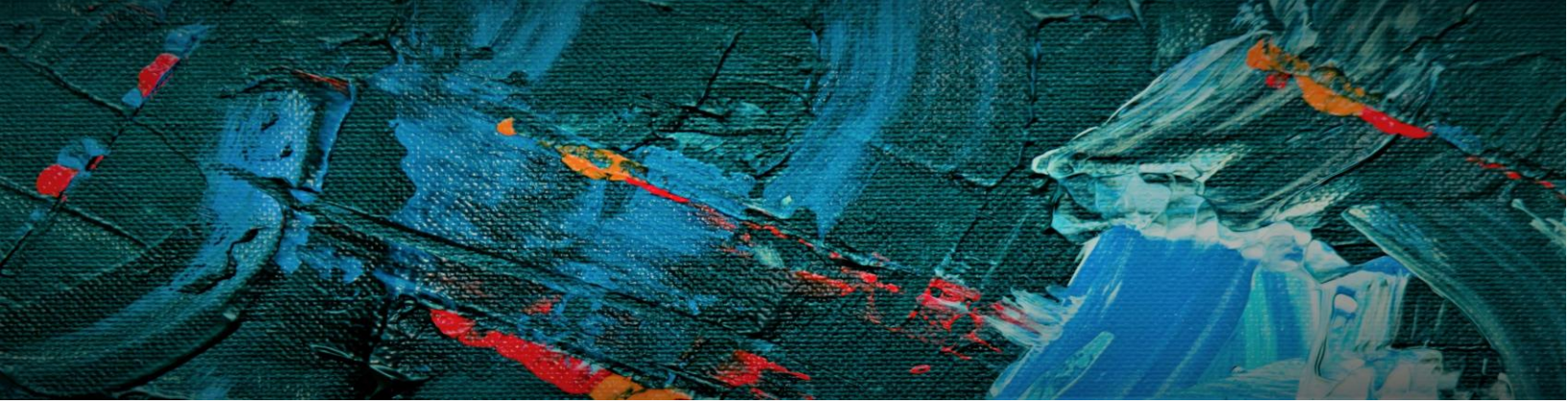


strategy could trade and when it should hold cash instead. Exhibit 4 showed that implementation of a moving average strategy proved significantly beneficial to the strategy as it allowed the strategy to avoid several periods of significant drawdowns without hampering the upside performance.

Exhibit 5 replaced the traditional buy/sell method of Automatic Investment Management with a variable system that allowed the strategy to adapt to changing volatility levels, rather than using a fixed measurement for the entire life of the strategy. This would allow the strategy to use wider buy/sell parameters during higher volatility periods and closer scales during low volatility environments. Modifying the buy/sell logic helped to improve performance, but the strategy was still hampered by a lack of available capital during drawdown periods, reducing performance.

Additional leverage was added in Exhibit 6, allowing the strategy to use extra capital when it traditionally would have exhausted its cash reserve. This allowed the strategy to take advantage of drawdown periods by buying more than it otherwise would have been able to without dramatically increasing the risk profile.

Through several targeted modifications, we can significantly improve the risk-adjusted performance of Automatic Investment Management.



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