

SAA Portfolio Analysis Report

Author: Sanjeev Narasimhan

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Overview

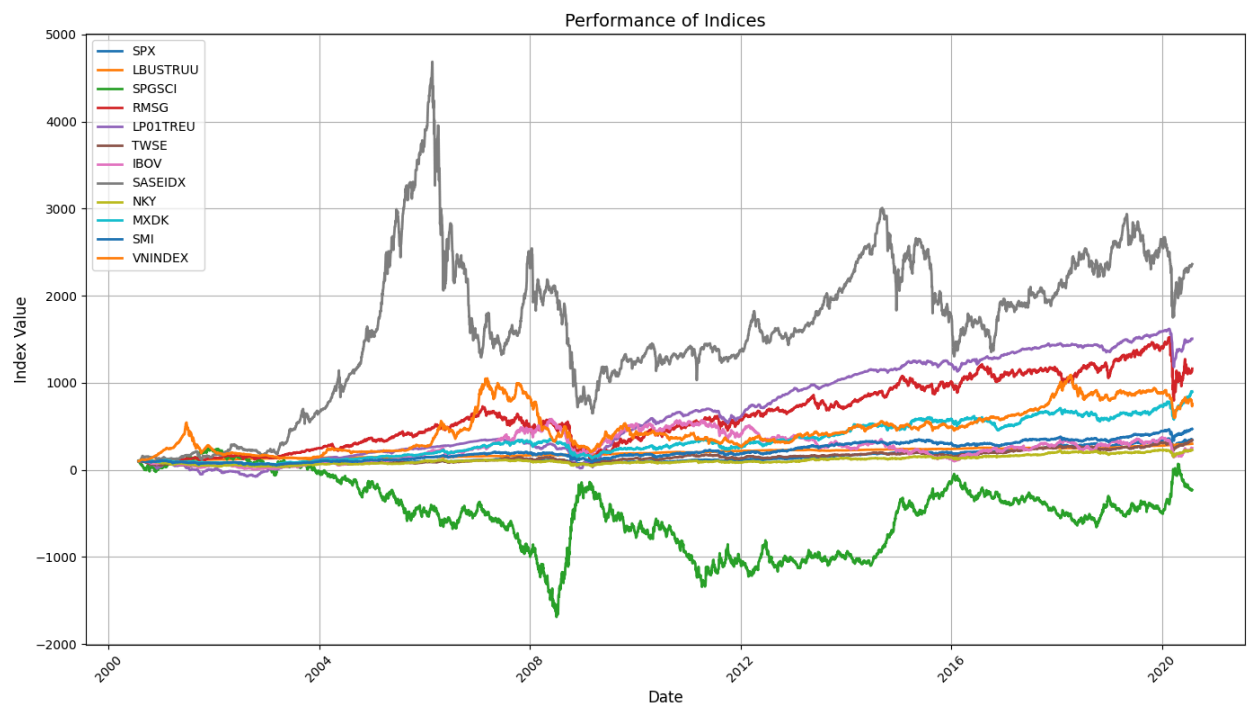
In the context of portfolio construction, a common question to consider is how much of the portfolio to allocate across asset classes. For the purpose of this SAA Portfolio, we will consider the following indexes:

- SPX (S&P 500 Index): The S&P 500 Index is a stock market index that measures the stock performance of 500 large companies listed on stock exchanges in the United States.
- LBUSTRUU (U.S. Aggregate Bond Index): The Bloomberg Barclays U.S. Aggregate Bond Index, also known as the Agg, is a broad-based flagship benchmark that measures the investment-grade, U.S. dollar-denominated, fixed-rate taxable bond market
- SPGSCI (S&P GSCI Index): The S&P GSCI is a world-production weighted index that measures the performance of the commodity market. It includes a diversified group of commodities, such as energy, agriculture, industrial metals, precious metals, and livestock.
- RMSG (Russell Midcap Growth Index): The Russell Midcap Growth Index measures the performance of mid-cap growth companies in the United States.
- LP01TRUE (Thomson Reuters Lipper Global Equity Index): The Thomson Reuters Lipper Global Equity Index is a global equity index that represents the performance of equity markets worldwide.
- TWSE (Taiwan Stock Exchange Index): The Taiwan Stock Exchange Index is a capitalization-weighted index of all listed common shares traded on the Taiwan Stock Exchange.
- IBOV (Ibovespa Index): The Bovespa Index is the benchmark index of the São Paulo Stock Exchange in Brazil. It tracks the performance of the most liquid stocks traded on the exchange.
- SASEIDX (Saudi Stock Exchange Index): The Saudi Stock Exchange Index is a capitalization-weighted index of all stocks listed on the Saudi Stock Exchange.
- NKY (Nikkei 225 Index): The Nikkei 225 Index is the leading stock market index for the Tokyo Stock Exchange. It consists of the 225 top-rated Japanese companies listed on the exchange.
- MXDK (MSCI Denmark Index): The MSCI Denmark Index is designed to measure the performance of the large and mid-cap segments of the Danish market.
- SMI (Swiss Market Index): The Swiss Market Index is the benchmark index for the Swiss stock market. It consists of the 20 largest and most liquid stocks traded on the Swiss Exchange.
- VNINDEX (VN Index): The VN Index is the benchmark index of the Ho Chi Minh City Stock Exchange in Vietnam. It tracks the performance of the largest companies listed on the exchange.

Benefits of Index Inclusion

- *Diversification and Risk Mitigation*: Incorporating the above indexes into our portfolio enhances diversification through exposure to a different geographic region/ currency, reducing portfolio volatility and improving risk-adjusted returns.
- *Potential for Higher Returns*: Historically, some indexes tend to perform better than others, and by incorporating these indexes into our portfolio, investors can enhance the portfolio's overall returns, as well as tap into economic growth potential of some of these markets.
- *Hedging*: The inclusion of international equities in the portfolio provides a hedge against specific risks associated with the US market, such as regulatory changes, political instability, or economic downturns, reducing its sensitivity to external shocks.

Historical Index Performance



Portfolio Construction

Steps for Optimization

To determine the optimal allocation of our portfolio across the above indexes, we began with an equal weighted portfolio, and using an optimizer, determined the allocation that maximized the Sharpe Ratio over a 20 year period given the following goals and constraints:

Constraints

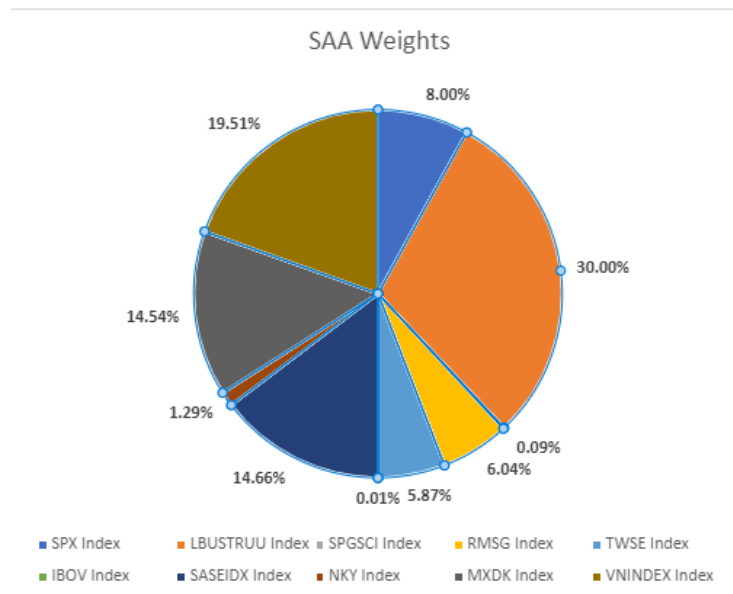
- Minimum Annualized Target Return $\approx 9\%$
 - Using the S&P as a benchmark for annualized returns, the Annualized 20 Year Return for the S&P (SPX) was $\approx 8.9172\%$. As such, we wanted our portfolio to generate competitive returns to the S&P.
- Maximum Annual Volatility $\approx 11\%$
 - Using the S&P and a Rebalancing 60/40 Portfolio as a benchmark for volatility, the Annual 20 Year Volatility for the S&P (SPX) was $\approx 20.1886\%$, and $\approx 11.2024\%$ for the 60/40. As such we wanted to end up with a portfolio that was generally less volatile than these benchmarks
- Maximum Allocation for any Index = 30%
 - To ensure that our portfolio is not too susceptible to economic/ country specific shocks, we set a cap on allocation such that no index can account for more than 30% of the portfolio.

Goal

- Maximize the Sharpe Ratio
 - After the optimizer considers the above constraints, it then identifies the allocation that results in the highest Sharpe Ratio, or risk-adjusted relative returns

Optimization Results

Index	Weights
SPX Index	0.0800
LBUSTRUU Index	0.3000
SPGSCI Index	0.0009
RMSG Index	0.0604
TWSE Index	0.0587
IBOV Index	0.0001
SASEIDX Index	0.1466
NKY Index	0.0129
MXDK Index	0.1454
VNINDEX Index	0.1951



Under the optimizer, the above weights were determined to be most optimal, returning the following metrics:

- Expected Portfolio Return: 11.90%
- Expected Portfolio Volatility: 10.29%
- Sharpe Ratio: 1.1268

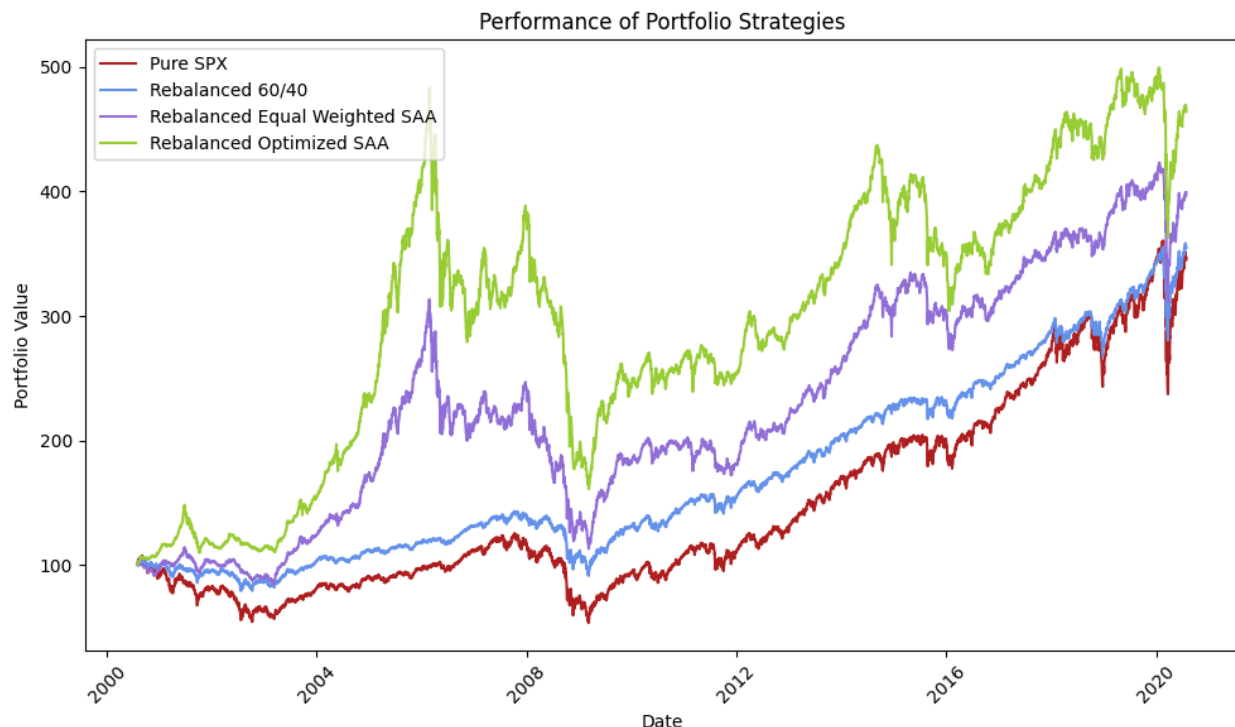
It is important to note that these are expected values and are not necessarily accurate as to their actual performance over the 20 year period

Gauging Metrics

Portfolio Strategy

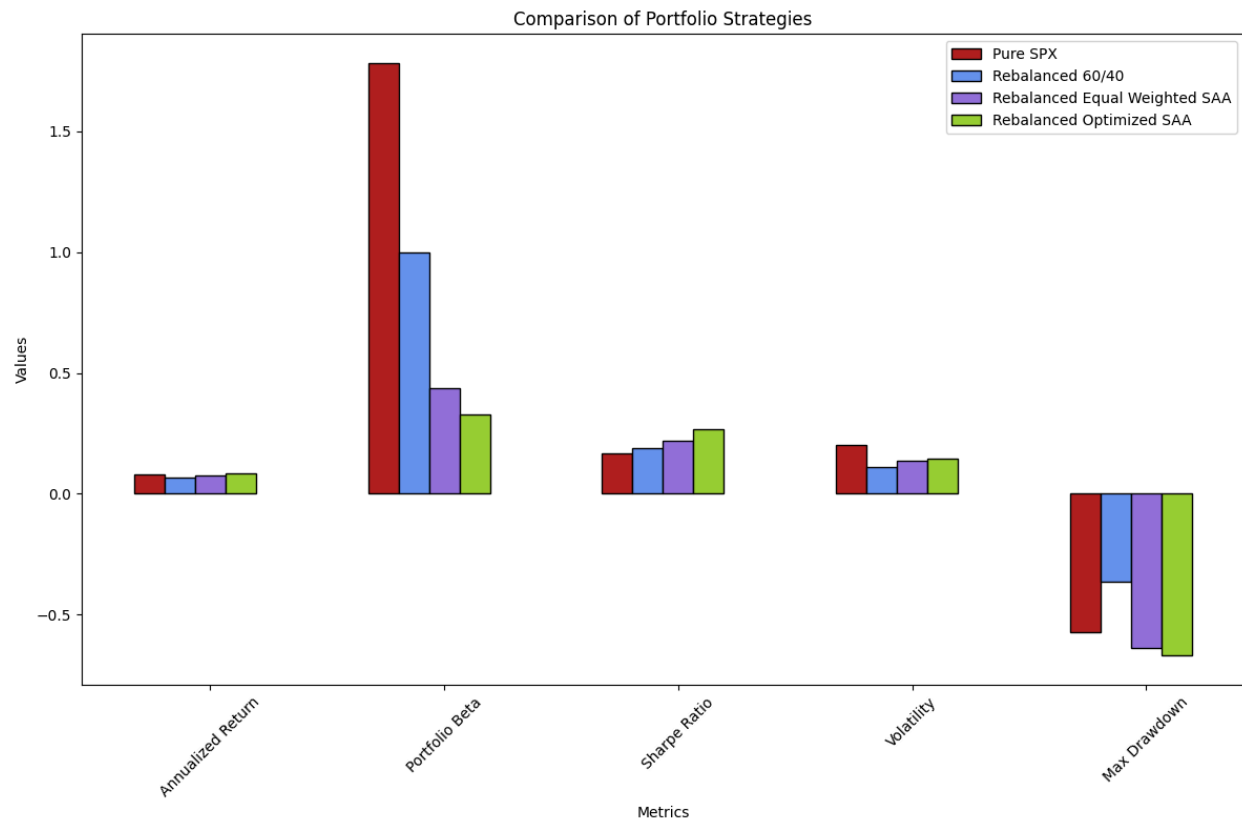
In the content of SAA Portfolios, the effectiveness of the strategy comes from maintaining the optimal allocation, and as such rebalancing periods are commonly used to maintain the benefits that arise from strategic asset allocation. For the purposes of this portfolio, we will be using a quarterly rebalancing strategy where we rebalance and reallocate the total portfolio value on the first of January, March, June, and September. This same rebalancing strategy was applied to the following portfolio allocation strategies:

- Pure SPX
 - To properly gauge the effectiveness of our strategy we want to compare our performance to a strategy of only investing in the S&P, as we want to see whether or not there are higher returns to be found if we diversify from the S&P
- Rebalanced 60/40
 - A rebalanced 60/40 is a common benchmark to gauge the performance of an portfolio strategy as it has historically been able to generate competitive returns over the long term while reducing the volatility of the portfolio. As such is has been the standard strategy for investors with a moderate risk tolerance
- Rebalanced Equal Weighted SAA
 - To properly gauge the performance of our optimized allocation strategy, we can compare its performance to one in which our portfolio equally weights the indexes. This will allow us to see if using the optimizer with the above constraints resulted in metrics better/worse than if we did not
- Rebalanced Optimized SAA (Our Strategy)



The graph above shows the historical growth of a \$100 investment into the different investment strategies. When we consider the SPX (Red), the benchmark 60/40 portfolio (Blue), and the equal weighted SAA (Purple), our optimized SAA Portfolio (Green) strongly outperforms the benchmarks and the SPX. This tells us that by modifying a pure S&P or 60/40 portfolio and looking outside of the US, we can capture some of the returns to be found in the indexes of emerging markets and those strong economies.

It is important however to note that our optimized SAA strategy is highly volatile. Unlike the S&P and 60/40 strategies that have (relatively) consistent returns and experience minimal changes in the portfolio over the course of the past 20 years, our strategy's performance is far less predictable and very volatile.



	Annualized Return	Portfolio Beta	Sharpe Ratio	Volatility	Max Drawdown
Pure SPX	0.0802	1.7798	0.3947	0.2031	-0.5710
Rebalanced 60/40	0.0673	1.0000	0.5965	0.1129	-0.3615
Rebalanced Equal Weighted SAA	0.0759	0.4392	0.5575	0.1361	-0.6390
Rebalanced SAA	0.0846	0.3295	0.5878	0.1440	-0.6668

The above bar chart illustrates the performance of the different types of portfolios over a 20 year historical period. Based on their performances relative to the benchmarks of the 60/40 portfolio and the S&P, it is clear that our SAA Portfolio had the greatest performance.

Comparing 20 Year Historical Performance of Optimized SAA to Benchmarks (60/40 and S&P):

- Greatest Annualized Returns at ~8.46% VS. ~6.73% & 8.02%
- Low Beta at ~0.3295 VS. 1.0 & 1.7798
- High Sharpe Ratio at ~0.5878 VS. ~0.5965 & 0.3947
- Comparably High Volatility at ~14.4% VS. ~11.29% & ~20.31%
- Highest Δ (Max Drawdown) at ~66.68% VS. ~36.15% & ~57.10%

The above metrics tell us that our SAA Portfolio is able to outperform the SPX and our benchmark rebalancing 60/40 portfolio. Over a 20 year period, we are able to generate higher returns than both the SPX and 60/40, while taking on a comparatively lower level of risk (Beta). Overall, we are able to generate a higher risk adjusted return than the other portfolios used to compare to our SAA Portfolio except for the 60/40. As such, we believe our portfolio strategy to be well suited to generating stronger returns while maintaining lower risk, however, there is still a very prominent issue of the volatility and max drawdown of this strategy.

To be a viable long term portfolio strategy, we need to consider the volatilities of the individual indexes and adjust our portfolio strategy accordingly. By using the VIX as an indicator for instability/potential economic downturns in the US, we can work to mitigate the effects that economic shocks may have on 38% of our portfolio.

Using the VIX as an Indicator

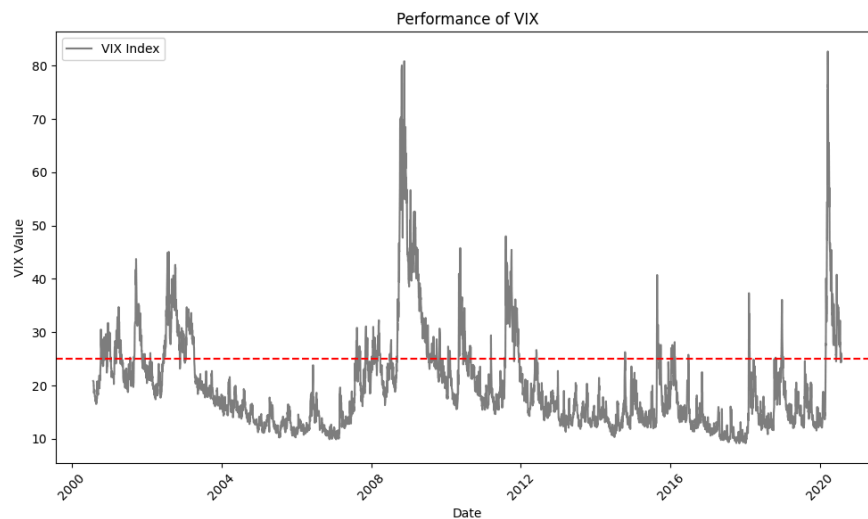
Understanding the VIX

The CBOE Volatility Index (VIX), is a real-time market index representing the market's expectation of 30-day forward-looking volatility of the S&P 500 index options. The VIX is often used as a measure of investor sentiment and market risk. When the VIX is high, it suggests that investors expect significant market volatility or uncertainty, while a low VIX indicates expectations of relatively calm market conditions.

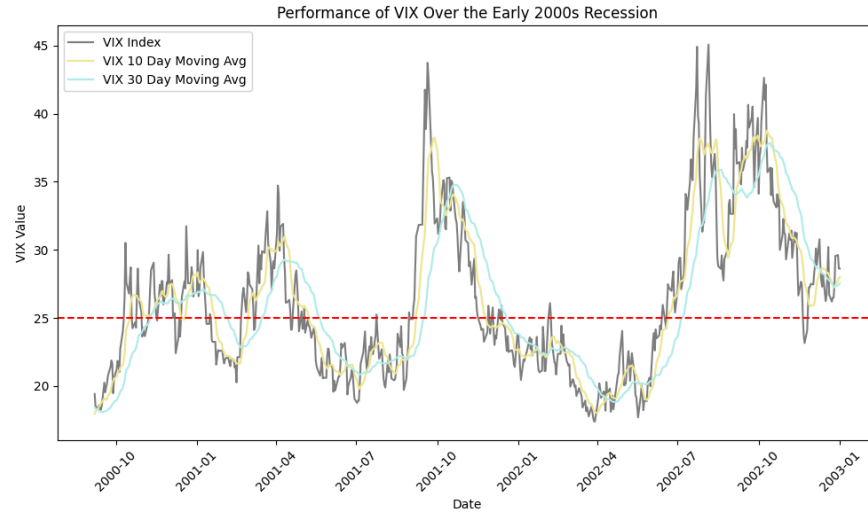
Incorporating the VIX into Our Portfolio

For the purposes of our portfolio, the intention is to recognize when the market is entering a period of uncertainty, and reallocate our portfolio using a strategy that is more resistant to economic shocks.

To begin this we can look to historical events that hurt/ slowed down the US economy and brought it to a recession: The Early 2000s Recession, The Great Recession, and the COVID Recession. By looking at the daily value of the VIX, its 10-Day, and 30-Day Moving Average, we can determine the threshold at which the indication of entering into a recession/ depression is strongest.

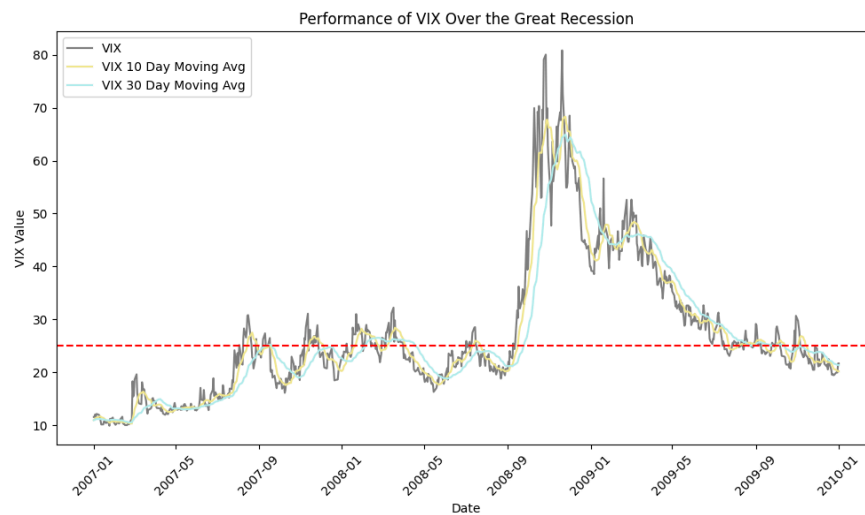


Early 2000s Recession



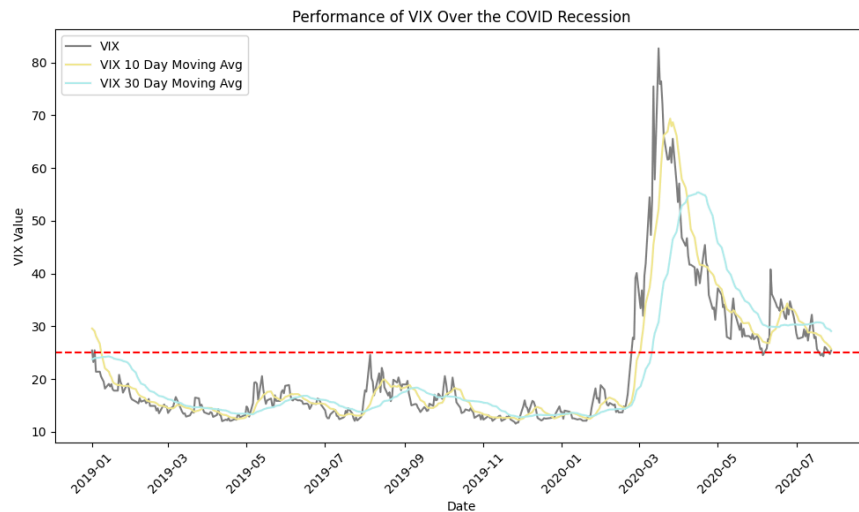
Looking at the above chart, we can observe the changing of the value of the VIX from the end of the year 2000 through the beginning of 2003. The Early 2000s Recession took place from March of 2001 through November of 2001, which is not entirely clear when looking at the VIX chart.

The Great Recession



Looking at the above chart, we can observe the changing of the value of the VIX from the beginning of the year 2007 through the beginning of 2010. The Great Recession took place from December of 2007 through June of 2009, which is far more observable.

The COVID Recession



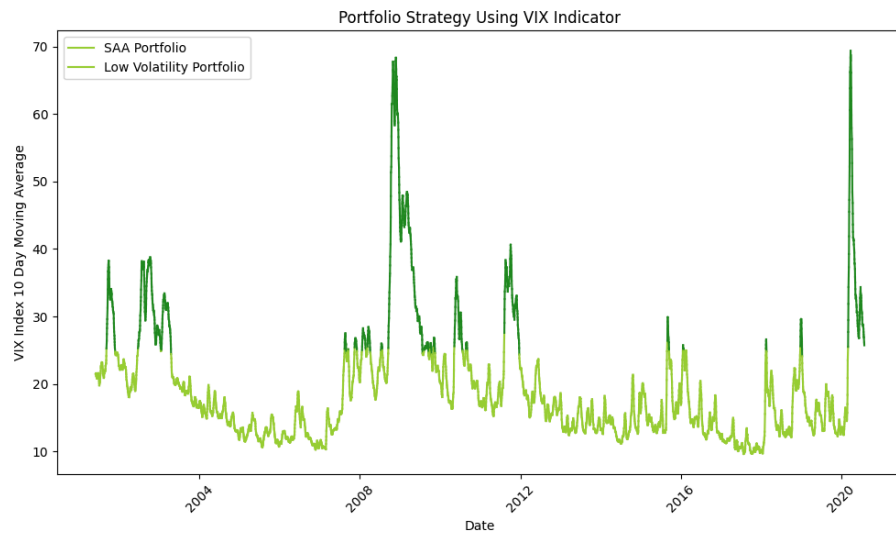
Looking at the above chart, we can observe the changing of the value of the VIX from the beginning of the year 2019 through the end of 2020. The COVID Recession took place from February of 2020 through April of 2020, which is by far the most observable trend out of the 3 recessions considered.

Setting Baseline for VIX as Indicator

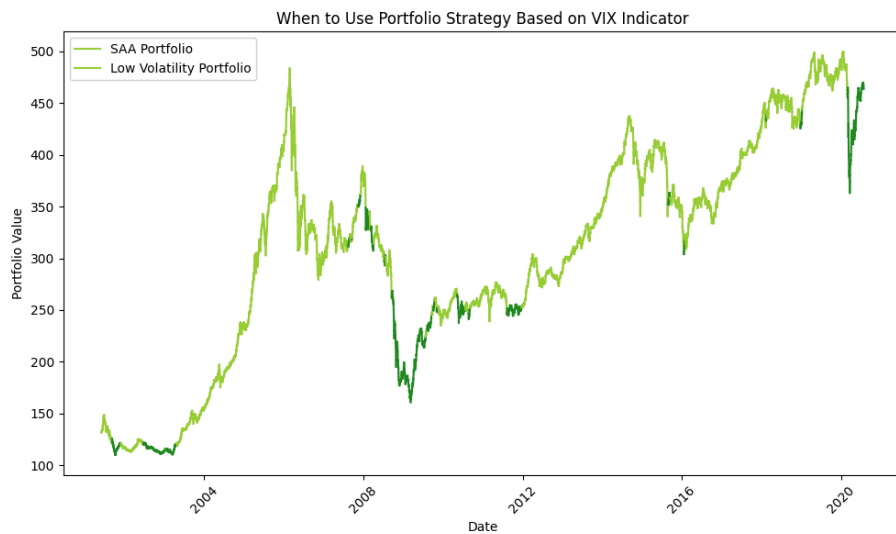
To ensure that our indicator is not triggering at unnecessary points in time, we can set a threshold that aligns with the most prominent spikes in the VIX. The red line in the above graph illustrates this as a threshold of 25 is set. If the VIX is above 25, we believe that the market will experience a downturn, and if below 25, we believe it to be normal.

If we use the above threshold with the VIX, we can see that it would trigger our indicator very often, whereas the moving averages smooth out the spikes. To best capture this while not lagging too far behind our indicator, we will use the 10-Day Moving Average as shown in light blue.

Effect of VIX Indicator on SAA Portfolio



The above chart visualizes when the VIX indicator would trigger overlaid on the VIX performance over the course of 20 years. Looking at the above chart, this threshold using a 10-Day Moving Average is able to capture some of the spikes in the VIX, which would indicate that we should change portfolio strategies.



The above chart now overlays VIX indicator with our SAA Portfolio. As shown in the chart, we are able to avoid some of the areas of drawdown using this VIX indicator, which aligns with some of the recessions considered for the VIX Indicator. It is important to note however that we are not able to “avoid” all of these instances of high drawdowns.

Next Steps

To fine tune this approach of using indicators we should also consider the volatilities in international markets. By using multiple volatility indicators we can shift out portfolio construction/ allocation to adapt to changes/ expected changes in international markets.

The “Low Volatility Portfolio” that I intend to use is the “Ray Dalio All Weather Portfolio” which I can track using the following ETFs:

- VTI (Vanguard Total Stock Market ETF): VTI seeks to track the performance of the CRSP US Total Market Index, providing investors with exposure to the entire U.S. stock market, including large, mid, small, and micro-cap stocks.
- TLT (iShares 20+ Year Treasury Bond ETF): TLT aims to track the investment results of the ICE U.S. Treasury 20+ Year Bond Index, offering investors exposure to long-term U.S. Treasury bonds, typically providing a hedge against economic uncertainty and acting as a safe-haven asset.
- IEI (iShares 3-7 Year Treasury Bond ETF): IEI seeks to track the investment results of the ICE U.S. Treasury 3-7 Year Bond Index, offering investors exposure to intermediate-term U.S. Treasury bonds, providing a balance between yield and interest rate risk.
- DBC (Invesco DB Commodity Index Tracking Fund): DBC tracks the performance of the DBIQ Optimum Yield Diversified Commodity Index Excess Return, offering investors exposure to a diversified basket of commodities, including energy, agriculture, industrial metals, and precious metals.
- GLD (SPDR Gold Shares): GLD aims to track the performance of the price of gold bullion, providing investors with a simple and cost-effective way to invest in physical gold, often used as a hedge against inflation and currency fluctuations.

Appendix

Sources

Bloomberg. (2019). *Bloomberg*. Bloomberg.com.

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Lazy, M. (n.d.). *Ray Dalio All Weather Portfolio: ETF allocation and returns*. Lazy Portfolio ETF.

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Additional Charts

