The idea of what we know today as the VIX first originated sometime in the mid to late 1980s. Two financial economists, Menachem Brenner and Dan Galai, began publishing a series of papers in 1989, proposing the creation of a series of volatility indices; they pushed for the creation of volatility indices on the stock market, fixed income, and foreign exchange rates. Eventually, their ideas became somewhat accepted, leading the Chicago Board Options Exchange(CBOE) to introduce the CBOE Volatility Index(VIX) in 1993. Although initially slow to gain traction, the VIX eventually became the benchmark for stock market volatility. At a general level, the VIX is an index that represents the expected stock market volatility for the S&P 500 and is computed from a strip of options prices. More specifically, the VIX is the square root of the risk-neutral expectation of the S&P 500 variance over the next 30 calendar days and is quoted as an annualized standard deviation. It derives its value from puts and calls that are at or near the money, with maturities between 23 and 37 days until expiration; by aggregating the implied volatility of this strip of options, the VIX's value is determined, representing the market's best estimate of future volatility. This best estimate of future volatility: implied volatility, is derived from the known, observable market price of the option, along with other factors, allowing market participants to back out the implied volatility/expected annualized standard deviation of the underlying asset. Thus, when the price of VIX is high(the average price since 1993 has been roughly 19.75), market participants are willing to pay higher premiums for options; this occurs when the underlying asset is/is expected to be more volatile- the more volatile an asset is, the greater the likelihood that it finishes in the money. The VIX is not a tradable index; the VIX just represents the price of the current basket of S&P 500 options. However, market participants can gain different types of exposure to the VIX through a variety of financial instruments like futures, options, ETPs, and OTC products.

To the average, non-technical market participant, the VIX is very commonly referred to as the "fear index". Popular financial media refers to it as such because, generally, a high or spiking VIX is correlated with sharp down movements in equity markets. But, in reality, it isn't exactly a measure of fear- a large change in VIX just represents a change in investors' expected market volatility. Normally, since equity indices(especially in the U.S.)have a strong tendency to slowly(with low volatility) grind up over time, a change in this status quo normally occurs when some new kind of previously unknown risk is being priced in. This new risk creates more uncertainty/ dispersion around the proper pricing of financial assets, typically leading to risk premium expansion. There is a negative correlation of around -.75 to -.80 between SPY and VIX daily changes.

Over the decades since its creation, as VIX has become an increasingly popular index, and as markets have become more technical and competitive, the concept of volatility as an asset class has evolved into a widely accepted trend. Several different types of "volatility as an asset class" firms have evolved out of this relatively new trend: volatility arbitrage, relative value volatility, and tail risk hedging funds have sprung into existence to collect fees in this area. In today's market, the VIX not only measures implied volatility but also serves as an indicator of liquidity, exerting more complex effects on the market. Currently, something like 80-90% of all transactions in markets are executed by algorithms. Various option strategies, especially the buying of put options, have become extremely relied upon by a significant number of investors and traders. Through the act of buying put options, market participants pay a known premium to mitigate their portfolio losses beyond a desired level. This has many interesting implications; what happens when the typical liquidity providers of put protection stop supplying puts in times of market stress? As markets have become more automated, and as people have become accustomed to using options to hedge risk, the VIX has grown in importance. It's become commonplace to incorporate market volatility/underlying asset volatility into the construction of quantitative portfolios. Every trader of essentially every asset class has VIX either on their screen or incorporated into a model in some way. When the VIX is low, many different types of quantitative strategies leverage up to try and maintain desired amounts of market risk in order to achieve higher levels of returns. This scenario is common during periods of low interest rates and low inflation, driven by the Federal Reserve's accommodative monetary policies.

To test this hypothesis, we built a backtesting algorithm using Python. Our general thesis was that statistically measured, large VIX up moves could serve as a good signal for buying/mean reverting SPY over medium frequencies(1-year hold times). We believe that a 1-year hold time is optimal because it not only avoids short-term capital gains but also closes the position after the signal's predictive ability tapers off. This idea originated from a variety of ways that we think about the behavior of markets during periods of stress. We believe that when equity index volatility reaches extreme levels, a portion of the most recent large move in volatility can be attributed to short volatility market participants liquidating their positions. When there’s a four-sigma volatility event, someone is always forced to inelastically buy to close their positions to meet margin calls, further exacerbating the move in volatility, and creating a reflexive move to even higher levels. Additionally, at these times, the normal providers of this kind of liquidity(mostly market makers) pull their orders, or they greatly widen their spreads- everyone wants to reduce risk at the same time. Simultaneously, as some of the original sellers are forced to cover and as liquidity worsens, fear is high, and market participants start buying portfolio protection/puts after volatility has already exploded higher, at any price, due to behavioral biases. This type of panicky, derisking environment strongly correlates with sharp declines in financial assets. During these periods, as markets move downwards and expected volatility rises, people are forced to continuously deleverage their market exposure. Investors concerned with retirement become worried and they sell, and lots of other types of unsophisticated market participants begin to sell out of fear- these flows come in at the exact time when liquidity in markets is at its lowest, creating dislocations/inefficiencies in asset values. During these periods, risk premiums on most assets widen(at least partially due to non-fundamental reasons), leading to increased future expected returns. This is the exact time that we want to provide liquidity to these types of market dislocations by buying SPY and betting on mean reversion.

To define these types of environments quantitatively, we use the VIX as a signal to go long on SPY. We have attempted to make our backtest as robust as possible; the period under examination begins on 1993-01-29 and concludes on 2023-03-15. Our model considers two parameters when deciding whether or not to generate a signal. The first parameter requires the VIX to close one standard deviation above its average closing price (with an average VIX close of 19.75 and a 1std of 8.21 points, the VIX would have to close roughly above 28 for a signal to be generated). The second parameter necessitates a four standard deviation change in VIX points day over day (on average, the VIX changes by 0.0018 points, with a 1std change of 1.69 points, so our signal is looking for the VIX to have changed roughly 6.76 points day over day). When these two parameters are met, a signal is generated, and the algorithm buys SPY. In our research, interestingly, we found that the initial generation of a signal is followed by very poor risk-adjusted returns for the following 5-10 days. Our implemented two-week lag, on average, is able to avoid this poor stretch of market returns, allowing our trades to be subjected to lower volatility and higher market risk premiums. We believe this trend of poor risk-adjusted returns after a generated VIX signal isn't merely noise in the data: theoretically, it makes sense for markets not to bottom when the VIX is at its highest; VIX is often at its highest when a lot of market participants are blowing out of positions, causing inelastic buying of options, but since VIX and implied volatilities, in general, have a strong tendency to mode revert(it's difficult for market participants to expect an annual standard deviation of 30%+ for long periods of time), VIX tends to come back down to more normal levels while the market continues lower. So because of this rationale and tendency in the data, we decided to implement a two-week lag to our 100% allocation to SPY.

We decided not to do a continuous backtest because we're trying to find evidence that very high VIX levels are predictive of subsequent higher risk-adjusted market returns. This medium-term signal only goes off during rare occurrences of market stress; it wouldn't be something that you base your entire portfolio's allocation on long-term. Since 1993-01-29, under our defined parameters, our algorithm has generated 35 trade signals, 33 of which had positive returns over their 1-year holding periods. The average holding-period return of the 35 generated signals was 25.7%, and the median return was 22.45%. Most importantly, the average sharpe was 0.99; a sharpe of roughly 1.0 on a security as scalable as SPY is relatively rare. The parameters we chose were not optimized using our discretion or with a machine-learning parameter optimization algorithm. The results remain roughly the same when we slightly adjust the parameters. Additionally, we decided to compare our results to randomly simulated 1-year holding period SPY risk-adjusted returns. Simulating 10,000 random buy and then close 1-year later trades between our analyzed period (1993-01-29 to 2023-03-15) resulted in an average sharpe of 0.61, with a 99% confidence interval of (0.58-0.63). These simulated results are higher than the SPY's realized sharpe of 0.46 over the entire period likely due to the fact that the SPY only has large drawdowns on rare occasions, so most of the randomly-simulated trades occur during non-volatile, medium return periods.

The backtesting algorithm reveals that using large VIX up moves as a signal for buying SPY over medium frequencies (1-year hold times) results in seemingly statistically significant risk-adjusted returns. We believe our backtest captures relatively high equity risk premiums when asset prices are most likely dislocated from their true fundamental value due to forced deleveraging and behavioral biases.