Volatility as an Asset Class

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Abstract

This paper explores how an option trading strategy known as dispersion trading can be used to give investors exposure to volatility in their portfolios to diversify returns. Using a large dataset of at-the-money options from SPDR ETFs, we identify a systematic way to identify dispersion trading opportunities. We show that a systematic dispersion trading method can be modeled into an ETF to give various investors exposure to volatility as an asset class. The natural alternative hypothesis argues there are already ETF products giving exposure to volatility; however, dispersion provides a hedged alternative to products linked strictly to rises and drops in the VIX which can cause severe volatility for investors during times of distress. Our paper provides new insights on how volatility can be used as an asset class in portfolios without having the risk of extreme movements in the VIX and VIX-linked products.

1 Introduction

Modern portfolio theory (MPT) as introduced by Markowitz (1952) [6] has shaped the way investors construct portfolios for the better part of a century. By illustrating the benefits of diversification, MPT has helped investors find assets of varying correlations to include in their portfolios to reach a target risk-return profile. While MPT performs well during normal market environments, during periods of uncertainty, correlations trend towards one for most assets. The diversification benefits MPT offers during normal market environments tends to evaporate when uncertainty and volatility increases (Loretan 2000) [5]. Assets linked directly to volatility such as the VIX and VIX-linked products can solve some of the shortcomings of MPT; however, many volatility products can suffer extreme movements during and after times of uncertainty. This paper offers an alternative solution to invest in volatility to solve the shortcomings of both MPT and investing in products directly linked to volatility. Ultimately, we will see how dispersion trading can be used to help generate uncorrelated returns and increase diversification for an investor's portfolio.

Dispersion trading is designed to capitalize on the overpricing/under-pricing of index options relative to the constituent options that make up the index. Option pricing theory identifies inputs into the Black-Scholes model (Black and Scholes (1973))[7] as the current spot price, strike price, time to expiration, volatility, and interest rate. All the variables of the Black-Scholes model are observable in the market except for volatility. As a result, option prices imply a volatility for the underlying asset. The volatility value that is derived is known as implied volatility (IV) which is the market's forecast of an asset's volatility in the future. Since volatility is the only unknown variable in option pricing, options can be a proxy for pricing volatility.

We generalize volatility trading into two main categories. First, there is volatility product trading that involves trading products directly linked to volatility. For example, trading any products that are linked to the VIX or volatility/variance swaps. The VIX is the Chicago Board Option Exchange's (CBOE) Volatility Index that tracks the stock market's expectation of volatility based on SP 500 index options. Volatility and variance swaps are forward contracts with a payoff based on the realized volatility or variance of an underlying asset. Second, there is option trading that uses options to indirectly trade volatility because of the pricing of implied volatility. This paper will be focused on the second category of volatility trading by using options to trade volatility.

To implement dispersion trades, we will be using 1-month at-the-money (ATM) straddles. In the option market, ATM means an option with a strike approximately equivalent to the underlying asset's current spot price. A straddle is when a trader is long both a call option and a put option with the same expiry and strike prices. Since a straddle is long both a call and a put, the trader is making a bet that the underlying asset will make a large move up or down during the life of the trade. Straddles provide a vehicle to bet on an asset's volatility because traders' profit on large/volatile moves to the upside or downside. When executing a dispersion trade, a trader will either be short straddles on the index and long straddles on the constituents or long straddles on the index and short straddles on the constituents.

Dispersion strategies are mostly designed to be delta neutral. This means the dispersion portfolio does not have exposure to underlying asset movements to the upside or downside, but rather only exposure to how volatile the movements are. By maintaining delta neutrality throughout the trade, dispersion trading gives investors more pure exposure to volatility. Despite providing exposure to volatility, dispersion trades differ from the VIX or other volatility linked products because dispersion requires traders to be simultaneously long volatility and short volatility. By making a long volatility and short volatility bet, dispersion trading is much more protected from price blowups like the VIX index experienced in February 2018, December 2018, and March 2020. The protection dispersion trading offers makes the strategy suitable for an ETF.

We plan to build upon the research done in the past on the topics of dispersion trading and volatility as an asset class. First, our dispersion trading models build on Deng (2008)[3] and Allen (2005)[1] by incorporating Deng's naïve dispersion model as well as more complex models that consider implied correlation and using Allen's methodologies to weight dispersion trades. Next, we expand on Goldman Sachs' research (Grant 2007)[4] and Allianz's (Brunner 2015)[2] index that incorporate volatility as an asset class to build our own ETF that uses dispersion to model volatility. Section 2 discusses previous literature and how our topic relates, section 3 discusses our data and implementation strategies, section 4 shows how the strategy can be implemented into an ETF, section 5 offers the main results, and section 6 concludes the paper.

2 Literature Review

Deng (2008)[3] attempts to explain the source of dispersion trading profits by testing dispersion strategies before and after structural changes occurred in the option market around 2000. While the results are mixed, Deng shows that dispersion strategies are highly dependent on the implied vs realized volatility and correlation relationships between index options and constituent options. By starting with a naïve dispersion trading model (explained further in section 3.1) and building on the model by including hedging and correlation analysis, Deng shows how dispersion trading can be dependent on both the opportunities present in the market, and type of execution strategy. Deng's research provided a framework to build a systematic dispersion trading model.

Allen (2005)[1] provides further research that supports Deng's analysis of the importance of implied vs realized volatility and correlation relationships between index options and constituent options in dispersion trading; however, Allen expands on the implementation strategy. Allen focuses on the weighting of dispersion trades and how different weightings can change the structure of the trade. By using a correlation-weighted dispersion trade, a trader will weight the dispersion trade vega-neutral at the start to isolate the implied correlation relationship between the index options and its constituent options. While implied volatilities will still have an impact on the results of the trade due to the positive relationship between correlation and volatility, the initial vega-neutral weighting enables correlation changes between the index and its constituents to drive more of the trading profits. Allen's work gave us a basis to expand on Deng's initial implementation models to explore further how the weighting of a dispersion trade can impact the overall trade results.

Moving past dispersion trading implementation, the main goal of this paper is to use the results of dispersion trading models to build an ETF to increase diversification in investor portfolios. Grant (2007)[4] explains how equity index volatility meets the definition of an asset class because of the non-trivial returns and diversification benefits index volatility offers. To test the performance of including equity index volatility in a portfolio, Grant shows the impact on portfolios when a short index volatility strategy is introduced to standard equity and bond portfolios. The strategy involves going short index volatility via variance swaps and allocating a percentage of a portfolio to the short volatility strategy. Ultimately, Grant concludes that portfolios with a non-trivial allocation to the short volatility strategy outperform similar portfolios without the volatility strategy on a risk and returns basis.

Brunner (2015)[2] expands on Grant's work by showing the construction of Allianz's Variance Risk Premium-Index (VPT-Index). Brunner and Grant both explain the benefits of using volatility as an asset class in a portfolio through short volatility trading strategies. Allianz's VPT-Index tracks the performance of a short volatility strategy. The VPT-Index offers a framework to build a volatility trading strategy ETF from.

We will further Brunner and Grant's work by building an ETF (further explanation section 4) that tracks dispersion trading. While the VPT-Index was a successful implementation of tracking a volatility trading strategy, there are downsides to a short-only volatility trading strategy. Since volatility tends to go through long periods of little activity followed by dramatic spikes, being either only long volatility or only short volatility leaves investors without protection to volatility's unpredictable moves. Dispersion trading is by design short volatility and long volatility offering investors protection to volatility's unpredictable nature.

3 Data and Model

To implement the dispersion trades using straddles, we collected historical call and put options for both the SPY ETF and select SPDR ETF sector tickers. The sector ETFs we chose were XLK, XLV, XLF, XLY, and XLI which represent the technology, healthcare, financial, consumer discretionary, and industrial sectors of the SP 500. We chose the subset of 5 sectors of the SP 500 because the options on those 5 ETFs were more liquid and popular than the rest of the sectors leading to more accurate option pricing. To collect the data, Bloomberg's Excel Add-In was leveraged to create large spreadsheets of historical option data. Similar to Deng, we chose 1-month ATM strikes for the puts and calls of the straddles we tested with. Below is a sample of SPY call option data from our dataset.

Table 1: Example of Three Month ATM SPY Call Data from Bloomberg

SPY 3/20/15 C205		**SPY 4/17/15 C201**	
Date	**Price**	**Date**	**Price**
1/2/2015	5.72	2/2/2015	6.53
1/5/2015	4.15	2/3/2015	7.77
1/6/2015	3.45	2/4/2015	7.25
1/7/2015	4.31	2/5/2015	8.70
1/8/2015	5.84	2/6/2015	8.39
1/9/2015	4.85	2/9/2015	7.76

For any missing data/jumps in the option prices, we interpolated option prices by using the Black-Scholes formula where the IV input was the average IV of the previous options for the ticker's given expiration and strike. While we recognize the interpolation does not provide perfect accuracy, the estimation is close to market traded prices and only impacts the path of the strategy not the final profit and loss. Implied volatility of the options was calculated using the secant method. Since the secant method finds the roots of any given function, we used Black-Scholes as our function and the current market prices of the options as our inputs.

3.1 Naive Dispersion Strategy

Building on the naïve dispersion strategy introduced by Deng, we developed our own naïve model as a baseline for dispersion trades. Starting from January 2015 (can change to earlier) to October 2020, we create a portfolio of long and short near 1-month ATM straddles. Since the most popular dispersion trade is one that is short index option straddles and long constituent straddles, our naïve model is short SPY 1-month ATM straddles and long the sector ETF 1-month ATM straddles each month. The popularity of the short index straddles, long constituent straddles dispersion trade is due to the relative overpricing of index volatility relative to constituent volatility as noted by Bollen and Whaley (2004)[8]. The overpricing is explained by a variety of factors such as investors willing to pay higher premiums for protections on indices rather than individual sectors or stocks.

The trading day after the expiration of the 1-month ATM options, our naïve strategy creates a new portfolio of straddles with the next month ATM options. During the month leading up to expiration, our strategy tracks the value of the portfolio by appropriately weighting the value of each of the straddles in the portfolio. Our portfolio uses SPY ETF options as a proxy for SP 500 index options and the SP 500 sector ETF options XLK, XLV, XLF, XLY, and XLI as a proxy for constituent options that make up the SP 500. As mentioned in our data overview, the subset of sector ETFs were selected because they are the 5 most popular and liquid SP 500 sector ETFs. Thus, every month the naïve strategy will go short 1-month ATM SPY straddles and long 1-month ATM sector ETF straddles. Since dispersion is a bet on the relative overpricing/underpricing of implied volatilities, we consider the variance of an index formula

$$\sigma_I^2 = \sum_{i=1}^N \omega_i^2 \cdot \sigma_i^2 + 2 \cdot \sum_{i=1}^N \sum_{j>1} \omega_i \cdot \omega_j \cdot \sigma_i \cdot \sigma_j \cdot p_{ij} \quad (1)$$

where σ_I^2 is the index variance, ω_i for i = 1,2,...,N is the weights for sector i, σ_i^2 is the individual stock variance, and p_{ij} is the pairwise correlation between the returns of sector i and sector j. From the equation, we see by having sector volatilities and the weights of the sectors, we can solve for index volatility. Using this methodology, we can weight our naive dispersion trades accordingly.

To implement naive dispersion trades, we go short the SPY ETF straddle and long each sector ETF straddle weighted by their individual sector weight. As a result, the sum of the weights in the dispersion portfolios is 0. For each month, our strategy tracks the weighted performance of the dispersion portfolio.

From equation 1, we can solve for a measure of average correlation when we know the implied volatilities of all the sectors and the index. The implied average correlation, or the average correlation implied from option prices ($\bar{p}$), is

$$\bar{p} = \frac{\sigma_I^2 - \sum_{i=1}^N \omega_i^2 \cdot \sigma_i^2}{2 \cdot \sum_{i=1}^N \sum_{j>1} \omega_i \cdot \omega_j \cdot \sigma_i \cdot \sigma_j} \quad (2)$$

Since the naive dispersion strategy is short index volatility and long sector volatility, profits are made when the realized volatility of the index is low and realized volatilities of the sectors are high. When realized index volatility is low and realized sector volatilities are high, realized average correlation will be lower than implied average correlation. As Deng emphasizes, a main source of risk dispersion strategies are exposed to is the variation of correlation between individual component sectors. In the more advanced dispersion implementations in the following sections, the implied and realized correlation relationship is the main driver for execution.

3.2 Other Dispersion Strategies

This is where we will discuss the implementation of our more advanced strategies. Will be filled later on

4 ETF Implementation

In order to make dispersion trading more accessible to all investors, we would like to create an open-end ETF. An open-ended ETF allows the creator to issue an unlimited amount of shares, and they function as a redeemable security (RBS 2010). The open-ended ETF has greater flexibility compared to traditional equity ETFs because open-ended ETFs allow active management, reinvesting dividends and investing in derivatives (SEC 2019). The ETF share price is based on the underlying Net Asset Value (NAV) divided by the total outstanding shares. For example, in our dispersion strategy, we would need to account for cash, as well as long and short positions to determine what the underlying asset pool is worth.

There is further regulation on ETFs that hold derivatives. Due to how quickly the underlying assets may change, we need to report all the underlying assets daily, this would include the notional value, number of contracts and type of derivative for each derivative in our holdings. Interestingly, the ETFs are not required to publish daily holdings on EDGAR, instead they are encouraged to have them on their own website. This is easier and costs less to do. ETFs also need to create an investment prospectus, which describes the investment objective and price that their shares will sell at initially, this value must be based on the NAV per the SEC (2019).

ETFs also need a benchmark or index to track, in our case, we will base our ETF on our dispersion trading strategy. This is another advantage of an open-ended fund. The first iteration of our ETF can be solely based on Dispersion Trading, where we aim for beta neutral returns. As we begin backtesting, we will monitor the NAV of our holdings over the time period, and ensure that we have data on the assets we buy and sell, along with cash balances.

We could also explore a leveraged ETF with hopes to double or triple the gains or losses within a certain period, however, the focus for now is to get the main ETF completed first and analyze the outcome of our backtested trading strategies.

5 Results

This is where we will discuss our results.

6 Conclusion

Where the conclusion will go.

References

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